The Distribution and Circulation of the *denarius* in the Second Century *AD*

Matthew James Ball

Lincoln College, University of Oxford

Submitted in fulfilment of the requirements of the degree of Doctor of Philosophy in Ancient History

Michaelmas 2026

103,161 words
(Including footnotes and appendix)

Contents

Acknowledgements ... *i*
Abstract ... *ii*
List of Figures ... *iii*

Introduction

1: The aims of this study ... **1**
2: The structure of this study ... 3
3: Second-century numismatics: an overview ... 5
4: The data used by this study
4.*i*. Why hoards? ... 12
4.*ii*. Data collection ... 16
5: Dividing the empire ... 21
6: Analysing the data
6.*i*. Preparing the data for analysis ... 27
6.*ii*. Dividing the data ... 29
6.*iii*. Chi-squared (χ^2) ... 31

Chapter 1: Trajan ... **38**
i. Results of χ^2 tests at the level of the issue ... 39
ii. Distribution at the level of the issue ... 49
iii. Results of χ^2 tests at the level of the design ... 57
iv. Summary ... 70
Chapter 2: Hadrian ... **75**
i. Results of χ^2 tests at the level of the issue ... 76
ii. Distribution at the level of the issue ... 87
iii. Results of χ^2 tests at the level of the design ... 94
iv. Summary ... 114
Chapter 3: Antoninus Pius ... **117**
i. Results of χ^2 tests at the level of the issue ... 120
ii. Distribution at the level of the issue ... 138
iii. Results of χ^2 tests at the level of the design ... 144
iv. Summary ... 164
Chapter 4: Marcus Aurelius and Lucius Verus ... **166**
i. Results of χ^2 tests at the level of the issue ... 172
ii. Distribution at the level of the issue ... 198
iii. Results of χ^2 tests at the level of the design ... 205
iv. Summary ... 215
Chapter 5: Commodus ... **219**
i. The data: problems; results of limited χ^2 tests at the level of the issue ... 220
ii. Where are the coins? ... 227
iii. The size of the coinage ... 233
iv. Why so small? ... 246
v. Summary ... 258

Chapter 6: Discussion **262**
i. Audience targeting 264
ii. Coin supply 272
iii. Circulation 279

Bibliography **293**

Appendix: Hoards used by this study **308**

Annexes
1: **Trajan**
Results of design-level χ^2 tests on *denarii* from hoards closing up to *c.* 250 320
2: Hadrian
2.1: Results of design-level χ^2 tests on *denarii* from hoards closing up to 180 326
2.2: Results of design-level χ^2 tests on *denarii* from hoards closing up to 192 331
2.3: Results of design-level χ^2 tests on *denarii* from hoards closing up to 211 336
2.4: Results of design-level χ^2 tests on *denarii* from hoards closing up to *c.* 250 341
3: Antoninus Pius
3.1: Results of design-level χ^2 tests on *denarii* from hoards closing up to 180 347
3.2: Results of design-level χ^2 tests on *denarii* from hoards closing up to 192 354
3.3: Results of design-level χ^2 tests on *denarii* from hoards closing up to 211 361
3.4: Results of design-level χ^2 tests on *denarii* from hoards closing up to *c.* 250 370
4: Marcus Aurelius and Lucius Verus
4.1: Results of design-level χ^2 tests on *denarii* from hoards closing up to 180 380
4.2: Results of design-level χ^2 tests on *denarii* from hoards closing up to 192 385
4.3: Results of design-level χ^2 tests on *denarii* from hoards closing up to 211 392
4.4: Results of design-level χ^2 tests on *denarii* from hoards closing up to *c.* 250 399
5: **Commodus**
Proportions (%) at which *denarii* struck under Antoninus, Aurelius and Commodus occur in hoards closing *c.* 180-260 408

Acknowledgements

This project was made possible by a generous grant from the Leverhulme Doctoral Centre's *Publication Beyond Print* initiative, which aimed to support research into the dissemination of ideas and visual media in formats other than the printed word. I am indebted to my supervisor, Professor Christopher Howgego, whose patient guidance and support during the preparation of this thesis were invaluable; his perspectives on the evidence I laid before him added a dimension to my research that would otherwise be absent. I hope that the text below serves as a demonstration of Chris's ambition that the abundant data gathered by the Coin Hoards of the Roman Empire (CHRE) project should not be an end in itself, but a springboard for new and interesting angles of research. I would also like to extend thanks to my examiners, Professors Andrew Wilson and Fleur Kemmers, for their guidance. At the British Museum, I am thankful to my colleagues in the Department of Money and Medals, particularly to Dr Andrew Brown, Dr Eleanor Ghey, and Richard Abdy, who provided much friendly advice and support was when I was trying to balance my studies and the challenges of a new, full-time curatorial position. Last, but by no means least, I dedicate this thesis to two people: first, to my late grandfather, Frank Holt (1929-2022), who sparked a lifelong interest in Roman coinage when he sellotaped a radiate of Victorinus from his own collection into my birthday card in 2005. Second, to my partner, Liam, without whom I would not have been able to see this through to completion.

Abstract

This thesis examines the interregional distribution of newly struck *denarii* during the second century (corresponding with the reigns of Trajan, Hadrian, Antoninus Pius, Marcus Aurelius, and Commodus) in order to reconstruct patterns of silver coin supply and to build an understanding of the nature and pace of subsequent circulation. Drawing on a dataset of more than 100,000 *denarii* from over 300 hoards extracted from the Coin Hoards of the Roman Empire (CHRE) project database, this study represents the first attempt to systematically analyse the second-century silver both at the level of the issue and the level of the design. This thesis employs the Chi-squared (χ^2) method of testing to compare observed and expected frequencies of *denarius* issues and designs across seven broad regions of the empire. This approach allows statistically significant deviations from 'normal' distribution to be identified while accounting for major disparities in sample size between regions and hoards. Particular attention is paid to whether discrete groups of varying sizes were preferentially distributed in specific regions and, in turn, whether these reflect regular fiscal-administrative activity or deliberate audience targeting by the Roman state.

List of Figures

Introduction

0.1 Fluctuations in the numbers of silver coins found, by date of minting and by region of find (Reproduction of Hopkins 1980, p. 113, fig. 4.

0.2 Relative frequencies per Reece Period of *denarii* in Britain - PAS single finds compared with CHRE hoards. Expressed as a percentage of total number of coins in each dataset

0.3 Map of hoards containing *denarii* of the reigns Trajan-Commodus recorded to the level of the design in this study's dataset. Matthew Ball.

0.4 Map of all hoards containing *denarii* of the reigns Trajan-Commodus on the Coin Hoards of the Roman Empire database. © Coin Hoards of the Roman Empire Project.

0.5 Map of the seven regions under analysis in this study. Matthew Ball.

0.6 *Denarii* of Trajan, *RIC* II 216-223. Top row left-right: © British Museum (1911,0414.72); © British Museum (R.11591); © British Museum (R.11588); Middle row: © American Numismatic Society (1971.4.15); © British Museum (1928,1101.14); Bibliothèque nationale de France (IMP-2740). Bottom row: © British Museum (1867,0101.1648); © British Museum (R.11592).

Chapter 1: Trajan

1.1 Map of hoards containing *denarii* of Trajan in this study's dataset recorded to the level of the design. Matthew Ball.

1.2 Standard deviations at the level of the issue - hoards closing up to *c.* 250.

1.3 Reproduction of Spoerri Butcher and Hellings 2017, p. 68, Figure 3.

1.4 Standard deviations at the level of the issue - hoards closing up to 161.

1.5 Standard deviations at the level of the issue - hoards closing up to 180.

1.6 *Denarius* of Trajan, *RIC* II 336; *MIR* 513v. © American Numismatic Society (1905.57.346).

1.7 Relative frequencies of *denarius* issues of Trajan, expressed as percentage of the total number of coins in each dataset.

1.8 Standard deviations at the level of the design (hoards closing up to *c.* 250).

1.9 *Denarius* of Trajan, *RIC* II 337; *MIR* 520v. © Portable Antiquities Scheme (SWYOR-39F636).

1.10 *Denarius* of Trajan, *RIC* II 190; *MIR* 194. © British Museum (BNK,R.332).

1.11 *Denarius* of Trajan, *RIC* II 28; *MIR* 10a. © American Numismatic Society (1948.19.1135).

Chapter 2: Hadrian

2.1 Map of hoards containing *denarii* of Hadrian in this study's dataset recorded to the level of the design. Matthew Ball.
2.2 *Denarius* of Hadrian, *RIC* II.3 3036. © Münzkabinett Winterthur (R 983).
2.3 *Denarius* of Hadrian, *RIC* II.3 3059. © Kunsthistoriches Museum, Vienna (RÖ 8891).
2.4 *Denarius* of Hadrian, *RIC* II.3 3072. © Kunsthistoriches Museum, Vienna (RÖ 41301).
2.5 Standard deviations at the level of the issue - hoards closing up to c. 250.
2.6 Relative frequencies of *denarius* issues of Hadrian, expressed as percentage of the total number of coins in each dataset.
2.7 Standard deviations at the level of the issue - hoards closing up to 161.
2.8 Standard deviations at the level of the issue - hoards closing up to 180.
2.9 Standard deviations at the level of the issue - hoards closing up to 192.
2.10 Standard deviations at the level of the issue - hoards closing up to 211.
2.11 Standard deviations at the level of the design (hoards closing up to *c.* 250).
2.12 *Denarius* of Hadrian, *RIC* II.3 218. © Portable Antiquities Scheme (SF-AF887A).
2.13 *As* of Hadrian, *RIC* II.3 242. © Portable Antiquities Scheme (PUBLIC-423E46*)*.

Chapter 3: Antoninus Pius

3.1 Map of hoards containing *denarii* of Antoninus Pius in this study's dataset recorded to the level of the design. Matthew Ball.
3.2 *Sestertius* of Antoninus Pius, *RIC* III 742. © British Museum (1872,0709.631).
3.3 *Aureus* of Antoninus Pius, *RIC* III 74b. © Münzkabinett Berlin (1921/1).
3.4 Standard deviations at the level of the issue - hoards closing up to 180.
3.5 Standard deviations at the level of the issue - hoards closing up to 192.
3.6 Standard deviations at the level of the issue - hoards closing up to 211.
3.7 Standard deviations at the level of the issue - hoards closing up to *c*. 250.
3.8 Relative frequencies of *denarius* issues of Antoninus, expressed as percentage of the total number of coins in each dataset.
3.9 Standard deviations at the level of the design - hoards closing up to 180.
3.10 Standard deviations at the level of the design - hoards closing up to 192.
3.11 Standard deviations at the level of the design - hoards closing up to 211.
3.12 Standard deviations at the level of the design - hoards closing up to *c*. 250.
3.13 *Denarius* of Marcus Aurelius as Caesar, *RIC* III 437. © American Numismatic Society (1956.127.744).
3.14 *Denarius* of Marcus Aurelius as Caesar, *RIC* III 458. © Museu de Prehistòria de València (38184; Llíria hoard).
3.15 *Denarius* of Marcus Aurelius as Caesar, *RIC* III 473. © American Numismatic Society (1944.100.49025).
3.16 *Denarius* of Antoninus Pius, *RIC* III 156. © Institut für Numismatik und Geldgeschichte, Vienna (S_01448).

Chapter 4: Marcus Aurelius and Lucius Verus

4.1 Map of hoards containing *denarii* of Marcus Aurelius and Lucius Verus in this study's dataset recorded to the level of the design. Matthew Ball.
4.2 *Denarius* of Faustina II as Augusta, *RIC* III 688. © British Museum (1930,1113.12)
4.3 *Denarius* of Diva Faustina II, *RIC* III 744. © American Numismatic Society (1944.100.49247; Cyprus hoard).
4.4 *Denarius* of Lucilla, *RIC* III 791. © American Numismatic Society (1944.100.49616; Cyprus hoard).
4.5 Relative frequencies of *denarius* issues of Aurelius, expressed as percentage of the total number of coins in each dataset.
4.6 *Sestertius* of Marcus Aurelius, *RIC* III 978. © British Museum (1872,0709.681).
4.7 *Denarius* of Lucius Verus, *RIC* III 566. © American Numismatic Society (1927.999.185).
4.8 *Denarius* of Lucius Verus, *RIC* III 584. © British Museum (1860,0330.185).
4.9 *As* of Lucius Verus, *RIC* III 1448. © Münster University Archaeological Museum (M 2281).
4.10 *Denarius* of Lucilla, *RIC* III 757. © Portable Antiquities Scheme (HAMP-30C271).
4.11 *Denarius* of Lucilla, *RIC* III 786. © Portable Antiquities Scheme (PUBLIC-BB5329).
4.12 *Denarius* of Marcus Aurelius, *RIC* III 192. © Portable Antiquities Scheme (CAM-5B85C3).
4.13 *Denarius* of Marcus Aurelius, *RIC* III 326. © Museu de Prehistòria de València: (39034; Llíria hoard).
4.14 Standard deviations at the level of the issue - hoards closing up to 180.
4.15 Standard deviations at the level of the issue - hoards closing up to 192.
4.16 Standard deviations at the level of the issue - hoards closing up to 211.
4.17 Standard deviations at the level of the issue - hoards closing up to *c.* 250.
4.18 Standard deviations at the level of the coin - hoards closing up to 180.
4.19 Standard deviations at the level of the coin - hoards closing up to 192.
4.20 Standard deviations at the level of the coin - hoards closing up to 211.
4.21 Standard deviations at the level of the coin - hoards closing up to *c.* 250.

Chapter 5: Commodus

5.1 Map of hoards containing *denarii* of Commodus in this study's dataset recorded to the level of the design. Matthew Ball.
5.2 Relative frequencies of denarius issues of Aurelius and Commodus, expressed as percentage of the total number of coins in each dataset.
5.3 *Denarii* of Commodus, *RIC* III 168(a). © Museu de Prehistòria de València (44220 and 44237; Llíria hoard).
5.4 *Denarii* of Commodus, *RIC* III 168(a). © Museu de Prehistòria de València (44225 and 44228; Llíria hoard).
5.5 *Denarii* of Commodus, *RIC* III 266. © Museu de Prehistòria de València (44225); © Portable Antiquities Scheme (SOM-9F66C1).

5.6 *Denarii* of Commodus, *RIC* III 272. © Museu de Prehistòria de València (44842); © Portable Antiquities Scheme (GLO-5A576B).
5.7 *Denarii* of Commodus, *RIC* III 168(a). © Museu de Prehistòria de València (44220); © Portable Antiquities Scheme (WMID-8A8E02).
5.8 *Denarii* of Commodus, *RIC* III 139. © Museu de Prehistòria de València (40917); © Fitzwilliam Museum, Cambridge (CM.RI.1584-R).
5.9 *Denarii* of Commodus, *RIC* III 241. © Museu de Prehistòria de València (44734); © Bonn University (R.29.029).
5.10 *Denarii* of Commodus, *RIC* III 273. © Museu de Prehistòria de València (44842); © Albert-Ludwigs University (02626).
5.11 *Denarii* of Commodus, *RIC* III 26B. © American Numismatic Society (1956.127.1129 and 1956.127.1130; Tell Kalak hoard).
5.12 *Denarii* of Commodus, *RIC* III 139. © American Numismatic Society (1956.127.1180; Tell Kalak hoard); © Museu de Prehistòria de València (40919; Llíria hoard).
5.13 *Denarii* of Commodus, *RIC* III 139. © American Numismatic Society (1956.127.1179; Tell Kalak hoard); © Museu de Prehistòria de València (40923; Llíria hoard).
5.14 *Denarii* of Commodus, *RIC* III 176. © American Numismatic Society (1956.127.1200; Tell Kalak hoard); © Museu de Prehistòria de València (44299; Llíria hoard).
5.15 *Denarii* of Commodus, *RIC* III 241. © American Numismatic Society (1956.127.1222; Tell Kalak hoard); © Museu de Prehistòria de València (44722; Llíria hoard).
5.16 *Denarii* of Commodus, *RIC* III 237. © American Numismatic Society (1956.127.1229; Tell Kalak hoard); © Portable Antiquities Scheme (NMS-F11B22).
5.17 *Denarii* of Commodus, *RIC* III 15B. © American Numismatic Society (1956.127.1123; Tell Kalak hoard, and 1995.11.315).
5.18 *Denarii* of Commodus, *RIC* III 139. © American Numismatic Society (1956.127.1180; Tell Kalak hoard); © Albert-Ludwigs University (02594).
5.19 *Denarii* of Commodus, *RIC* III 237. © American Numismatic Society (1956.127.1229; Tell Kalak hoard); © Museum of Fine Arts, Boston (12.546).
5.20 *Denarii* of Commodus, *RIC* III 36A. © American Numismatic Society (1911.23.359; Larnaca hoard); © Philipps University, Marburg (MR336).
5.21 *Denarii* of Commodus, *RIC* III 12. © British Museum (1843,1024.369); © Portable Antiquities Scheme (NCL-30DA23).
5.22 *Denarii* of Commodus, *RIC* III 122a. © American Numismatic Society (1956.127.1176; Tell Kalak hoard); © British Museum (BNK,R.609).
5.23 Distribution of die links observed on *denarii* of Commodus, expressed as percentage of denarii in die survey.
5.24 *Denarii* of Commodus, *RIC* III 352. © American Numismatic Society (1956.127.1933; Tell Kalak hoard); © Museu de Prehistòria de València (39060; Llíria hoard).
5.25 *Denarii* of Commodus, *RIC* III 417. © Museu de Prehistòria de València (39204; Llíria hoard); © British Museum (2013,4909.101; Selby hoard).
5.26 *Denarii* of Commodus, *RIC* III 424. © American Numismatic Society (1956.127.887; Tell Kalak hoard); © Portable Antiquities Scheme (HAMP-8F18EF).

Chapter 6: Discussion

6.1 *Denarius* of Trajan, *RIC* II 28; *MIR* 10a. © American Numismatic Society (1948.19.1135).
6.2 *Denarius* of Hadrian, *RIC* II.3 218. © Portable Antiquities Scheme (SF-AF887A).
6.3 *Denarius* of Marcus Aurelius as Caesar, *RIC* III 431. © British Museum (R.13238).
6.4 *Denarius* of Antoninus Pius, *RIC* III 156. © Institut für Numismatik und Geldgeschichte, Vienna (S_01448).
6.5 *Denarius* of Lucius Verus, *RIC* III 566. © American Numismatic Society (1927.999.185).
6.6 Relative frequencies of *denarius* issues *c*. 98-192, expressed as percentage of the total number of coins in each dataset (with *denarii* of 141-161).
6.7 Relative frequencies of *denarius* issues *c*. 98-192, expressed as percentage of the total number of coins in each dataset (without *denarii* of 141-161).

Introduction

1. The aims of this study

The purpose of this study is to identify broad interregional differences in the distribution of a large dataset of hoarded Roman *denarii* drawn from the Coin Hoards of the Roman Empire (CHRE) project database and, further, to ask whether these differences are indicative of where newly struck *denarii* were released into circulation into antiquity.[1] Analysis will focus first on the spatial distribution of coins at the level of the issue (*i.e.,* by year, or episode, of striking), and then at the much finer level of the individual coin design. It is hoped that this two-pronged approach will enable us to gain an understanding of a) where, when, and why the Roman state was sending large quantities of newly struck *denarii* on an almost year-by-year basis, and b) the extent to which discrete batches of coins were hived off from these larger production runs for dispatch to different locations around the empire for various fiscal reasons. Given what we know of the way in which *aes* denominations were occasionally released into circulation, it is reasonable to ask whether discrete groups of new *denarii* were also dispatched on the basis of their reverse designs – either because this was a convenient way of organising shipments, or because the state believed the subject-matter bore some relevance to coin-using audiences on the receiving end.[2]

The period under analysis broadly correlates with the second century, beginning with the accession of Trajan in 98 and ending with the assassination of Commodus in 192. Here we have a clear run of reigns, corresponding with the height of the empire's power and wealth, that have not yet been subjected to broad, interregional distributional analyses on the basis of the coin type such as those that have already been carried out by scholars such as Kemmers

[1] The CHRE database is a constantly expanding repository of coin hoards of the Roman imperial period that, at the time of writing (October 2025), lists 17,108 hoards containing more than 7,000,000 coins: https://chre.ashmus.ox.ac.uk/.

[2] See, *e.g.*, Walker 1988; Hobley 1998; Hekster 2003; Kemmers 2003, 2005, 2014; Marzano 2009; Elkins 2011.

(2003, 2005, 2006 2009a-c, 2014) on the reigns of the first and early third centuries. It is logical, therefore, that we should try to 'bridge the gap' by focusing on the second century – a task more possible than ever owing to the great quantity of easily obtainable data now available to the researcher on the CHRE database.

The decision to focus on *denarii* alone was informed by several factors. The first is that we are already fairly certain that *aes* coins (the *sestertius*, *dupondius*, and *as*), once dispatched from Rome to the provinces, circulated in ways that were highly regionalised owing to their lower mobility (Kemmers, *op. cit.*). We are also aware that they were occasionally distributed on the basis of their reverse designs – *e.g.,* the *BRITANNIA aes* of Hadrian and Antoninus, which Walker's (1988) analysis of the coins from the Sacred Spring in Bath (1988) showed were sent to Britain. The second is more particular to this study: for reasons historic to the CHRE project, the best-represented of all the Roman denominations for the period from *c.* 27 BC to *c.* 250 is the silver *denarius*.[3] In this respect, then, the focus of this study was dictated by the availability of data on the CHRE database, but this is hardly a bad thing: our understanding of the way in which newly struck *denarii* were distributed and (particularly) the nature of their circulation is rather less settled than similar questions in respect of the *aes* denominations. This study aims to go some way to addressing these questions.

[3] This is especially true of hoards recorded to the level of the design. Data collection in the CHRE project's early phase relied heavily upon the work of collaborators willing to donate their own pre-assembled hoard datasets for upload to the project database, *e.g.,* the collection of 167 *denarius* hoards donated by Bill Metcalf in 2014. The ultimate aim of the CHRE is to collect data on all hoards deposited within and without the territory of the Roman empire over the whole imperial period, *c.* 27 BC-*AD* 518, regardless of denomination or metal. The project is currently in its second phase, which will see a particular emphasis placed on boosting the quantity of design-level data available on its database. For more, see: https://chre.ashmus.ox.ac.uk/content/about.

2. The structure of this study

***i.* Chapters 1-4** will focus on the reigns of the second century, beginning with Trajan (**Chapter 1**) and ending with the reign of Marcus Aurelius (**Chapter 4**). A dataset of hoarded *denarii* for each reign will be subjected to Chi-squared (χ^2) tests in order to gauge the extent to which regional variations exist in the distribution of *denarii* by issue period (*i.e.*, date of creation) and reverse design (for a description of the statistical method underpinning the tests, see section 6.*iii*, below). In so doing, these chapters will mark the first, high-level interregional distributional analyses for the silver coinages of these reigns.

Regional concentrations of entire issues or particular reverse designs will be discussed with reference to the factors that might have brought them about, *e.g.*, major wars or campaigns that might have caused the state to send substantial quantities of newly struck *denarii* to the region(s) in question. On rare occasions, clear connections can be discerned between the subject-matter of the reverse designs and the regions in which they concentrate. It will be seen, however, that not all regional concentrations at the level of the issue or coin (*i.e.*, of the reverse design) are explicable as the products of known historical events or attempts at audience targeting; many are probably best described as evidence for the 'normal' shipment of new coins from Rome in order to satisfy any number of fiscal and administrative functions of the state, which is just as interesting.

The detection of regional concentrations of any sort not only contributes to our knowledge of how and where the Roman state released newly struck coins into circulation. It will be argued that the very fact that these concentrations remain detectable in hoards closing as late as the first half of the third century means that many *denarii* did not circulate too far from where they were originally released, although the way in which such concentrations generally weaken over time does clearly attest to a degree of subsequent inter-regional circulation. This has an obvious bearing on the mobility of the Roman silver coinage, as well as debates surrounding the integration of the Roman economy as a whole.

ii. **Chapter 5**, on the *denarii* of Commodus, takes a different approach. It was envisioned, at the outset of this project, that this chapter would centre on an exploration of the distribution of the *denarius*, as in the case of the previous four reigns. This turned out to be only half possible: the first section of this chapter will proceed much as **Chapters 1-4**, presenting the results of χ^2 tests carried out on a dataset of hoarded *denarii* in order to expose regional differences in their distribution. These tests were perforce more limited in scope owing to a relative shortage of available *denarii* of Commodus on the CHRE database. Testing to the finer level of the design was completely impossible because the quantities of coins per-design were far too low once divided between the regions and issue periods under survey.

The focus of this chapter is instead an exploration of the reasons why Commodan *denarii* appear to be less common than those of their second-century predecessors, or the Severan emperors that came afterward (although the reasons for the relative abundance of the latter, following the debasement of the *denarius* under Severus, are fairly obvious). This is not a problem unique to the CHRE database, but endemic to virtually all sources of coin data for the reign of Commodus, be they hoards, single finds, assemblages, or museum collections. Examination of a representative dataset of Commodan *denarii* drawn from the Online Coins of the Roman Empire (OCRE) website will reveal a surprisingly high number of die links between hoards and single finds as widely separated as Spain, Britain, and Jordan. These will be used as the basis for discussion on the size of the Commodan silver coinage, and how this relates to ongoing research into the metallurgy of the *denarius* in the second half of the second century.

iii. **Chapter 6** will discuss the evidence presented in **Chapters 1-5**, picking out themes that emerged in the course of analysis and how these might contribute to our understanding of wider research into questions coin supply, state finance, and circulation in the Roman Empire, as well as identifying areas where future research is needed.

3. Second-century numismatics: an overview

The period 98-192 has received a substantial amount of attention from scholars interested in all manner of topics connected to the coinage. A good many works have focussed on the iconographic significance and ideological meaning of everything from single types to entire issues or whole coinages. Moving chronologically through the reigns of the second century, we have: Blamberg (1976) and Roche (2002), who used coins in unison with other art forms to characterise the public image of Trajan and his family; Hekster (2014) on the depiction of Trajan's family members on the coinage, and the particular motivations behind his commemoration of his natural father on *aurei* and *denarii*; Thill's (2014) year-by-year analysis of imperial 'action scenes' on the *aurei* and *aes*; Elkins' (2018) detailed chronological exploration of all designs that show the links between panegyric, elite discourse, state monuments, and coins; Toynbee (1925) on the ideological and iconographic significance of Antoninus Pius' types; Strack's general chronologies and surveys of the various coinages of the period (1931, 1933, 1937); Ameling (1992) on the types of Faustina II and Commodus as Caesar; Beckmann (2012, 2021), ditto, on the types of Faustina I and Faustina II (including a new chronology on the back of extensive die studies carried out on the gold and *aes* denominations); Schachinger (1997) on the depiction of Hadrian's travels on his provincial series; Komnick (2001) on the legitimating role of the various so-called 'restoration' series; Keltanen (2002) on the ideological meaning of the types of imperial women; Beckmann (2017) on the motives behind Marcus Aurelius' 'restoration' of Marc Antony's legionary *denarii*; Börner's (2012) analysis of the iconographic programme of Aurelius' coinage; Kaiser-Raiss (1980) on the various guises and portrayals of Commodus; and Woods (2019) on the unique Fortuna Manens types under the same emperor.

The above are but a sample of the works so far published. Beckmann (2012b, pp. 40-14) and Yarrow (2012, pp. 428-448) give helpful overviews of the notable types employed under Trajan, Hadrian and the Antonines, as does Szaivert (1986) for the reigns of Aurelius, Verus, and Commodus. For all reigns there are, of course, the introductions to the relevant sections of Mattingly's *BMC* III (1936), as well as *RIC* II, Woytek's (2010) landmark rearrangement of Trajan's coinage, Abdy's new *RIC* II.3 (for Hadrian), and – soon – Beckmann's revised *RIC* volume on the reign of Commodus, now in preparation.

Analyses of the shifting array of types applied to the second-century coinage have been carried out by Rowan and Noreña. Rowan's study of the coins of Antoninus Pius and Faustina (2011, 2013) showed that messages were differentiated according to metal: *aurei* generally pushed lofty themes on the imperial family and the emperor's *pietas*, while *denarii* and *aes* mainly communicated his concern for the Roman *annona* and other material benefits of his rule. Analysis of the enormous coinage struck for Diva Faustina I showed how the divine empress played an important part in the shaping of Antoninus' own ideology: reverse types likened her to the goddess Ceres (52% of her posthumous *aurei*; 32% of *denarii*; 24% of *aes*), while the still-living emperor was associated with Annona on coins struck in his name. Although Rowan was interested in pointing to the links between types and real-world events (*e.g.*, the striking of Victoria types after Antoninus' British victory in the 140s, or the concentration of *BRITANNIA* types in Britain), it was not her purpose to examine their physical dispersal around the empire.

Noreña (2001) assembled an inventory of around 140,000 hoarded *denarii* of the first and second centuries. Among these, he identified the eleven most common types depicting imperial virtues. The extent to which one personification was emphasised over another was, he argued, an indicator of the ideological character of a reign. His book on the same subject (2011) sought to chart the changing set of ideals ascribed to the emperor. Noreña charts innovations such as the emergence of Providentia types under Trajan and their prevalence on the coins of the Marcus Aurelius; the first appearance of Liberalitas and Indulgentia as stand-alone personifications on the coins under Hadrian, the high number of Ceres and Annona types on the coinage of Antoninus and Faustina, and Commodus' association with Nobilitas.[4] All these innovations are explained with reference to the portrayal of the emperor in other media. As Noreña points out, the years 98-192 are marked by a notable correspondence between the laudatory language used on both inscriptions and coins.

Other works have focussed on the proper arrangement of the coinages struck between Trajan and Commodus. Allen (2007), Beckmann (2007), and Woytek (2010) have all dealt with the arrangement of Trajan's coins. Woytek and Blet-Lemarquand (2017) used stylistic analysis to attribute the restoration of Augustus' Caius and Lucius *denarii* to Hadrian's reign. Abdy's recent reassessment of Hadrian's coinage in *RIC* II.3 has already been mentioned. Duncan-Jones (2006) took on problems surrounding the dating and size of the coinages struck for various empresses, focusing particularly on Crispina, hoping to establish the relative size of their emissions in relation to those of their male counterparts. Beckmann carried out further work (2009b, 2012a) on the *aurei* and *aes* struck for Diva Faustina I. His die-studies are followed by useful commentaries on what Faustina's commemorative coinage tells us about her place in Antoninus' overall numismatic programme. Beckmann's works are primarily concerned with the establishment of proper sequences, and not what distribution might tell us about the dissemination of imperial ideologies. In 2009a, however, he used an article on the coinage of Trajan to make the interesting argument that the allotment of types to different metals was motivated not by ideology, but by the practicalities of production: types for the *denarii* were simpler because of the prodigious number of dies required, while *aurei* and *aes* were assigned more complex or topical designs because their lower production figures (in the case of gold) and larger flans (*aes*) merited the extra effort.[5]

---

[4] Providentia, pp. 92-99; Liberalitas and Indulgentia, pp. 258-260; Ceres and Annona, pp. 120-122 (also noted by Rowan 2013); Nobilitas, pp. 232, 254.
[5] A theory repeated in 2012a, on the coinage of Diva Faustina I.

Introduction

The metallurgy of the silver coinage was the subject of a major investigation by David Walker (1977), who used x-ray fluorescence (XRF) to identify four key debasements over the course of the second century. Walker's work was innovative for its day; he was aware, for instance, of the need to penetrate the silver-enriched outer layer typical to Roman silver coins in order to gain reliable readings of their alloys, but the XRF method itself was flawed, resulting in data indicating original weights and purities that were both too high and too variable.[6] That said, Walker's general picture of gradual decline in both purity and weight is still broadly correct, if not in finer points of detail. More recent research undertaken by Kevin Butcher and Matthew Ponting (2012, 2014) analysed core samples drilled from the heart metal of *denarii* to arrive at a more secure timeline of debasement and weight reduction. Their work will play an important part in informing the analyses that are to follow, especially with regard to the coinages of Aurelius and Commodus.

The number of works to address regional variations in the distribution of second-century coins directly are relatively few. Wide-ranging studies, like Kemmers' (2009a, 2014) innovative examinations of regional differences in the typological make-up of Flavian *aes* across western Europe, or Elkins' (2017a, 2017b) analysis of the typology and distribution of Nerva's coinage (in all metals), do not presently exist for the second century. Those that do are narrower in focus, dealing with specific types or designs: Todd (1966) and Walker (1988) both looked at the proliferation in Britain of the *BRITANNIA aes* of Hadrian and Antoninus, although the question of whether they were shipped to the province from Rome or struck on imported dies has not been settled. Walker (*ibid.*) further claimed to have spotted several other types amongst the Bath deposit that were transported to or manufactured in Britain, including types of Hadrian, Aurelius Caesar, Diva Faustina I, and Faustina II (*cf.* Hobley 1998, whose

6 Butcher and Ponting 2009, p. 270.

own analysis of *aes* distribution in the western empire did not find many such patterns).[7] Peter (1996) was one of the earliest scholars to discern patterns in the frequency of *aes* types in different regions of the western empire, though his data are old and in need of reassessment. Marzano (2009) analysed the depiction of Trajanic buildings on *aes* denominations and their distribution across Europe, finding that more utilitarian buildings (*e.g.,* the Circus Maximus and Portus) were depicted on *aes* denominations likelier, in her view, to be used on a more frequent basis by the urban populace, while structures glorifying the emperor in a more general way (*e.g.,* Trajan's Column) were mainly struck on gold and silver which and circulated widely. Elkins (2011, 2015) looked at architecture on Trajanic *aes*, painting a more nuanced picture of their circulation than Marzano. He noted, for instance, that the famous bridge type on *sestertii* appears to have been widely dispersed and not confined to Rome or Italy, although the number of coins upon which he bases his judgment can be rather low. Woytek (2010) noted some types of Trajan that concentrate in the Balkans, such as a series of small *aes* with a wolf and twins reverse that occur almost exclusively on the Lower Danube.[8] Ellithorpe analysed Trajanic *denarii* from Romania, making the provocative argument that types referencing the conquest of Dacia were targeted at both Romans and recently-subjugated Dacians within Dacia itself.[9] Ellithorpe's view is that these types would have resonated in different ways depending on whether the viewer was a Roman or a Dacian (which is, of course, true), but whether it was the mint's intention that its designs be read in different ways by two distinct audiences is completely unknowable, if not unlikely.

Virtually all these studies concern themselves with *aes* denominations rather than the silver *denarii*. Exceptions exist. Ben Hellings (2025) devotes an entire chapter of his wide-

---

[7] Though the 'British association' (to mangle Walker's own phrasing) of these types is not as apparent as it is in the *BRITANNIA* design. Clay (1989, pp. 214-*ff.*), commenting on Walker's findings, makes further valuable observations on the logistics of *aes* supply to Britain in the second century.
[8] Woytek 2010, nos. 599-600.
[9] Ellithorpe 2017a (PhD thesis) and 2017b (proceedings of INC 2015).

ranging study of monetisation in the northwestern provinces of the empire to the role of *denarii* (and other denominations) of the second century. Duncan-Jones also looked at *denarii* struck in the period from Trajan to Commodus in order to highlight empire-wide differences in coin populations, but his work presents case-studies of the distribution of particular issues and designs, rather than the whole coinages.[10] In his 1994 work *Money and Government*, he points to *denarii* struck for Sabina that never appear to have circulated in parts of the east, and to one Trajanic type (*RIC* II 147, depicting a trophy) that, he alleges, is primarily concentrated in northwestern Europe. His purpose here was not to identify instances of audience targeting *via* reverse designs (he fundamentally disagreed with the idea, *per e.g.* Ellithorpe or Kemmers (2014), that the state occasionally targeted messages at coin users), but to make the point that the existence of regional concentrations proves that the *denarius* cannot have been as mobile as some would think (*contra* Hopkins 1980).

Carlos Noreña (2011) also doubted that the mint used coins as vehicles for targeted messaging, but for the opposite reason. The thesis of his book, *Imperial Ideals*, is that the mint took the strategic decision to prioritise the production of a set group of unchanging types, thereby saturating the circulating coinage a permanent set of with images representing a collection of key imperial ideals that would eventually take root in the minds of coin users. He theorises that the mint avoided targeted messaging *via* coin types, especially on the silver, because those messages were bound to lose their meaning almost as soon as the coins entered circulation.[11] This assumes a highly mobile silver coinage that would eventually intermingle to such a degree that any regional distinctions that once existed would be removed. This, in turn, allowed Norena to assume that the relative frequencies at which reverse types occurred in his dataset of coin finds (mainly Balkan, and mainly from the Reka Devnia, a. k. a 'Marcianopolis', hoard) mirrored the quantities in which they were originally produced.

---

[10] Duncan-Jones 1989; 1990, pp. 38-42; 1994, pp. 174-179; 1999; 2005.
[11] Noreña 2011, p. 190.

The truth, as this study hopes to demonstrate, is something in between. Duncan-Jones' analyses took place before the advent of large databases like the CHRE. It may be that the complete absence of types from the regions he surveyed is less an indication of actual distribution, nor less proof of a highly fragmented circulation pool, than of the size of the sample or the way in which it was analysed.[12] This is not to say that the frequency of *denarius* types did not vary from region-to-region, just as it cannot be said that the integration of the coinage is such that, oftentimes, there is no difference to be found in the distribution of *denarii* at the regional level (*cf.* Hopkins, Noreña). Work by Spoerri Butcher and Hellings (2017) has shown that the relative frequencies at which *denarius* issues appear in hoards as widely spaced as northwest Europe and the Balkans are remarkably consistent. Rather, definite regional concentrations do exist, but, unlike certain concentrations on the *aes*, no single *denarius* issue or reverse design has been found to have been completely trapped in one region alone.[13] Walker and Kemmers were able to show that observable concentrations of *aes* types at Bath and on military sites probably indicate regionalized distribution in antiquity, and Creighton (2014) was able to tease out differences in the composition of *denarius* hoards at the level of the issue even within Britain. The following chapters will show that this is possible on an empire-wide scale – not just at the level of the issue but, on occasion, to the level of the design as well. Duncan-Jones thought of reverse designs as little more than control marks for the benefit the mint, and that geographical variations in type populations were of "no regional significance, and no propaganda meaning… shipping a coin whose reverse celebrated, say, Felicitas or Pietas to one region and not another probably meant little in itself."[14] In many

[12] Spoerri Butcher and Hellings 2017, p. 54.
[13] Mixing did occur on a substantial scale: see Howgego 1994, pp. 12-*ff*. Howgego (*ibid.*, 1995b, pp. 108-109), seeking to strike a balance, considered both sides of the Hopkins/Duncan-Jones debate. He noted that Hopkins failed to notice very real variations in the distribution of *denarius* types (British evidence for which is set out by Creighton 2014), and that Duncan-Jones' model was wrong to say that a lack of homogeneity in the coinage is *de facto* proof of a fragmented economy.
[14] 1994, pp. 177-178; 2005, p. 475.

cases, this will be seen to be true: evidence for regionalised distribution – which certainly did occur – cannot automatically equated with targeted distribution according to the reverse type.

4. The data used by this study

4.*i.* Why hoards?

The first and most fundamental question to be addressed must be the decision to focus on hoards. The answer is simple: a study like this would be virtually impossible without recourse to hoards because precious metal coins such as *denarii* are enormously underrepresented in the record of single finds and site assemblages. It should also go without saying that hoards offer the best and most efficient way of assembling a dataset of the size required to perform wide-ranging analyses across the whole expanse of the empire, as is the intention here: in Britain, for instance, something like 85% of all reported *denarii* come from hoards as opposed to single finds or site assemblages.[15] They offer an unrivalled window onto coin production, use, circulation, and deposition, as evidenced by the numerous studies that have placed them at the centre of their research.[16]

Despite their obvious advantages, it is true that hoards come with their own issues. Some may have been selectively compiled (*e.g.* hoards containing pre- or post-reform *denarii* of Nero) or closed with a coin many years later than the rest of the deposit, thereby altering the profile of a hoard that is largely 'early' in character. These are not so much problems as features of this branch of evidence that ought to be taken into account by any study attempting to use it. Nevertheless, several scholars have cast aspersions on the reliability of hoards as indicators of what was actually in circulation. Ellithorpe (2017a), whose own study was not

[15] Bland *et al* 2020, p. 268.

[16] They are far too many list, even in an abbreviated form. See Howgego, Mairat, and Wilson (eds.) 2022 for several enlightening chapters and onward bibliographies on the phenomenon of hoarding across Britain, Europe, and the Near East.

so dissimilar in its aims to this one, chose to focus on single finds alone in adherence to the belief that they better reflect the profile of the circulating coinage by virtue of the fact that most of them must have been chance losses, as opposed to hoards, which *ipso facto* must be the product of intentional selection and rejection.[17] In this, he follows Wigg-Wolf (2009, p. 109) – himself following Collis (1988) – who said that single finds may be "a better reflection of the coins actually in circulation than material from hoards, which are affected by various distortions as a result of selection." Kemmers, too, rejected hoard evidence in favour of single finds from her research into various aspects of coin distribution in northwestern Europe in the first to third centuries on the same grounds (2006, 2009a 2009b, 2009c, 2014).[18]

An alternative perspective – and the one to which this study subscribes – is that hoards better reflect the sorts of coins that could actually be used in a given place. There is no evidence whatsoever to suggest that hoards (at least in the second century) were formed with reference to the typology of their coins, whereas patterns of single finds can be muddied by (*e.g.*) discards, hence, the much higher percentage of plated coins as single finds than in hoards. There is also no doubt that a focus on single and site finds leaves the researcher open to problems of residuality and insecure dating. Hoarded coins are both easier to gather in quantity, since fewer silver and gold coins crop up individually, and easier to date — a crucial consideration for anyone wanting to reconstruct original patterns of distribution.[19] Wigg-Wolf's (*ibid.*) main concern was that site and single finds ought to represent a large and random selection of what was really in circulation; the numerous factors involved in excavation (time, competency of diggers, *etc.*) that govern the recovery of coins make this requirement easier said than done. Coin hoards, being more or less single, contained deposits,

[17] Ellithorpe 2017a, pp. xxvii-xxviii.
[18] Although, in fairness, Kemmers' area of interest – especially in parts of 2009a and 2014 – was the difference between *aes* coin profiles in and around military bases in the first century, for which single finds and site assemblages are best suited in any case.
[19] Howgego 1995, p. 220.

satisfy this requirement: not only can hoards from the period under survey here be said to contain a representative mixture of the range of issues and designs in circulation, but they also offer us the quantity necessary to build up a sizable inventory of coins from a particular region or locality within a reasonable time-frame. This last factor is a more a practical consideration that a theoretical one, but it is no less important.

Another useful counter to the notion that single finds better represent the sorts of types and issues in circulation in each region was put forward by Hopkins who, in his highly influential article *Taxes and Trade* (1980), remarked that the relative frequences *per annum* of first- and second-century *denarii,* both singly found and hoarded, are strikingly similar. His data for single finds of *denarii* in Germany tracks, in its peaks and troughs, the same patterns observed not only in German hoards but also those from Britain, the Gallic provinces, the Balkans, and even the various single finds and hoards from Dura Europos in Syria (see **Figure 0.1**, below).[20]

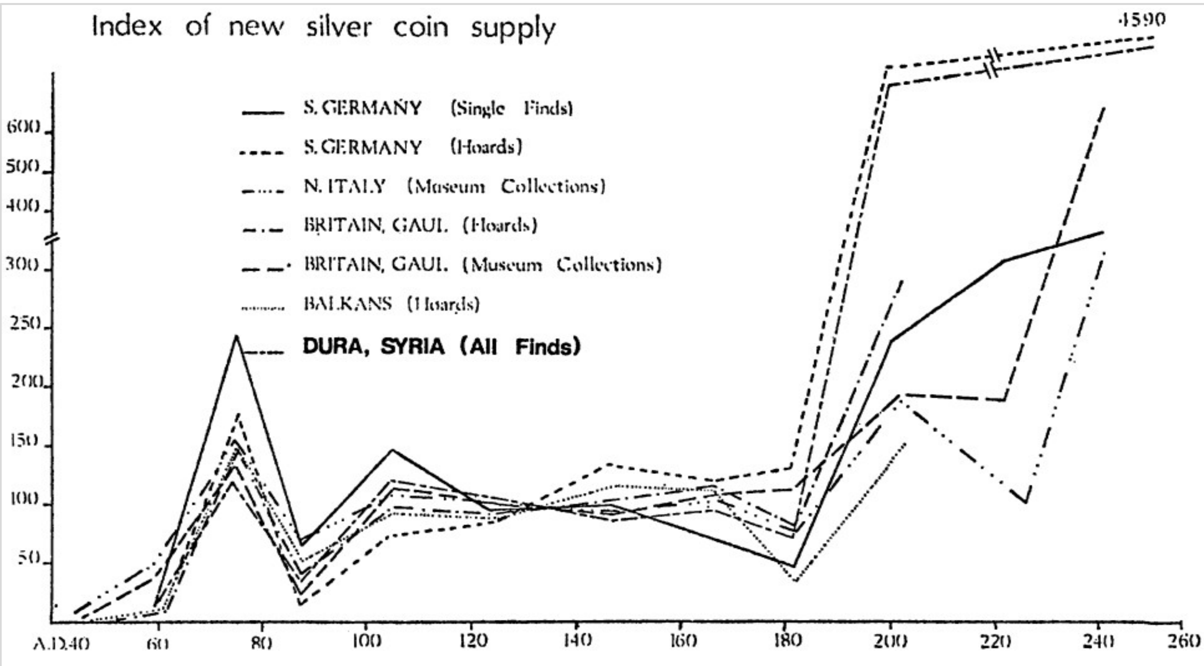

Figure 0.1: Fluctuations in the numbers of silver coins found, by date of minting and by region of find (Reproduction of Hopkins 1980, p. 113, figure 4)

[20] Hopkins 1980, pp. 113-115, comparing German hoards with single finds taken from *FMRD*.

Much the same can be seen in coin find data for England and Wales (**Figure 0.2**), where the relative frequency by Reece Period of singly found *denarii* recorded through the PAS roughly tracks that seen in the hoard record (sourced from CHRE).[21] The actual quantities of single finds to hoarded coins might be different, but in both datasets the proportional relationships between periods are basically the same: as single finds and in hoards, the commonest *denarii* are those of Period 7 (Antoninus), followed, in joint second place, by those of Periods 5 and 6 (Trajan and Hadrian), then Period 8 (Aurelius), and, lastly, Period 9 (Commodus).[22]

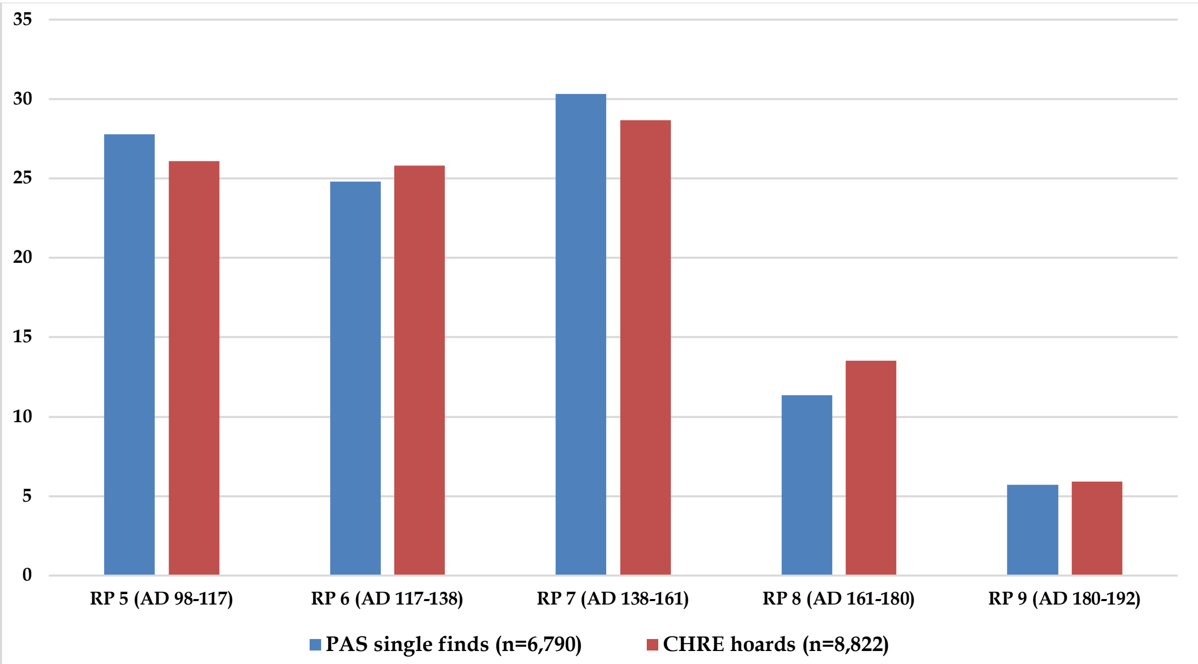

Figure 0.2: relative frequencies per Reece Period of *denarii* in Britain – PAS single finds compared with CHRE hoards. Expressed as a percentage of total number of *denarii* in each dataset

None of this seeks to deny that some hoards were the product of selective processes that caused their composition to diverge in some way from the make-up of the circulating pool of

---

[21] More precise year-by-year frequencies are not possible because this study's CHRE dataset has been cleaned and sorted in ways that prevent like-for-like comparison with the PAS single finds without a great deal of preparatory work. *E.g.*, large numbers of the PAS coins are still dated according to *RIC* II, whereas the CHRE coins have been dated and rearranged after Woytek and Abdy's arrangements in *MIR* 14 (Trajan) and *RIC* II.3 (Hadrian).
[22] This kind of parity between hoards and the single finds profile is not true across time: see Bland *et al* 2020, pp. 264-268 and figures 7.31-7.36 for Gallic radiates in Britain.

coinage. The Llíria hoard, for instance, closes fifteen or so years into the Severan era, but coins of Severus and his family form only a small portion of its contents. A case could therefore be made that Lliria's owners made a deliberate attempt to assemble a hoard largely composed or finer *denarii* pre-dating the debasement of 194. Despite this, the rest of Lliria's contents bear a sound resemblance to the profiles of large hoards containing second-century *denarii* from elsewhere in the empire, with the relative frequences of the coinages of Trajan, Hadrian, Antoninus, Aurelius, and Commodus being the same as in the British single finds in **Figure 0.2**, not to mention the other hoards in our dataset.

4.*ii.* Data collection

The primary source of data for this study was the database of the Coin Hoards of the Roman Empire (CHRE) project.

This research project began life as an investigation into the potential extent of audience targeting on the imperial coinage, with an eventual focus on the second century. Data collection therefore focused on hoards containing coins recorded to the level of the design (*i.e.*, with descriptions of both obverse and reverse types, complete with references to the *Roman Imperial Coinage* and similar works) on the CHRE project database.

Phase one of data collection involved downloading from the CHRE database all hoards with design-level data already recorded. These data were checked and cleaned by the author, who was pleased to return them to the CHRE project for re-upload to the database. In many cases, it was possible to check and refine hoard terminal dates through consultation of original hoard lists. This exercise helped to correct erroneous dates of issue and hoard closure, and also saw the addition of references from newer reference works like Bernhard Woytek's 2010 *MIR* volume on Trajan, and Richard Abdy's *RIC* II.3 (Hadrian), both of which supersede older works in the arrangement and dating of their respective coinages.

The second, much longer phase involved adding design-level data to the far greater number of hoard records on the CHRE database that lacked this information. In many cases, the only information available for these hoards was the number of coins per reign and possible closing dates. Further research by the author sought to determine which of these records might be improved with reference to original hoard reports that could be mined for typological information and catalogue references such as *RIC*, *BMC*, Cohen, *etc.* (as opposed to *e.g.* antiquarian hoards, for which typological data is mostly unobtainable). The resultant coin lists were handed over to CHRE so that the relevant database records could be updated. The reconstruction of hoard lists and cross-checking with original literature, much of it in languages other than English, was a time-consuming and laborious process that took over a year to complete.

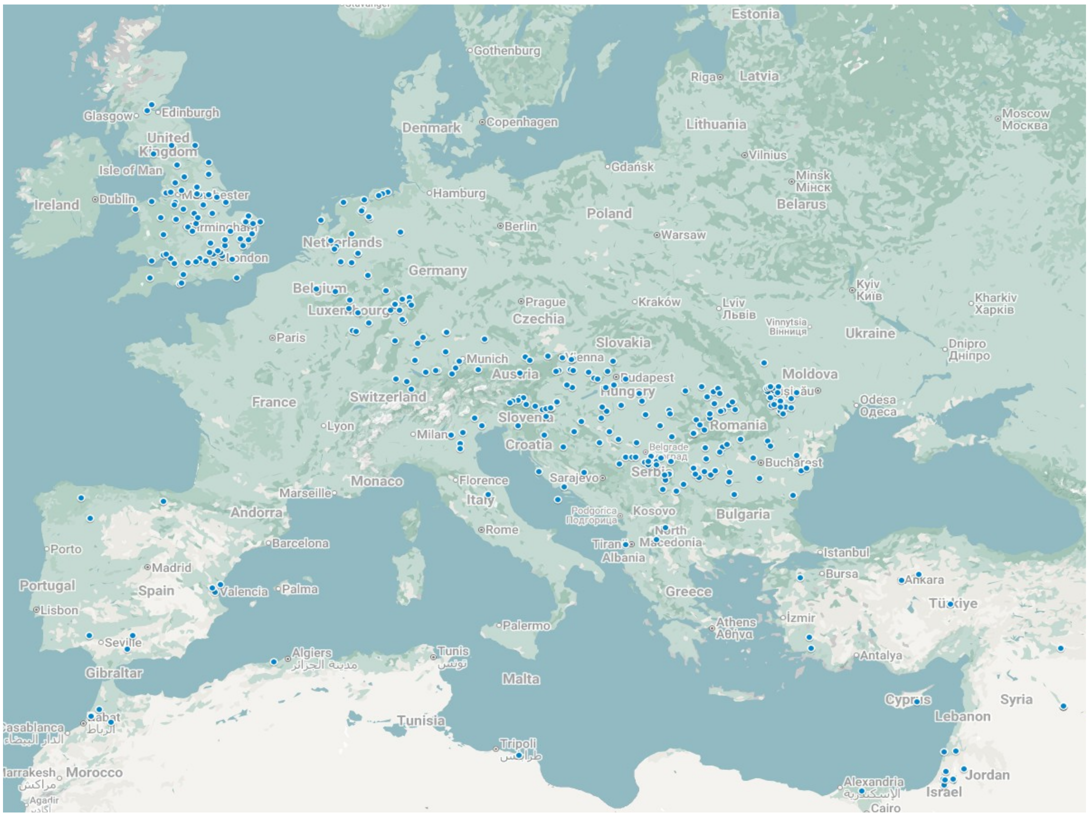

Figure 0.3: hoards containing *denarii* of the reigns Trajan to Commodus recorded to the level of the design on the CHRE database at the time of data collection (n=338). Find an interactive version of this map with links to CHRE records at: https://www.google.com/maps/d/edit?mid=1LRPzKVhmk5axNYHPQngcHzZ-370a8Rs&usp=sharing

In all, this data gathering period yielded 102,027 *denarii* within 338 hoards from across the length and breadth of the empire (see distribution map in **Figure 0.3**); they are listed in the Appendix, ordered by closing date. The complete dataset of hoarded *denarii* assembled for each of the reigns under study here, as well as a digital version of the Appendix, is downloadable from: https://docs.google.com/spreadsheets/d/1c-cReD0ciiDZ2jaOgeW-i86xT0n7uk7K/edit?usp=sharing&ouid=117635636080075228868&rtpof=true&sd=true.

Data collection naturally focused on areas corresponding with former provinces of the empire, as well as certain areas that were never (or were never entirely) formally occupied, but were nevertheless within the empire's sphere of control and influence (*e.g.*, Scotland and parts of the central and eastern European frontiers beyond the Danube). In the main, though, **Figure 0.3** shows that the bulk of the dataset sits along the line of the European *limes*: in Britain and along the line of the Rhine and Danube. This reflects – in a more distilled form, since data collection here focussed on hoards with design-level data alone – the general disposition of all hoards recorded on the CHRE database (compare with **Figure 0.4**, below). Differing standards of recording between countries have resulted in phenomena such as the difference we observe between hoarding in *e.g.* Britain and North Africa.[23] The latter was by far the wealthier part of the empire, but it is in large part because of Britain's superior history of collaboration with metal detectorists, as well as generally higher standards of recording and publication, that it boasts by far the better dataset.[24] Other noticeable gaps in the dataset include hoards from the Gallic provinces, for which plentiful hoard data *does* exist, but not, at the time of collection, in sufficient quantity to the level of the design. Much the same can be said of the provinces to the south of the Balkan Mountains – taking in Thrace, much of Macedonia, Epirus, and Achaea – where design-level data was virtually non-existent. National differences in hoard reporting naturally play a large part in these discrepancies;

[23] Howgego and Wilson 2022, pp. 11-13.
[24] Bland 2020, pp. 123-124.

other factors at play include the degree to which hoard recovery in antiquity might have differed between interior areas and frontier zones, for instance, as well as modern-day differences in the quantity of data entered onto the CHRE database by its various collaborating partners, who are scattered across Europe and the world.[25] **Figure 0.4**, below, shows the spread of all coin hoards containing *denarii* dating to this study's period of interest; note the uneven distribution. Compared with **Figure 0.3**, it can be seen how great a difference existed (at the time of data collection) between the number of coin hoards that were recorded to the level of the design and those that were not, particularly in Gaul. In effect, therefore, this study is closer to an examination of the supply and circulation of *denarii* in the frontier provinces – and, to an extent, in Italy – rather than a general, full-scale distributional survey of the empire as a whole. The frontier regions of the empire had various factors in common, not least of which were the presence of large numbers of salaried soldiers on the one hand, and, on the other, a corresponding need, on the part of the state, to ensure that these individuals and the administrative framework behind them were supplied with coinage. Comparisons of *denarii* found in Britain, the Rhineland, and the Danubian frontier are, therefore, likelier to be more productive than imposing models of coin supply and circulation observable at the militarised frontiers onto the rest of the empire, for which sufficient coin-level data are sorely lacking (see again **Figures 0.3** and **0.4**).

There were, doubtless, mechanisms that enabled administrators in areas away from the frontiers to request and obtain coinage, either from provincial treasuries or even from the centre, but it is reasonable to suppose that the absence of large bodies of soldiers requiring payment and other forms of finance (*e.g.*, at times of war), will have meant that the nature of this supply was fundamentally different. It cannot be assumed that the state took equal care

[25] Bland 2020, pp. 122-127 runs through the long list of data collection biases facing the reporting and publishing of hoards, followed by regional variations in the chronological distribution of hoards on the CHRE database, the differences in which are governed by a mixture of ancient and modern factors.

to supply newly-struck *denarii* to the lesser-militarised interior of Gaul, say, as it did to Britain, nor can it be taken for granted – given compelling evidence for regionalised circulation of *denarii* that will be presented in the following chapters – that *denarii* circulated away from frontier zones and mixed (or did not mix) in a like manner. The lack of sufficient coin-level data for the Gallic interior (for instance) might not only be a function of modern reporting and recording practices, but also of the general availability of *denarii* in these areas (or, of course, both).

Figure 0.4: all hoards containing *denarii* of the reigns Trajan-Commodus (n=2,128) on the CHRE database at the time of data collection (plotted within the CHRE web app)

Finally, it goes without saying that hoards vary wildly in size: the smallest in the dataset sourced from CHRE yielded just one *denarius* of the second century; the largest, Reka Devnia, comprises around 40% of the entire dataset – some 41,316 *denarii* of the reigns from Trajan to Commodus.[26] Solutions to the possible distortions and biases that can arise from comparing smaller hoards with much larger ones are better presented below, in the section outlining the analytical method.

5. Dividing the empire

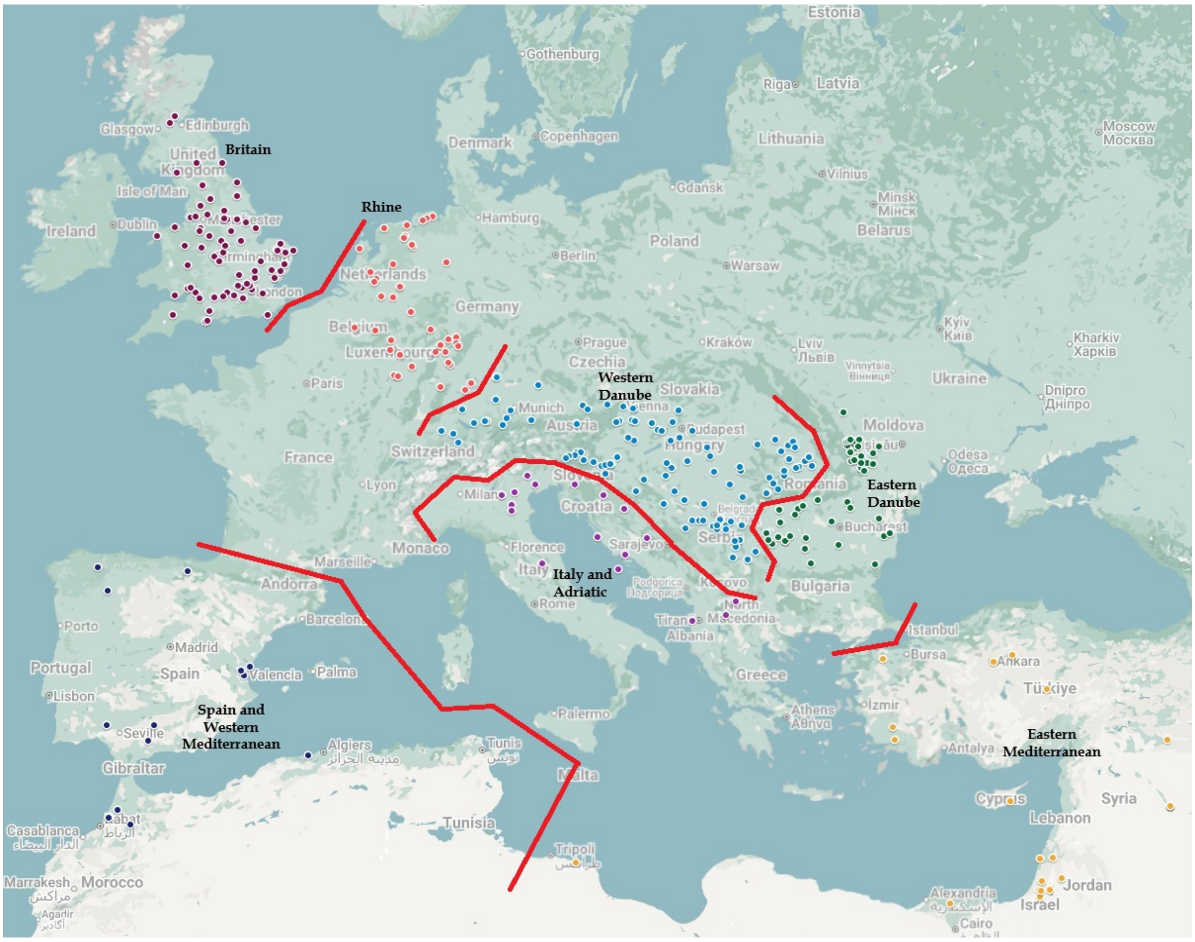

Figure 0.5: the seven regions under analysis. Moving clockwise, from west to east: (**1**) Spain & the Western Mediterranean, (**2**) Britain, (**3**) the Rhine, (**4**) Italy and the Adriatic, (**5**) Western Danube, (**6**) Eastern Danube, (**7**) Eastern Mediterranean

[26] A recent publication (in Bulgarian Cyrillic) suggests that the Reka Devnia hoard – which was found in two large ceramic containers and subsequently divided, initially between the finders and then between two museums in Varna and Sofia - may, in fact, have been two hoards: Lazarenko 2025. On the discovery, see Moushmov 1930 and 1934, and Lazarenko 2014. See also the re-examination and re-publication of the hoard, resolving some issues regarding its contents and composition, published by Metcalf (2002 and 2004).

The aim of this study is to attempt an understanding of how the distribution of the silver coinage differs at a very broad, regional level rather than a more 'zoomed-in' approach that involving site-by-site comparisons. In so doing, its intention is to provide a broad view that complements – and is complemented by – more focussed regional studies such as Hellings (2025) or Kemmers (2006, 2009a on the *aes*) on coin distribution and circulation in the northwestern provinces. To a large extent, the division of the empire into regions suitable for analysis was dictated by the disposition of the data: as section 4.*ii* and **Figure 0.3** lay out, hoards recorded to the level of the design on the CHRE database were, at the time of data collection, mainly concentrated in Britain and the European frontiers with a smaller number being scattered through Spain, along the North African coast, Italy, Turkey, and the Near East. The dataset was divided into seven large regions more or less along these lines, as seen in **Figure 0.5**, above. They are:

1. **Spain and the Western Mediterranean.** Hoards from Hispania Tarraconensis and Hispania Baetica in modern-day Spain have been joined, for analytical purposes, to the handful of available hoards from the North African countries of Morocco and Algeria (Roman Mauretania Tingitana and Mauretania Caesariensis). The most important hoard of this group is Llíria, Valencia (CHRE no. 12824, containing 5,653 *denarii* of the second century), without which the number of coins from this region would be very low indeed.
2. **Britain.** An area essentially correspondent with the boundaries of Roman Britannia, for which there is abundant data owing to a comparatively good history of recording hoards and coin finds, exemplified by the Portable Antiquities Scheme (PAS). The inclusion of hoards from beyond the Wall zone in the north is not necessarily a problem, since virtually all these coins must have crossed over from within the province itself. In any case, there were only two hoards from the area of modern Scotland recorded to design-level at the time of data collection: Briglands (5265) and Falkirk (3072).

3. **Rhine.** Straddling either bank of the river from Gallia Belgica and Germania Inferior in the north to Germania Superior in the south. Hoards cluster in and around the major centres of Frankfurt, Mainz, and Cologne on the central section of the Rhine. Very few hoards recorded to an adequate standard were available further east of the two Germanies (outside the empire) and that portion of Gallia Belgica closest to the frontier. The few hoards recorded to the level of the design from the Gallic interior proper, corresponding with the Cisalpine provinces, Gallia Lugdunensis, Gallia Aquitania, and Gallia Narbonensis, should properly have formed their own group or groups, but were insufficient in number to feature in this analysis.
4. **Italy and the Adriatic.** All Italian data, bar the hoard from Gualdo Tadino (13869), come from the coastal northwest, in the modern Veneto. These are grouped with five further hoards from those parts of Dalmatia and Macedonia (Slovenia, Croatia, Bosnia, and Albania) that are separated from the rest of the Balkan provinces by the high Dinaric mountain range: Postojna (8848), Sveti Petar Mrežnički (3019), Majdaniste (16144), Zadar (3045), Solin (17391), Vis (17396), Bugojno (16146), Skopje (4788), Kičevo (9771), and the major hoard from Durrës (9351; the largest of this group, with 3,156 second-century *denarii*). Many of these are on or near the coast, including port towns and cities that were important in antiquity: Zadar (ancient Zara), Split (Spalatum), Vis (Issa), and Durrës (Dyrrachium). This fact arguably makes these hoards the more natural partner of the Italian hoards than those of the Balkan interior and Danubian frontier, from which they are separated by greater distances as well as the Dinaric mountains.
5. **Western Danube.** As with the Rhine, the data for this group – which contains more hoards than any other – straddles the river frontier from its source near Lake Constance through the provinces of Raetia, Noricum, Pannonia Superior and Pannonia Inferior, northern Dalmatia, across the Hungarian Plain, and into Moesia Superior. This group also takes in

much of Dacia, including a number of hoards around Alba Iulia (Apulum), Cluj (Napoca), and Moigrad (Porolissum).

6. **Eastern Danube.** The hoards of this region are clearly separated from those of the Western Danube by the Carpathian Mountain range, which separates the Hungarian Plain to the west from the corridor of land stretching to the shores of the Black Sea. Around half of the Eastern Danube's hoards sit either side of the River Danube itself, in a region bounded by the Balkan Mountains to the south and the Carpathian Mountains to the north and west. This region corresponds with portions of south-eastern Dacia and virtually all of Moesia Inferior, and can boast of the enormous Reka Devnia hoard (3046), which contains nearly half of all the *denarii* gathered for this study. The other half form a tight cluster in the region of Moldavia (north-eastern Romania and Moldova). This awkward stretch of the frontier zone, bounded by the provinces Dacia to the west and Moesia Inferior, was only temporarily under formal Roman control before its abandonment under Trajan or Hadrian.[27] The majority of this cluster close much later, from the mid-160s all the way up to Maximinus Thrax, *c.* 235. Their deposition has been linked to repeated Sarmatian and Dacian incursions that are said to have begun around the time that the latest of them was closed.[28]
7. **Eastern Mediterranean.** The low number of hoards recorded to the level of the design from this region, which stretches, clockwise, from Turkey, through Syria, the Levant and Egypt, to one outlying hoard in Libya (15419), is regrettably low. The main concentration lies in Israel and Jordan, where recording and publishing are comparatively better, but the overall sparsity of data means that this region features least in the analyses that are to follow. That said, there are important hoards here; the Tell Kalak hoard (5282), for instance, contains 1,762 second-century *denarii.* As will be seen, especially in **Chapter 5**

[27] Bennett 1997, p. 165; Birley 1997, pp. 84-85.
[28] Găzdac 2010, pp. 52-53.

(Commodus), it provides a useful point of comparison with the contents of similarly large hoards at other ends of the empire (*e.g.,* Llíria).

The divisions outlined above and in **Figure 0.5** correspond with the broad regional divisions put forward by the ORBIS project, which theorises communication networks based on the presence of defining natural barriers (seas, mountains), ease of travel and travel times, and the expense associated with road and waterborne transport.[29] They also correspond with the divisions employed by Richard Duncan-Jones back in 1994. This was not by design: when faced with a similar dataset (many of the hoards being scrutinised here are the same as those used by Duncan-Jones), the same geography, and a common problem (*i.e.*, how to divide that dataset in ways that make sense within the context of the geography of the empire) it is unsurprising that the resultant divisions of the empire should be so similar.[30] The only points of difference are that the present study treats Spain and the western end of the Mediterranean as its own entity (*per* ORBIS), whereas Duncan-Jones united the Spanish and Gallic provinces under the single designation of 'West Continent'. He also elected to consider all hoards from the Danubian frontier as a single group, while here they are divided into western and eastern sections.

It should be borne in mind that both Spain and the Western Mediterranean and the Eastern Mediterranean will play only a partial role in the analyses that are to follow. For most of the reigns under survey here, both of these regions are characterised by insufficient quantities of design-level data for analysis to take place. Among the analytical approaches deployed below are phased analyses of *denarii* according to their terminal dates of the hoards to which they belong; this enables us to look at the geographical distribution of coins from hoards that close – and were possibly deposited – closer to their dates of issue, thereby

[29] ORBIS (the Stanford Geospatial Network Model of the Roman World) was constructed by a project team led by Walter Scheidel and Elijah Meeks, and can be found online at: https://orbis.stanford.edu/.
[30] Duncan-Jones 1994, pp. 262-266.

providing some clue as to where batches of newly struck coins might originally have been released into circulation. Tracking the distribution of *denarii* by isolating and analysing hoards of successively later closing dates then makes it possible to comment on the extent to which they circulated after their release (*e.g.,* is a regional concentration of reverse type *x*, visible in hoards closing by 180, still visible in hoards closing into the third century?). The answer to this question will dictate the extent to which the silver coinage can be characterised as an integrated whole, on the one hand, or as a series of distinct circulation pools on the other. Both options are extremes; the results of the analyses presented in the succeeding chapters will suggest that the truth occupies a middle ground in which virtually <u>all</u> *denarius* issues and reverse types achieved a wide circulation, while some continued to circulate on something approaching a regionalised basis (determined by where they were released into use).

To this end, the hoards in this study will be grouped into broad categories depending on whether they close by 161, 180, 192, 211, and up to *c.* 250. Most of the hoards from Spain and the Western Mediterranean–– Llíria, Castrillo de Cabrera (12902), Thamusida Northern Hoard (13315), and Thamusida Southern Hoard (13314) – terminate after 200, so this region will not feature in these phased analyses until the 211 subset (1,396 coins) at the earliest. Only three hoards from this entire region terminate any earlier: Cortalago (17565), Tipasa 1948-1950 (4942), and La Polonia (12889), all closing 143/144, but these returned just seven coins between them and are therefore useless from an analytical point of view. The Eastern Mediterranean is in much the same position: only two of its hoards terminate before 200: Manyas, (5474) and Dura Europos 21 (9826), closing 160 and 192 respectively. The majority of hoards in this region close between 214-264, meaning the Eastern Mediterranean can only be seriously analysed in the subsets formed of hoards dating up to 211 and *c.* 250 or later.

It should also be stressed that, in some regions, the majority of coins come from just one or two dominant hoards. For the 180, 192, and 211 subsets, Italy and the Adriatic returned a respectable number of coins (1,026, 1,059, and 1,061 per subset) from four, six, and seven hoards respectively, the largest single concentration of which (888) come from the Durrës (1941) hoard alone, closing 175. The Rhine returned 500, 600, and 1,014 coins from a larger number of hoards than in Italy (12, 15, and 23 hoards respectively for the 180, 192, and 211 subsets), but of these it is the two hoards from Stockstadt (5255 and 16545) that dominate, with 426 *denarii* between them. As has already been stated, the hoards from Spain and the Western Mediterranean only returned enough coins to permit analysis from the subset of coins from hoards closing up to 211 and in the entire dataset of hoards closing up to *c.* 250. These are not divided equally: of the 1,396 *denarii* from just a handful of hoards, 1,377 of them come from the Llíria hoard alone. Moving to the Eastern Danube, the 13,705 *denarii* from the enormous Reka Devnia hoard completely overshadow the 3,761 *denarii* from the 52 other hoards from this region. These figures are presented only to draw the reader's awareness to the fact that the distribution of *denarii* within each of the regions is far from equal. In many cases, this unevenness will mean that the interregional comparisons will, essentially, be comparisons between the contents of several large hoards rather than a constellation of a great many hoards. This is not necessarily a problem from a theoretical point of view: a fair number of large hoards, if reasonably spaced, are arguably equally likely to evince regional imbalances in the spread of coin types or of whole issues as would a dataset composed of hundreds of much smaller hoards. As Spoerri Butcher and Hellings 2017 (p. 68) made us aware, the contents of larger deposits are a good guide to the general make-up of the coinage.

6. Analysing the data

6.*i.* Preparing the data for analysis

The coin hoard data taken from the CHRE database was divided between the regions outlined above. After checking and cleaning (see this above, section 4.*ii*), the data for each reign were grouped according to their date of issue and then further subdivided into subsets based on the reverse design. Doing so guaranteed that the analyses that were to follow could scrutinise the interregional spread of coins at the very highest level (*i.e.,* date of issue) and at the much finer level of the design (*i.e.,* comparing the distribution of individual reverse types or designs belonging to a one issue period). The division of the dataset by reverse design was not a simple matter of separating coins out by their *RIC* numbers. As an example, take **Figure 0.6**, which shows *denarii* corresponding with *RIC* II (Trajan) nos. 216-223:

Figure 0.6: *denarii* of Trajan struck 103-105, *RIC* II 216-223 (*MIR* 190). *S P Q R OPTIMO PRINCIPI.* Dacian captive seated right (nos. 216-219), either upon a shield or beneath a trophy (nos. 220-223)

Struck in the period 103-105, the basic reverse design across all *denarii* with these *RIC* numbers is essentially the same: a Dacian captive seated right. The differences between them are relatively minor, and can be boiled down the style of the imperial portrait on the obverse, and whether the Dacian on the reverse is seated either upon a shield or beneath a trophy. These differences were important to the editors of *RIC* II, but are not appropriate here. It is, of course, possible that sub-groups such as the ones displayed in **Figure 0.6** could have been dispatched to any single region or combination of regions for fiscal (if not typological) reasons, but to divide and analyse the coins according to individual *RIC* numbers would almost certainly result in groups of coins too small to support analysis (see section 6.*iii*., below, for a description of the analytical method employed here). For the present study, all that truly matters is that: a) all these captive Dacian types were struck within the same space of time, and b) their basic design, as well as the message it conveys, is essentially the same: *i.e.,* a

Dacian captive. For the purposes of analysis, then, all Trajanic *denarii* with the *RIC* numbers 216-223 were combined into a single category, defined by the reverse design, in order that their distribution could be compared against all the other designs struck within the same issue period. Only in cases where a design was struck for different members of the imperial family at the same time – *e.g.*, identical depictions of Concordia on *denarii* of both Aurelius and Verus – was separation maintained in order that the analyses might detect any possible differences in their distribution.[31]

6.*ii.* Dividing the data

As already mentioned, the coins of each reign will be divided into discrete subsets based on the closing dates of the hoards. **Chapters 1-5** test the distribution of *denarii* at the level of the issue and the design by dividing them into four subsets according to the terminal dates of the hoards to which they belong, these being: hoards closing by 161, 180, 192, and 211. Testing will also take place on the 'complete' dataset for each reign – *i.e.*, all hoards taken together, with no filter placed on their terminal dates. The results of tests on the four subsets will be compared to the complete and uncontrolled dataset in order to see if this technique can help us to understand whether stripping hoards back according to their closing dates enables us to get closer to 'original' patterns of distribution, before mixing in the course of circulation had the chance to dull or entirely destroy all trace of where coins were being sent.

Dividing and analysing hoards according to terminal date is not a new technique, though it is still relatively uncommon. Howgego, in several places through his 1994 article on coin circulation and the Roman economy, used terminal dates to distinguish differences in the composition of hoards, *e.g.*, the rising proportion of eastern *denarii* in Severan-era hoards from

[31] It would have been perfectly feasible for the mint to hive off the produce of *officinae* tasked with the production of *denarii* in the names of other members of the imperial family, such as empresses: Beckmann 2012a points to the coinage of Diva Faustina I being confined within one or two *officinae*. See Woytek 2012 for a detailed description of the structure and organisation of the mint in second century.

the 190s onward.[32] Lockyear also manipulated the data in this way, using it to successfully identify regional variations in the distribution of Republican *denarii* by year and issue.[33] Găzdac, too, used hoards with terminal dates staggered through the second century in order to obtain a better picture of how coins were supplied to Dacia and the Balkan provinces in the reigns of Trajan, Hadrian, Antoninus, Aurelius, and Commodus.[34]

It will be seen in the course of discussion that regional concentrations of this-or-that issue or design commonly crop up in groups of hoards with earlier closing dates, and that these concentrations continue to appear in deposits with progressively later closing dates, persisting through the hoard record into the third century. Whether this means these concentrations persisted *through time* (rather than in hoards of a similar date that just happen to close with coins of earlier or later mintage) is an open question. It cannot be denied that many of the hoards with an 'early' closing date – up to *e.g.* 161 or 180 – could have been assembled and deposited at later dates than their latest coins suggest. It is possible, nevertheless, that a good number – *e.g.,* those from the Western Danube and Eastern Danube closing in the 170s, during the Marcomannic War – were indeed closed soon after the addition of their latest coins. The true number, admittedly, remains unknown, and methods that might be employed for better gauging how far a hoard's closing date reflects the actual date of its assembly and final closure are likewise uncertain. One possibility might be in the weights of the coins themselves: the degree of wear sustained by coins over time can provide objective evidence on the date of withdrawal of hoards from circulation, as Hoyer (2013) demonstrated by using regression analyses on *sestertii* from Gallic hoards struck *c.* 69-161. However, the weights of individual coins are not routinely available on the CHRE project database, so this course of inquiry is not open to us here. In any case, it is now known that the weights of *denarii*

---

[32] Howgego 1994, pp. 5-21 (on Severan hoards, see p. 15).
[33] Lockyear 2007, pp. 64-178.
[34] Găzdac 2010, pp. 126-134.

with slightly baser alloys, such as those struck toward the end of the second century, are not a wholly reliable indicator of their original weights due to the fact that base metals leach away while in the ground, leaving a coin of purer silver than was the case in antiquity.[35] Another method of gauging the likelihood that a hoard's closing date reflects its date of deposition would be to follow Creighton's (2014) example by examining the list of coins from each hoard in order to see whether their profiles might be described as 'new or 'old' (*i.e.,* weighted toward more recent issues or older ones), but to do so would have exceeded the timescale available to this study.

In the absence of any more precise method, dividing hoards by their closing dates was deemed reasonable giving the timescale and resource available to the author. Even if, in a worst case, it can be shown that none of the subsets reflect the actual deposition dates of the hoards in question, then we can at least look to the results of tests carried out on the complete and uncontrolled dataset of hoards closing up to *c.* 250, which often mirror the results of tests carried out on the subsets.

6.*iii.* Chi-squared (χ^2)

Chi-squared (χ^2) testing was chosen as the method for the analysis of interregional difference in the distribution of *denarii* by both issue and reverse design. This followed a period of trial-and-error in which it became apparent that more 'traditional' approaches to interrogating larger datasets of coins – *e.g.,* looking at relative frequences of coins from different regions expressed as percents or permills – would not be appropriate. Advice and training on the suitability and practical application of χ^2 received from staff at the Oxford University Statistical Consultancy (OxUSC) was an invaluable part of this process, for which the author is very grateful.

---

[35] Butcher and Ponting 2012, pp. 66-68; Butcher 2024.

Other uses of χ^2 within the field of archaeological numismatics have shown it to be a useful and effective test for determining whether observed differences and patterns within large datasets are likely to be of actual significance, as well as for the detection of trends that are not visible to the naked eye. See, for example, Davis *et al* (2025) and Romano *et al* (2012), who used χ^2 to determine whether results of metallurgical testing (on Athenian coins of the sixth century BC and silvered *nummi* from the Misurata hoard respectively) were of statistical significance; Brown (2008), who sought to establish the reality of perceived patterns in coin deposition within Romano-British burials; Evans (2006), who successfully used χ^2 to confirm the significance of observations made on the differences between the coin profiles of Caesarea Maritima and other sites; and Creighton (1992), who used χ^2 to explore the supply of *denarii* to Britain in the second century.[36]

The best way to explain χ^2 in relation to the data under survey here is to walk the reader through a real test on a small subset of the dataset of hoarded *denarii*. χ^2 tests can be undertaken manually, but it is easier and more convenient to use the 'R' software package, which, upon entry of a handful of basic commands, carries out all the necessary calculations itself.[37] The first step of χ^2 in R is the importation of a .txt file, containing a simple contingency table of the data one wishes to compare. See **Table 0.1**, below: a contingency table that has already been imported into R, listing the quantities – *i.e.,* the 'observed values' – at which reverse designs struck 112-113 occur in the seven regions under survey here.

[36] For all its advantages, χ^2 is not universally employed, and it is still common for scholars to exploit large numismatic datasets using more traditional methods, which are essentially reliant on the comparison of the frequency – commonly expressed in percent or permills – at which a given coin issue or type occurs in the region or regions under examination. See, for example, Elkins (2017a, 2017b), on the distribution of the coinage of Nerva. This is a fine work of scholarship, and it is very likely that many of the patterns of coin loss it claims to identify are indeed reflective of the truth, but its key problem is that its conclusions are based on little more than the scholar's own visual assessment of the data without subsequent recourse to verification through relatively simple statistical tests like χ^2.

[37] Both Warne 2021, pp. 410-455 and Scheller 2025, pp. 230-240 provide a detailed walk-through of the calculations involved in carrying out a manual χ^2 test, as well as how to interpret the results. For an introduction to χ^2 using R, see Scheller *op. cit.*, pp. 240-245.

```
> chisq$observed
                BRITAIN SP...W.MED RHINE ITA...ADR W.DAN E.DAN E.MED
ALIM ITAL            17          8    12        16    29    99    11
Arabia               22          1    14        20    31    95     9
Traj on horse        12         11    11         8    35    73    11
Traj Sr              29          6    12         8    40    73     5
VIA TRAIANA          22          6    13         9    33    72    12
```

Table 0.1: contingency table containing observed values for designs struck 112-113, viewed in R

The observed values within the contingency table are then ready to be subjected to a χ^2 test. All χ^2 tests begin with the assumption of a 'null hypothesis': that is, that the variables in question – here, coin designs and regions – are unrelated and independent of each another. χ^2 tests this hypothesis against the data. The code 'chisq$expected' is then entered so that we can inspect the 'expected values' for the dataset (**Table 0.2**, below). The expected values are nothing more than what χ^2 thinks the values of each cell in the table of observed values would be if there was no association between region and reverse design.

```
        Pearson's Chi-squared test

data:  T112_3
X-squared = 35.934, df = 24, p-value = 0.0557

> chisq$observed
               BRITAIN SP...W.MED RHINE ITA...ADR W.DAN E.DAN E.MED
ALIM ITAL           17          8    12        16    29    99    11
Arabia              22          1    14        20    31    95     9
Traj on horse       12         11    11         8    35    73    11
Traj Sr             29          6    12         8    40    73     5
VIA TRAIANA         22          6    13         9    33    72    12
> chisq$expected
                BRITAIN SP...W.MED    RHINE ITA...ADR    W.DAN    E.DAN     E.MED
ALIM ITAL      22.12881   6.942373 13.45085  13.23390 36.44746 89.38305 10.413559
Arabia         22.12881   6.942373 13.45085  13.23390 36.44746 89.38305 10.413559
Traj on horse  18.55593   5.821469 11.27910  11.09718 30.56271 74.95141  8.732203
Traj Sr        19.93898   6.255367 12.11977  11.92429 32.84068 80.53785  9.383051
VIA TRAIANA    19.24746   6.038418 11.69944  11.51073 31.70169 77.74463  9.057627
```

Table 0.2: view of a χ^2 test within R, showing p-value, observed values per reverse design and region, and, below, the expected values ('chisq$expected') generated by χ^2

Comparison of the observed values and the expected values allows χ^2 to generate a 'p' (or 'probability') value (see again **Table 0.2**). This p-value value is, in essence, a way for χ^2 to tell us whether one or more of the differences it has detected between the observed and expected values might be of some statistical significance. If coin design and region are likely to be independent of one another (*i.e.*, distribution is 'normal'), then the test will deliver a non-significant p-value value. If, on the other hand, the two variables are probably *not* independent, then the p-value will sit within a range of values denoting significance (*i.e.*, a value around 0.05 or less). In the example given above, it can be seen that when tested, the coin design data for 112-113 returned a p-value of 0.0557, indicating that a significant and non-independent relationship probably exists between one or more of the variables in the test.

The p-value is only of so much use: it tells us whether or not significant, non-independent relationships between the variables are present somewhere within the table of observed values, but it does not tell us how many, or how significant: only that they are there. In order to unpick where (*i.e.*, in which region) χ^2 has detected the possibility of a significant relationship between two or more of the variables under survey, the code 'chisq$residuals' is entered; this generates a table of residual values (see **Table 0.3**, below).

```
        Pearson's Chi-squared test

data:  T112_3
X-squared = 35.934, df = 24, p-value = 0.0557

> chisq$observed
              BRITAIN SP...W.MED RHINE ITA...ADR W.DAN E.DAN E.MED
ALIM ITAL          17          8    12        16    29    99    11
Arabia             22          1    14        20    31    95     9
Traj on horse      12         11    11         8    35    73    11
Traj Sr            29          6    12         8    40    73     5
VIA TRAIANA        22          6    13         9    33    72    12
> chisq$expected
               BRITAIN SP...W.MED    RHINE ITA...ADR    W.DAN    E.DAN     E.MED
ALIM ITAL     22.12881   6.942373 13.45085  13.23390 36.44746 89.38305 10.413559
Arabia        22.12881   6.942373 13.45085  13.23390 36.44746 89.38305 10.413559
Traj on horse 18.55593   5.821469 11.27910  11.09718 30.56271 74.95141  8.732203
Traj Sr       19.93898   6.255367 12.11977  11.92429 32.84068 80.53785  9.383051
VIA TRAIANA   19.24746   6.038418 11.69944  11.51073 31.70169 77.74463  9.057627
> chisq$residuals
                  BRITAIN  SP...W.MED       RHINE  ITA...ADR      W.DAN      E.DAN      E.MED
ALIM ITAL     -1.09027950  0.40140115 -0.39559148  0.7603687 -1.2336002  1.0172079  0.1817291
Arabia        -0.02738309 -2.25530837  0.14973322  1.8599215 -0.9023193  0.5941183 -0.4380407
Traj on horse -1.52192435  2.14629935 -0.08310297 -0.9297358  0.8026416 -0.2254027  0.7674360
Traj Sr        2.02920274 -0.10210306 -0.03440451 -1.1364365  1.2492974 -0.8399388 -1.4308842
VIA TRAIANA    0.62740406 -0.01563414  0.38023283 -0.7400299  0.2305874 -0.6515190  0.9776660
```

Table 0.3: as Figure 6, with the addition of the standardised residuals ('chisq$residuals') arising from the χ^2 test

Residual values (referred to from here onward as 'standardised residuals') are essentially the difference χ^2 observes between the observed and the expected values, thereby enabling us to understand which of the data are contributing to the high p-value generated by χ^2. Standardised residuals exist on spectrum of positives and negatives, with 0 as its centre point: positive values indicate an observed value that was higher than χ^2 expected ('overrepresented'); negative values indicate the opposite ('underrepresentation'). The larger or smaller they are, the greater the degree of difference, but it is generally accepted that standardised residuals equal to or greater than 2 signify areas of particularly high (and therefore significant) overrepresentation that would warrant further investigation.[38] Underrepresentation works on the same principle: standardised residuals of -2 or less signify areas where coins are comparatively less common than in other regions. Instances of overrepresentation are of particular interest to the present study, as these are likeliest to point to places where a coins are occurring in quantities that χ^2 deems unlikely to be the result of chance (*e.g.,* modern distortion in the number of coin finds reported between regions), and which might, upon closer inspection, be taken as evidence for regionalised distribution in antiquity.

The standardised residuals presented in the example pictured above contain a number of overrepresented values that are of interest. In Britain, the Divus Pater Trajan reverse design ('Traj Sr') returned a standardised residual value of 2.0292; in Spain and the Western Mediterranean, the standardised residual for the Trajan on horseback ('Traj on horse') design is even higher, at 2.1462. All the other values in the table of standardised residuals created by χ^2 fall within the two other categories outlined above: more or less 'normal' (between -2 and 2 standardised residuals), and 'underrepresented' (standardised residuals of -2 or lower). It should be borne in mind that areas where coins are underrepresented are not unimportant, since they often accompany overrepresentations in other regions; as will be seen at various

[38] Agresti 2007, see esp. p. 38; Sharpe 2015, p. 3; Naioti and Mudrak 2022, p. 2. Depending on the dataset, opinions still differ on where the critical boundary between normal and significant should lie: Sharpe 2015, *ibid.* (discussing MacDonald and Gardner 2000).

points in the succeeding chapters, they serve not only to show how imbalanced the distribution of newly struck *denarii* could be at the outset, but also that *denarii* did not always circulate far enough for these regional imbalances to be eliminated in their entirety.

The most important caveat to the above concerns numbers. It is crucial to ensure that the data being tested meet the numerical threshold necessary for χ^2 to deliver meaningful results. In order for R to effectively carry out the χ^2 test, a minimum of five coins per region for each design in question is required. Any fewer, and the standardised residuals derived from these numbers are unlikely to be trustworthy. This is not a hard-and-fast rule: sometimes, it is possible to include regions in a test where the number of examples is fewer than five - the deciding factor is the expected value that χ^2 assigns to its equivalent cell in the table of observed values. Cases where the expected value is less than five lead, inevitably, to that variable's exclusion from the test. Some might say that excluding data for a given region or design on the grounds that its observed and/or expected values are too low creates the false impression that the region in question produced no examples of a given coin whatsoever. On the contrary: our inability to compare something using a statistical method does not imply it is not there; it simply acknowledges the limits of our methods and the fact that it is hard to get accurate results from only a handful of coins of a given design or from a given region. It therefore falls upon the scholar to qualify statements on the spread of this-or-that design with a reminder that some regions or designs *did* produce coins that were not tested for sound reasons, but that their existence should, nevertheless, be borne in mind.

The merits of χ^2 are several. First, it encourages the researcher to exclude numerically unrepresentative data from analysis, thereby reducing the risk of misleading distortions. Second, it enables us to compare datasets of greatly different sizes almost as if they were equals, bypassing questions of numerical differences in order to locate statistical significance (it would be otherwise impossible to compare the coins of the Eastern Danube region to those of the other regions, for instance, because the dataset for the Eastern Danube contains the massive Reka Devnia hoard). Finally, it removes a good deal of human, subjective judgement from the analysis of coin distribution. Looking at the data by-eye alone, it would be tempting to conclude that a seeming bulge in the total number or proportion of design *x* from region *y* is significant based on both instinct ('it looks big and must be important') and a natural desire to draw a line between a concentration of a particular reverse design and known points in the historical narrative. This approach to the data might also lead us to overlook truly significant concentrations because they are not entirely obvious to the naked eye. This is not to say that scholarly judgement and a degree of instinct are removed entirely; χ^2 might tell us about the regions in which a design is over- or underrepresented, but it is down to the scholar to put these figures in their historical context. As will be seen in the following chapters, several instances of overrepresentation (of designs or even entire issues) in particular regions can plausibly be explained with reference to the known histories of those places – major campaigns, for instance, which appear to have been the catalyst for significant and repeated shipments of new *denarii*.

Chapter 1: Trajan (98-117)

Introduction

This chapter will use χ^2 tests to examine the spatial distribution of 17,969 Trajanic *denarii* from 266 hoards across the seven regions outlined in the Introduction.[1] See **Figure 1.1** for a map of their distribution. Prior to analysis, the *denarii* were sorted and ordered according to Bernhard Woytek's improved arrangement (*MIR* 14), which supersedes the ordering to be found in *RIC* II (1926) and elsewhere.

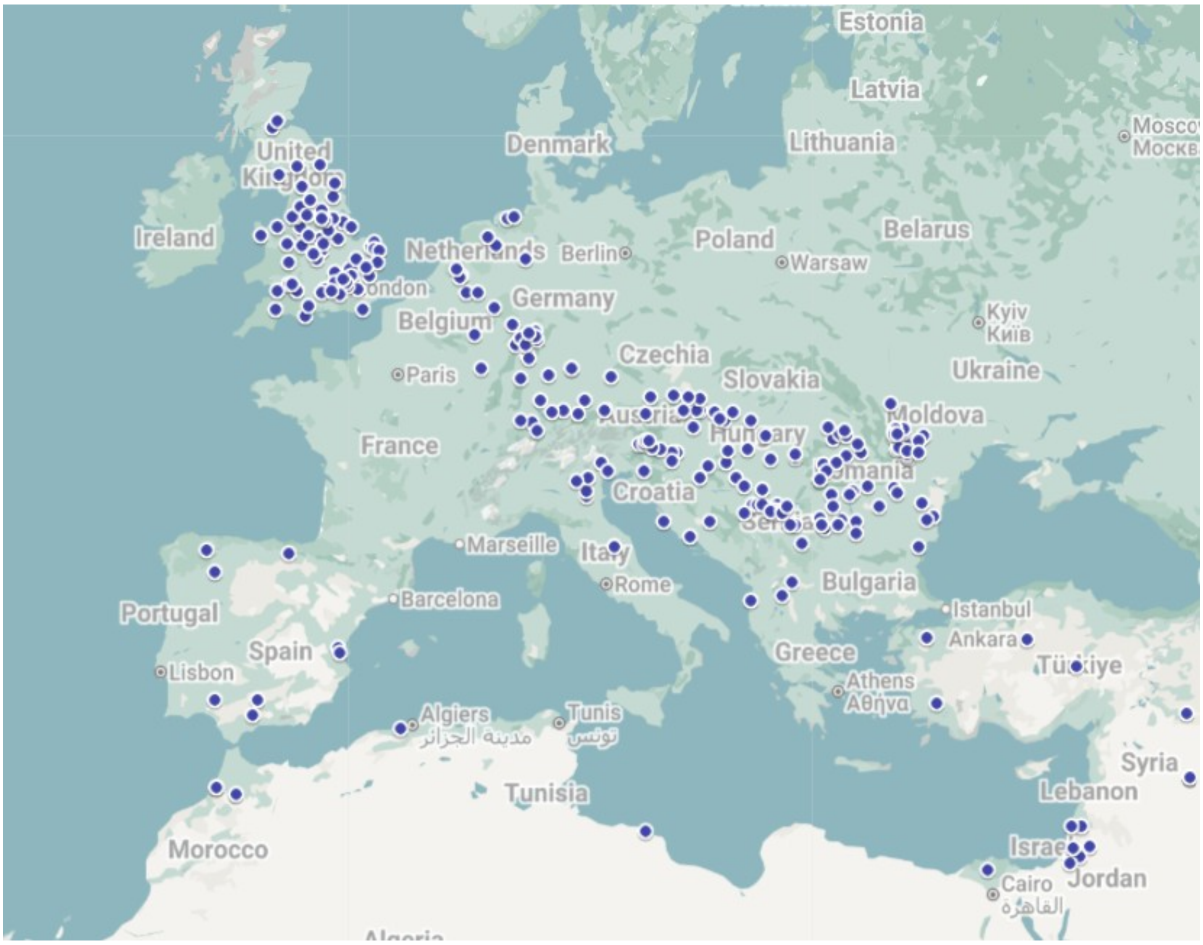

Figure 1.1: hoards containing *denarii* struck under Trajan in this study's dataset that were recorded to the level of the design on the CHRE database at the time of data collection (n=266). Find an interactive version of this map with links to CHRE records at: https://www.google.com/maps/d/edit?mid=17PIPHIxizoWwCDNOXI823GbVCUmKtSU&usp=drive_link

[1] See **Appendix** for a complete list of all hoards by closing date.

1: Trajan

Analysis will first take place at the level of the issue, followed by an assessment of how distribution differs at the level of the reverse design. The coins were divided up into the four subsets described in the Introduction: hoards closing by 161 (3,402 *denarii*), 180 (6,896 *denarii*), 192 (8,065 *denarii*), and 211 (10,200 *denarii*). It would have been ideal to test a subset of coins from hoards closing with issues of Trajan himself, or perhaps those of Hadrian, but hoards that do so are relatively uncommon.

As well as subjecting the four subsets to analysis, χ^2 will also be used to test the 'complete' dataset of 17,969 *denarii*, which closes with hoards running up to the middle of the third century. The results of this test can be compared with tests carried out on each of the subsets to see how far regionalised concentrations persist through time. It will be seen that, even in a dataset such as this, where the majority of the *denarii* come from hoards terminating in the later second or and third centuries, the χ^2 tests produced evidence for distinct regional concentrations in more than one region – many of which appear to have their origins in hoards with earlier closing dates (up to 161, 192, *etc.*). The degree to which these can be explained with reference to some of the known events of Trajan's reign – *e.g.,* the two Dacian wars of 101-102 and 105-106 – is limited, although plausible connections might be made to possible shipments of coins sent north to the Rhine frontier at the beginning of the reign, and to one of the three *congiaria* at Rome.

i. Results of χ^2 tests at the level of the issue

Tables 1.1-1.5, below, present the full set of results the distributional tests carried out on each of the subsets and on the complete dataset of hoards closing up to *c.* 250 and beyond. The observed values (the actual totals) per issue period and region are displayed first, followed by the standardised residuals arising from the χ^2 tests. A note on the presentation of the χ^2 results: emboldened black figures, where the standardised residuals are equal to or greater than 2, denote overrepresentations (*i.e.,* places where χ^2 suggests the quantity of *denarii* in a particular region could be significant) while figures equal to or smaller than -2, in red, denote underrepresentations (a comparative lack of coins).

The majority of issue periods were tested on their own. However, some were merged in order to create workable datasets, *e.g.*, *denarii* struck in the years 103, 103-104, and 103-105. None of these periods on their own returned enough coins for χ^2 testing. Rather than jettisoning them altogether, they were merged to create a single group covering the slightly broader period 103-105. Owing to a lack of coins for the years 98-99, 100, 107, 114, and 114-115, it was not possible to test these five issue periods except in the complete dataset (**Table 1.5**), where there were sufficient coins from all regions and all periods for a comprehensive test to be undertaken.

Table 1.1: ***Denarii*** **in hoards closing up to 161**

Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
98	45	17	7	17	61	13	21	**181**
98-99	21	7	2	11	32	4	12	**89**
100	18	5	3	10	39	2	18	**95**
101-102	24	4	7	10	56	11	10	**122**
102	49	7	13	22	75	18	25	**209**
103, 103-104, 103-105	55	3	3	14	59	3	15	**152**
106-107	42	6	4	22	64	9	20	**167**
107	14	1	3	8	20	3	1	**50**
107-108	114	25	20	63	131	22	54	**429**
108-109	144	30	23	41	194	47	45	**524**
110	62	8	14	22	92	20	11	**229**
111	32	2	4	19	48	6	13	**124**
112, 112-113/114/117	38	10	16	23	75	14	19	**195**
113-114	39	9	12	13	56	14	13	**156**
114	10	1	3	4	15	3	4	**40**
114-115	2	0	2	1	9	3	2	**19**
114-116	72	13	15	26	141	30	18	**315**
116	29	4	8	25	44	13	5	**128**
116-117	43	9	16	28	57	14	11	**178**
Qty	**853**	**161**	**175**	**379**	**1268**	**249**	**317**	**3402**

Standardised residuals
χ^2 = 143.68, df = 78, **p-value = 0.0002797**

Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Avg
98	0.2019	**2.3193**	-1.0099	-0.7566	0.1637	-0.8814	1.6026	0.2342
98-99	-0.8818	0.4690	-0.7045	0.7337	-0.1613	-0.0436	1.7266	0.1626
100	-0.7100	-1.9733	-0.9869	-0.4421	**2.3290**	-1.2810	**2.8415**	-0.0318
101-102	-1.5422	-0.7698	0.9304	0.6326	0.7757	0.2100	-0.8228	-0.0837

1: Trajan

Table 1.1: *Denarii* in hoards closing up to 161								
Period	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
102	-0.0065	-0.3634	1.0224	-1.1067	-0.5581	0.6089	1.1726	0.1099
103, 103-104, 103-105	**3.0942**	**-2.3554**	-1.2476	-0.2841	-0.0180	-0.8621	0.0825	-0.2272
106-107	0.4345	0.0307	-1.2789	-0.9979	0.7693	-0.3675	1.3574	-0.0075
107	0.8497	1.0592	-0.1823	1.4712	**-2.0241**	-0.7551	**2.2637**	0.3832
107-108	1.6891	-0.0499	0.0540	0.1639	-0.0785	-1.3045	-0.5520	-0.0111
108-109	0.2699	0.8773	0.0556	0.3933	-0.9545	0.8181	-1.9362	-0.0681
110	-1.2459	-0.2611	-1.3176	-0.2218	1.1670	0.5733	0.4833	-0.1175
111	-1.3314	1.5910	-0.3093	-0.3773	0.6580	0.1291	0.1506	0.0730
112, 112-113/114/117	0.0603	-0.9470	0.2133	-0.5875	-0.1491	1.0138	-0.5355	-0.1331
113-114	-1.4878	-0.0715	0.2065	-0.4381	-0.1060	**2.4549**	**-2.2548**	-0.2424

Table 1.2: *Denarii* in hoards closing up to 180								
Period	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
98	68	17	20	52	123	47	21	**348**
98-99	32	7	10	34	60	18	12	**173**
100	31	5	9	33	90	10	18	**196**
101-102	40	4	24	52	101	31	10	**262**
102	71	7	32	66	151	62	25	**414**
103, 103-104, 103-105	81	3	18	53	112	31	15	**313**
106-107	65	6	19	49	115	28	20	**302**
107	22	1	6	20	38	22	1	**110**
107-108	171	25	60	169	256	82	54	**817**
108-109	224	30	76	190	386	128	45	**1079**
110	90	8	34	90	167	61	11	**461**
111	46	2	12	42	99	22	13	**236**
112, 112-113/114/117	62	10	32	66	148	43	19	**380**
113-114	70	9	33	64	131	55	13	**375**
114	17	1	7	20	32	12	4	**93**
114-115	4	0	2	2	15	5	2	**30**
114-116	115	13	55	120	249	91	18	**661**
116	54	4	18	56	84	31	5	**252**
116-117	63	9	44	73	150	44	11	**394**
Qty	**1326**	**161**	**511**	**1251**	**2507**	**823**	**317**	**6896**
Standardised residuals χ^2 = 125.02, df = 78, **p-value = 0.0005802**								
Period	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Avg**
98	0.0664	**3.1121**	-1.2411	-1.4022	-0.2338	0.8043	1.4026	0.3583
101-102	-1.5134	-0.8567	0.9300	0.6472	0.6605	-0.0838	-0.4849	-0.1002
102	-1.0323	-0.8584	0.1115	-1.0519	0.1272	1.7404	1.5338	0.0814
103, 103-104, 103-105	**2.6100**	-1.5942	-1.1747	-0.5031	-0.0928	-1.0757	0.2883	-0.2203
106-107	0.8446	-0.3966	-0.8126	-0.7829	0.5732	-1.3739	1.7911	-0.0225
107-108	1.0041	1.3549	-0.2437	1.7052	**-2.2663**	-1.6286	**2.9284**	0.4077
108-109	1.0269	0.9560	-0.6385	-0.4129	-0.1771	-0.1408	-0.4332	0.0258
110	0.0679	-0.8432	-0.1586	0.6949	0.0456	0.7562	**-2.0996**	-0.2196
111	0.0377	-1.4959	-1.3917	-0.1254	1.4961	-1.1921	0.7719	-0.2713
112, 112-113/114/117	-1.3583	0.3776	0.5965	-0.3551	0.9245	-0.3913	0.5095	0.0434
113-114	-0.3153	0.0817	0.8591	-0.4899	-0.3753	1.4836	-0.9016	0.0489

Table 1.2: *Denarii* in hoards closing up to 180								
Period	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
114-116	1.1595	-0.6205	0.6930	0.0061	0.6728	1.3023	-2.1033	0.1586
116	0.7374	-0.7772	-0.2513	1.5198	-0.7304	0.1329	-1.8549	-0.1748
116-117	-1.5300	-0.0666	**2.5877**	0.1788	0.6519	-0.4833	-1.5592	-0.0316

Table 1.3: *Denarii* in hoards closing up to 192								
Period	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
98	82	17	22	54	138	61	21	**395**
98-99	39	7	11	35	68	36	12	**208**
100	40	5	1	33	102	35	18	**234**
101-102	54	4	27	53	114	48	10	**310**
102	105	7	41	66	166	81	25	**491**
103, 103-104, 103-105	105	3	21	54	125	48	15	**371**
106-107	80	6	19	49	138	55	20	**367**
107	25	1	6	20	48	20	1	**121**
107-108	213	25	65	170	306	139	54	**972**
108-109	280	30	85	193	432	172	45	**1237**
110	109	8	37	93	188	84	13	**532**
111	51	2	12	42	110	43	13	**273**
112, 112-113/114/117	76	10	32	67	170	60	19	**434**
113-114	95	9	34	65	156	75	15	**449**
114	22	1	7	20	39	15	4	**108**
114-115	6	0	2	2	17	6	2	**35**
114-116	146	13	59	121	282	128	19	**768**
116	64	4	19	56	97	40	5	**285**
116-117	85	9	49	75	179	67	11	**475**
Qty	**1677**	**161**	**549**	**1268**	**2875**	**1213**	**322**	**8065**
Standardised residuals χ^2 = 115.76, df = 78, **p-value = 0.003567**								
Period	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Avg**
98	-0.1020	**3.2431**	-1.1371	-1.0346	-0.1363	0.2475	1.4580	0.3627
101-102	-1.3739	-0.8810	1.0685	0.6041	0.4234	0.2379	-0.5789	-0.0714
102	0.1887	-0.8966	1.0458	-1.2813	-0.5725	0.8797	1.3724	0.1052
103, 103-104, 103-105	**3.0717**	-1.6203	-1.0363	-0.5732	-0.5351	-1.0075	0.1667	-0.2192
106-107	0.3360	-0.4916	-1.3783	-1.1515	0.7275	0.0124	1.5349	-0.0586
107-108	0.6252	1.2672	-0.4754	1.3784	-2.0258	-0.5327	**2.6659**	0.4147
108-109	1.2594	1.0642	-0.2930	-0.1184	-0.2492	-0.9608	-0.4199	0.0403
110	-0.2547	-0.8058	-0.1199	1.0148	-0.0024	0.4939	-1.6751	-0.1927
111	-0.8342	-1.4788	-1.6736	-0.1463	1.3753	0.3373	0.7465	-0.2391
112, 112-113/114/117	-1.5837	0.4519	0.2190	-0.1565	1.3407	-0.6121	0.5347	0.0277
113-114	0.0756	0.0103	0.3811	-0.6726	-0.2141	0.9546	-0.5729	-0.0054
114-116	-1.2001	-0.5977	0.6128	0.0135	0.6406	1.2219	-1.9699	-0.1827
116	0.5385	-0.7096	-0.2705	1.6654	-0.3718	-0.4042	-1.8173	-0.1956
116-117	-1.4745	-0.1585	**2.6370**	0.0295	0.8577	-0.4823	-1.7244	-0.0451

Table 1.4: *Denarii* in hoards closing up to 211								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
98	93	33	25	54	144	111	22	**482**
98-99	41	13	13	35	72	62	13	**249**
100	49	6	14	33	106	61	18	**287**
101-102	62	15	30	54	126	102	10	**399**
102	115	26	45	66	172	160	25	**609**
103, 103-104, 103-105	114	10	22	54	133	104	15	**452**
106-107	90	21	22	49	143	110	20	**455**
107	28	3	10	21	50	36	1	**149**
107-108	244	64	76	170	322	293	54	**1223**
108-109	319	70	98	193	451	359	46	**1536**
110	139	38	46	93	198	191	14	**719**
111	56	15	16	42	115	93	13	**350**
112, 112-113/114/117	93	34	34	67	175	143	19	**565**
113-114	107	21	37	65	164	153	16	**563**
114	24	7	9	20	41	25	4	**130**
114-115	7	2	2	2	17	8	2	**40**
114-116	171	46	66	121	297	293	20	**1014**
116	72	18	26	56	103	93	5	**373**
116-117	102	23	57	75	191	146	11	**605**
Qty	**1926**	**465**	**648**	**1270**	**3020**	**2543**	**328**	**10200**

Standardised residuals χ^2 = 143.68, df = 90, **p-value = 0.0002797**								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Avg
98	0.2019	**2.3193**	-1.0099	-0.7566	0.1637	-0.8814	1.6026	0.2342
98-99	-0.8818	0.4690	-0.7045	0.7337	-0.1613	-0.0436	1.7266	0.1626
100	-0.7100	-1.9733	-0.9869	-0.4421	**2.3290**	-1.2810	**2.8415**	-0.0318
101-102	-1.5422	-0.7698	0.9304	0.6326	0.7757	0.2100	-0.8228	-0.0837
102	-0.0065	-0.3634	1.0224	-1.1067	-0.5581	0.6089	1.1726	0.1099
103, 103-104, 103-105	**3.0942**	**-2.3554**	-1.2476	-0.2841	-0.0180	-0.8621	0.0825	-0.2272
106-107	0.4345	0.0307	-1.2789	-0.9979	0.7693	-0.3675	1.3574	-0.0075
107-108	0.8497	1.0592	-0.1823	1.4712	**-2.0241**	-0.7551	**2.2637**	0.3832
108-109	1.6891	-0.0499	0.0540	0.1639	-0.0785	-1.3045	-0.5520	-0.0111
110	0.2699	0.8773	0.0556	0.3933	-0.9545	0.8181	-1.9362	-0.0681
111	-1.2459	-0.2611	-1.3176	-0.2218	1.1670	0.5733	0.4833	-0.1175
112, 112-113/114/117	-1.3314	1.5910	-0.3093	-0.3773	0.6580	0.1291	0.1506	0.0730
113-114	0.0603	-0.9470	0.2133	-0.5875	-0.1491	1.0138	-0.5355	-0.1331
114-116	-1.4878	-0.0715	0.2065	-0.4381	-0.1060	**2.4549**	**-2.2548**	-0.2424
116	0.1813	0.2175	0.4792	1.4226	-0.6606	-0.0405	**-2.0447**	-0.0636
116-117	-1.1517	-0.8994	**3.0035**	-0.0147	0.9513	-0.4452	-1.9521	-0.0726

Table 1.5: *Denarii* in hoards closing up to *c.* 250 and beyond								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
98	111	34	45	59	170	285	53	**757**
98-99	47	13	19	40	86	178	20	**403**
100	55	6	26	36	107	166	32	**428**
101-102	71	15	44	63	160	281	44	**678**
102	131	27	69	71	216	446	62	**1022**

Table 1.5: *Denarii* in hoards closing up to *c.* 250 and beyond								
Period	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
103, 103-104, 103-105	133	12	45	61	156	324	52	**783**
106-107	103	21	41	59	167	339	41	**771**
107	36	3	19	32	62	128	14	**294**
107-108	295	65	127	185	385	867	123	**2047**
108-109	371	71	149	210	555	1299	151	**2806**
110	167	39	75	96	255	681	51	**1364**
111	69	15	37	46	135	273	37	**612**
112, 112-113/114/117	113	36	71	75	187	465	57	**1004**
113-114	128	21	57	72	205	475	58	**1016**
114	25	7	13	23	48	80	5	**201**
114-115	8	2	4	2	17	142	3	**178**
114-116	210	46	102	131	361	842	97	**1789**
116	90	18	33	59	137	305	29	**671**
116-117	138	25	97	80	234	525	46	**1145**
Qty	**2301**	**476**	**1073**	**1400**	**3643**	**8101**	**975**	**17969**
Standardised residuals χ^2 = 143.68, df = 90, **p-value = 0.0002797**								
Period	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Avg**
98	1.4283	**3.1145**	-0.0302	0.0026	1.334	**-3.0464**	1.8606	0.6662
98-99	-0.6411	0.7114	-1.032	1.535	0.4753	-0.2734	-0.3992	0.0536
100	0.026	-1.5852	0.0875	0.4595	**2.1715**	-1.9405	1.8212	0.1485
101-102	-1.6978	-0.6985	0.5522	1.4	1.9228	-1.4107	1.1889	0.1795
102	0.0112	-0.014	1.0205	-0.9666	0.6114	-0.6871	0.879	0.122
103, 103-104, 103-105	**3.269**	-1.919	-0.2568	-0.0006	-0.2177	-1.5435	1.4596	0.1129
106-107	0.4297	0.1274	-0.7427	-0.138	0.8549	-0.4608	-0.129	-0.0083
107	-0.2685	-1.7157	0.3446	1.9	0.3102	-0.3947	-0.4888	-0.0447
107-108	**2.0304**	1.4632	0.431	**2.0203**	-1.4728	-1.8385	1.1319	0.5379
108-109	0.6162	-0.3863	-1.4336	-0.583	-0.582	0.9549	-0.1016	-0.2165
110	-0.58	0.477	-0.7146	-0.9964	-1.2949	**2.6641**	**-2.6747**	-0.4456
111	-1.0583	-0.3009	0.0752	-0.2436	0.9807	-0.1751	0.6581	-0.0091
112, 112-113/114/117	-1.3728	1.8234	1.4267	-0.3644	-1.1599	0.5811	0.3418	0.1822
113-114	-0.1843	-1.1399	-0.471	-0.8045	-0.0684	0.7922	0.3867	-0.2127
114	-0.1456	0.7261	0.2879	1.8547	1.1356	-1.1153	-1.7884	0.1364
114-115	**-3.0986**	-1.2504	**-2.0333**	**-3.1869**	**-3.1773**	**6.8933**	**-2.1424**	-1.1422
114-116	-1.2611	-0.202	-0.4671	-0.7101	-0.0891	1.2486	-0.0072	-0.2126
116	0.4397	0.0534	-1.1166	0.9295	0.0825	0.1432	-1.2278	-0.0994
116-117	-0.712	-0.9679	**3.4621**	-0.975	0.1224	0.3872	**-2.0461**	-0.1042

Underrepresentations are, of course of interest. However, given this study's interest in the nature of coin supply (not to mention considerations of space), the greater part of discussion here and in succeeding chapters will focus on instances of overrepresentation, as these arguably offer a better view onto where, and when, the state was sending newly struck *denarii.*

For convenience, all instances of overrepresentation seen in **Tables 1.1-1.5** have been gathered together in **Table 1.6**, below, and colour-coded according to region.

Table 1.6: Regional overrepresentations over time *Fields marked ' - ' indicate where an issue was not present in sufficient numbers for testing to take place.						
Period	**Region**	***Denarii* in hoards up to 161**	***Denarii* in hoards up to 180**	***Denarii* in hoards up to 192**	***Denarii* in hoards up to 211**	***Denarii* in hoards up to *c.* 250**
98	**Spain & W Med**	**2.8857**	**3.1121**	**3.2431**	**2.3193**	**3.1145**
100	**Western Danube**	-	-	-	**2.3290**	**2.1715**
	Eastern Med	-	-	-	**2.8415**	1.8212
103, 103-104, 103-105	**Britain**	**2.6542**	**2.6100**	**3.0717**	**3.0942**	**3.2690**
107-108	**Britain**	0.5051	1.0041	0.6252	0.8497	**2.0304**
	Italy & Adriatic	**2.2312**	1.7052	1.3784	1.4712	**2.0203**
	Eastern Med	**2.4717**	**2.9284**	**2.6659**	**2.2637**	1.1319
110	**Eastern Danube**	0.5733	0.7562	0.4939	0.8181	**2.6641**
111	**Western Danube**	**0.2969**	1.4961	1.3753	1.1670	0.9807
114-115	**Eastern Danube**	-	-	-	-	**6.8933**
114-116	**Western Danube**	**2.2371**	0.6728	0.6406	-0.1060	-0.0891
	Eastern Danube	1.2921	1.3023	1.2219	**2.4549**	1.2486
116	**Italy & Adriatic**	**2.8646**	1.5198	1.6654	1.4226	0.9295
116-117	**Rhine**	**2.2082**	**2.5877**	**2.6370**	**3.0035**	**3.4621**

What can clearly be seen is that overrepresentations of issues stemming from hoards closing as early as 161 remain visible through to the groups of hoards closing either by 211 or by *c.* 250. Notable issues and regions in this regard are those of the years 98 (Spain & the Western Mediterranean), 103-105 (Britain), 107-108 (Eastern Mediterranean), and 116-117 (Rhine). Their continued overrepresentation, while other overrepresentations disappear after their first appearance in one of the early subsets (*e.g.*, the 114-116 issue in the Western Danube), is a curiosity.

If the pattern of overrepresentations seen above does indeed reflect where significant quantities of new *denarii* were sent after striking, then any range of explanations might be fielded as to why some of them last while others do not. It is possible that the regions with the strongest concentrations attest to particularly large or repeated shipments, and/or that the nature of circulation differed between those regions where concentrations appear to persist and where they do not. It is interesting to note, for instance, that among these regions are Britain and Spain, whose (pen)insular geographies might have played a role in preventing coins from wandering too far after being released into circulation. It will be seen time and again throughout this study that Britain, in particular, displays a tendency to hold on to shipments of silver coins, much in the manner of *aes*.[2] This is only a theory, of course, and would have to account for a) the concentration in the Eastern Mediterranean (107-108) and b), the fact that overrepresentations in another peninsular area of the empire – namely, Italy – do not appear to be as persistent. On Italy: it should be conceded that the overrepresentation for 116 does indeed appear to fizzle out, but the 107-108 issue returned overrepresentations for the 161 subset and in the complete dataset of hoards closing up to *c.* 250. The standardised residuals in between (for the 180-211 subsets) do not signify overrepresentation, although the result for the 180 subset is at the higher end of the 'normal' range. At other points in this study (*e.g.* in **Chapter 2**, **Table 2.6**, and **Chapter 3**, **Table 3.5**), Italy will show itself to be as likely as Britain and Spain to produce sets of overrepresentations spanning all hoard groups.

It is inevitable that we should want to speculate on the reasons that might lie behind some of the overrepresentations we see here at the level of the issue. To that end we might return to the overrepresentations of *denarii* struck 107-108 among the hoards from Italy and the Adriatic. Caution should, of course, be exercised when struck by the temptation to link overrepresentations in the hoard record to known events in the historical record, but it is perhaps worthy of note that 107 was the date of Trajan's third and final *congiarium*, held alongside a triumph and games to mark final victory over Dacia in 106. If a link between this overrepresentation and the *congiarium* of 107 is to be credited, then it might be asked why no similar overrepresentations occur at the level of the issue for *denarii* struck around the time of the first (in the year 99, presumably to mark the accession; 99) and second *congiarium* (in 103, marking the first Dacian victory). Answers to this can only be guessed at, but it should first be pointed out that although no evidence survives for *congiarium* II at the level of the issue,

[2] On the *aes* supply to Britain: Walker 1988; Kemmers 2009a, 2014.

there is an overrepresentation of a Pax and Dacian coin design of *c.* 103 among the Italian hoards (discussed in the section on coin designs, below). As to why the third *congiarium* was the only one to leave a mark at the level of the issue: perhaps it was simply the largest of three *congiaria* in terms of overall spend, or made use of more new *denarii* than its predecessors, therefore leaving a mark in the hoard record that the other two did not.[3] We hear from Casius Dio, among others, that the scale of the celebrations in 107 was unlike anything that had come before.[4] It will be seen in succeeding chapters of this study how frequently known *congiaria* are mirrored by Italian overrepresentations of *denarii* struck in the same years.

The remaining overrepresentations, which are spread between all regions and nearly all issue periods, defy attempts to apply historicising explanations. Note, for instance, the lack of any overrepresentations of *denarii* struck at the time of the first or second Dacian wars (101-102 and 105-106) in the Western Danube and the Eastern Danube – two regions that would surely have borne the brunt of much of the heightened military activity over these years. It is possible that gold was being used to finance the military in Dacia instead, but the evidence for this presently on the CHRE database is inconclusive; equally, stocks of older, recycled *denarii* might have been distributed instead.[5] The only hint that either of these regions were in

[3] Amounts spent on second century *congiaria* are hard to tally; *cf.* Duncan-Jones 1994, pp. 248-250 for estimates based on information drawn, in Trajan's case, from the *Chronography* of 354.

[4] Cassius Dio, Trajan 15.1 and 68.15.1; Pliny, *Letters* 8.4.2. See also Bennett 1997, pp. 102-103 for a description of the celebrations.

[5] Interestingly, of the handful of *aureus* hoards containing Trajanic *aurei* on the CHRE database from the Danubian frontier and the region of Dacia, the majority (seven out of nine; five of which are, admittedly, hoards of just one or two *aurei*) either end with or are significantly composed of issues of Trajan. Those that are datable were struck, in the main, around the time of the first Dacian war. See: **Râșnov**, Romania (CHRE 9195): two *aurei*, Trajan (*RIC* II 50/*MIR* 99: struck 101/102) and Hadrian (*RIC* II.3 50/51: struck 117); **Cristești**, Romania (CHRE 9124): single *aureus* of Trajan (*RIC* II 35/*MIR* 71: struck 100); **Jac**, Romania (CHRE 13189): single *aureus* of Trajan (*RIC* II 50/*MIR* 99: struck 101/102); **Vărădia**, Romania (CHRE 9205): two undated *aurei*, Nero and Trajan; **Banatska Palanka**, Serbia (CHRE 9189): 157 *aurei*, 100 of which unidentified. Identified portion ending seven undated *aurei* of Trajan; **Zemun**, Serbia (CHRE 2777): 250 *aurei*, 20 of which unidentified. Identified portion ending six *aurei* of Trajan (*RIC* II 15/*MIR* 23 and *RIC* II 5/*MIR* 55/56: both struck 98-99); **Bulgaria – Unknown Findspot** (CHRE 9790): single *aureus* (*RIC* II 762/*MIR* 407: struck 112-113); and **Belgrade – Batal Mosque, Serbia** (CHRE 2778): 27 *aurei*, ending with seven *aurei* of Trajan struck 98-117 and one *aureus* of Hadrian.

receipt of large numbers of new *denarii* in the run-up to the wars occurs in the Western Danube, in the form of a sole overrepresentation of coins struck in 100. This might perhaps be the result of Roman military build-up. It is known that Trajan, as soon as late 98, took the decision to tour the Danubian frontier, possibly with a view to a future invasion of Dacia, but the lack of subsequent overrepresentations for the war years is a conundrum; Bennett argues that the first war was not very long in the planning, which might account for the lack of evidence in the hoard record.[6] The second war (105-106) was sprung on the Romans with little warning, and so a lack of overrepresentations in the run-up is, again, understandable, but the absence of evidence for the arrival of large batches of new *denarii* dated 105-106 remains a challenge. Hobley, too, noted that neither war appeared to result in significant quantities of newly struck *aes* denominations in either Raetia or Pannonia.[7]

Our inability to explain many of the overrepresentations in **Table 1.6** is a reminder that so much of the decision-making framework that underlay the distribution of new *denarii* from Rome is lost to us, and that much of the activity that χ^2 has brought to the fore is likely to evidence what might be termed 'regular supply' to support provincial administration, finance army pay, *etc*. How decisions like this were arrived at is beyond us; Jones, to quote one example, quite reasonably speculated that movement of coin from Rome to a province might only occur when the administration of that province spent above their income and required a cash top-up.[8] Repeated and seemingly regular movements of new *aes* from Rome to Britain militate against this being a satisfactory cover-all explanation for why and when the government chose to move new coins into that province, at least.[9] Both Kemmers and Wigg-Wolf have wondered whether regular supply, outside of times of crisis, was organised on a cyclical basis, in which regions essentially took their turn to receive a bulk lot of one

[6] Bennett 1997, pp. 87-88.
[7] Hobley 1998, p. 38.
[8] Jones 1960, pp. 102-103.
[9] See again Walker 1988, esp. pp. 288-300.

year's production.[10] The evidence in **Table 1.6** does not entirely support this interpretation for Trajan's silver, although the ways in which overrepresentations alternate between the Western Danube and Eastern Danube might be suggestive. Similar results for the later reigns of Hadrian, Antoninus, and (to an extent) Aurelius present a stronger case for coin distribution being organised on a cyclical or rotational basis. We cannot forget, too, that we are only speaking of new *denarii*: an unknown quantity of shipments comprising older, recycled *denarii* will have taken place.

ii. Distribution at the level of the issue

Discussion has, so far, focussed on specific instances of overrepresentation in a small number of issue periods and regions. Their interest lies in that they are still visible in the surviving coin record, and because they shed light on when the state chose to move discrete batches of coins from Point A to Point B for specific purposes, known or unknown to us. Though interesting, these episodes are, by their nature, extraordinary, and on their own they are of small benefit to our understanding of the *overall* landscape of the circulating *denarius* coinage that lies behind them. In order to understand what the distribution of the *denarius* looks like at the level of the issue, the seven standardised residuals for each issue period – one per region – were averaged out, and their standard deviations plotted in **Figure 1.2**, below. These show that the standard deviation from the average on a per-issue basis is generally quite low: between 0.5371 and 1.9645, with a range of 1.427. The extreme outlier, in the form of the high standard deviation for 114-115 (3.6177), will be addressed below.

[10] Kemmers 2006, pp. 212-215; Wigg-Wolf 2014, p. 163.

1: Trajan

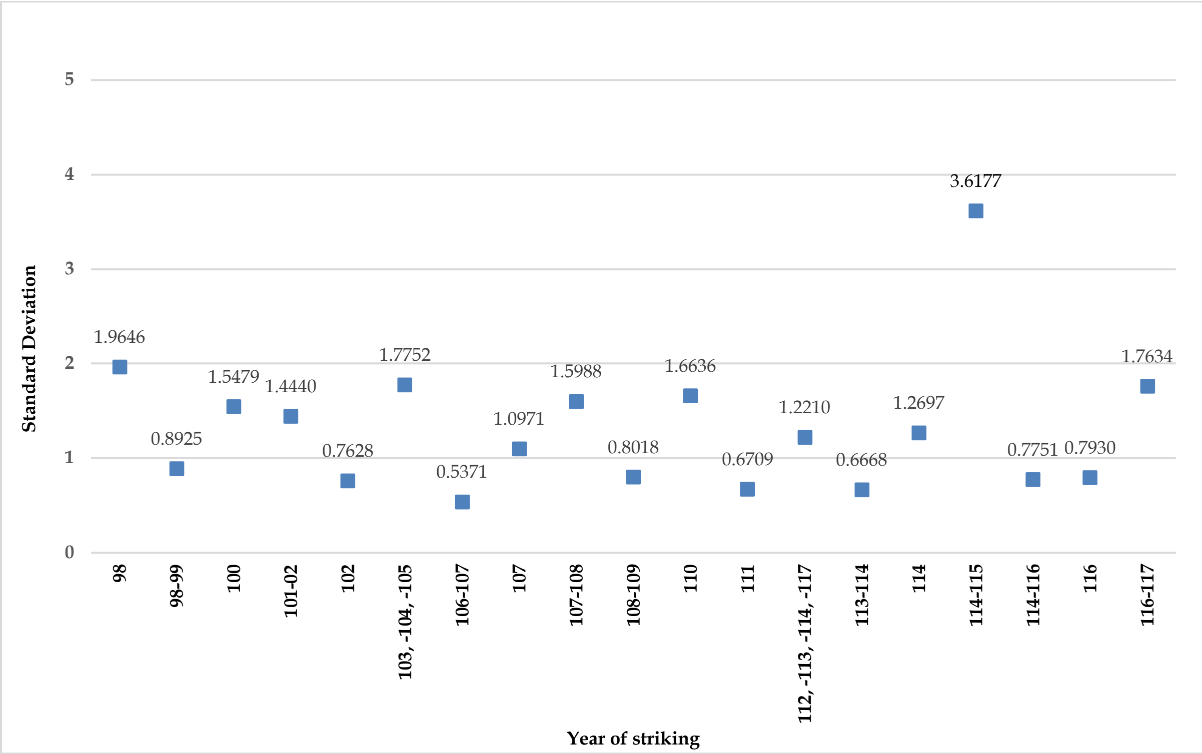

Figure 1.2: Standard deviations at the level of the issue – *denarii* in hoards closing up to *c.* 250. Range (excluding 114-115): 1.4274. Average (ditto): 1.3085

What the above tells us is that, in a dataset composed of hoards with no limit placed on their closing dates, the interregional distribution of the *denarius* at the level of the issue exhibits a low degree of variance. None of this is to deny that differences do exist; overrepresentations of particular issues in one or another region, discussed above in section *i*, show they do. Rather, the general picture is one in which most issues are present in most regions in broadly comparable proportions. The inferences that might be drawn from this are twofold: either virtually all *denarius* issues were released into circulation on a widespread basis to begin with, or – more likely, given the evidence presented in section *i.*, and throughout this study – circulation removed or dulled interregional differences brought about by an uneven coin supply. This finding complements similar work undertaken by Spoerri Butcher and Hellings (2017), who found that the relative frequencies at which Trajanic *denarii* occurred in two hoards datasets from two entirely different parts of the empire (Romania and northwest Europe) mirrors, to a striking degree, the frequency at which *denarii* belonging to those same issues appear in the enormous Reka Devnia (Bulgaria) hoard. This, they argued, demonstrates that the pool of Trajanic *denarii* as it currently exists across Europe is virtually homogenous at the broader level of the issue: see a reproduction of their chart below (**Figure 1.3**).

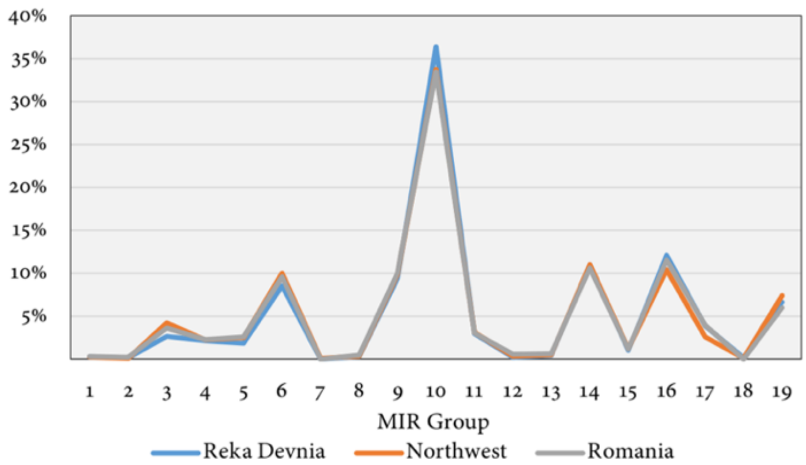

Fig. 3 – The relative frequency of Trajan's denarius issues, expressed in percentage of the total number of coins within each sample (Reka Devnia: n = 5,205; Northwest: n = 1,161; Romania: n = 3,508)

Figure 1.3: Reproduction of Spoerri Butcher and Hellings 2017, p. 68, Figure 3

If we are to conclude, on the basis of this, that circulation is responsible for the broad degree of uniformity we see at the level of the issue in hoards closing as late as *c.* 200-250, then it is natural to wonder if coins from hoards with much earlier closing dates, *e.g.* 161 or 180 (the earlier of the four subsets being tested here), exhibit a wider degree of interregional variance.

To test this, **Figures 1.4** and **1.5**, below, plot the standard deviations for the χ^2 standardised residuals arising from tests on the 'early' subsets of hoards closing by 161 and 180 in **Tables 1.1** and **1.2**, above. Whether they do or do not exhibit a lesser degree of homogeneity at the level of the issue is – surely(?) – one of, if not the, tests that does or does not validate the decision to analyse hoards according to their closing dates.

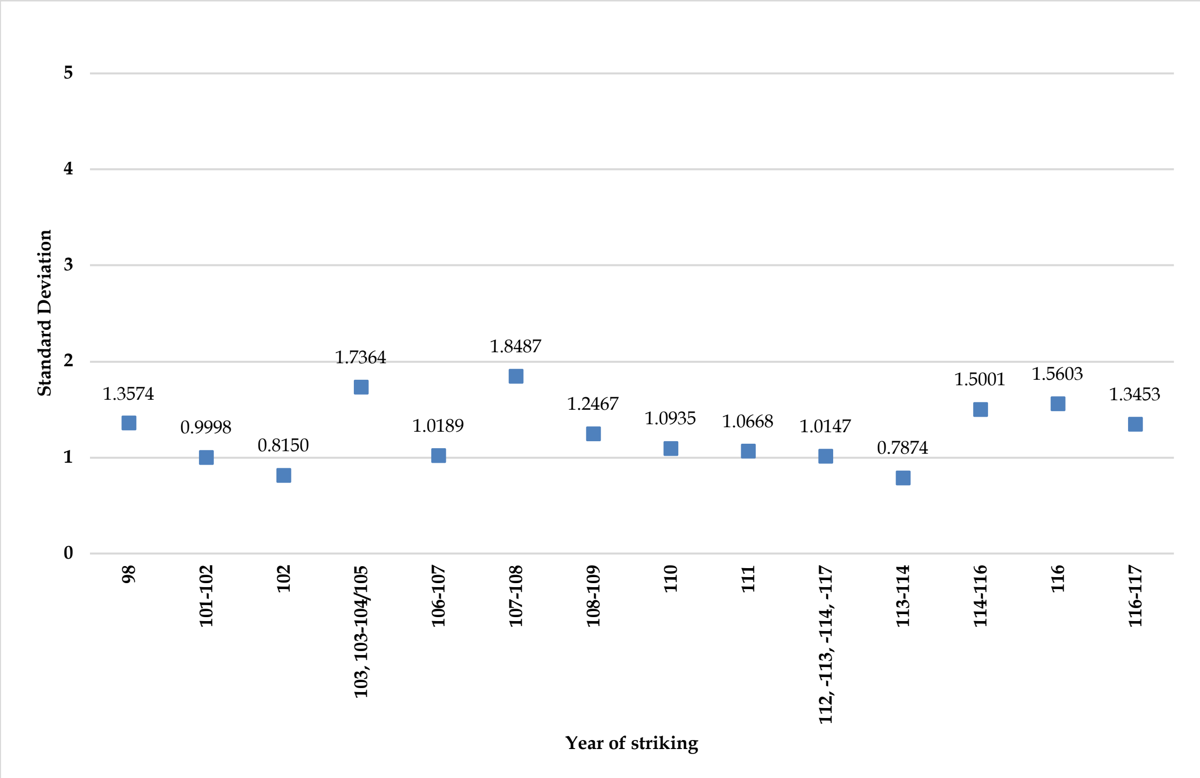

Figure 1.4: Standard deviations at the level of the issue - *denarii* in hoards closing up to 161. Range: 1.0613. Average: 1.2422

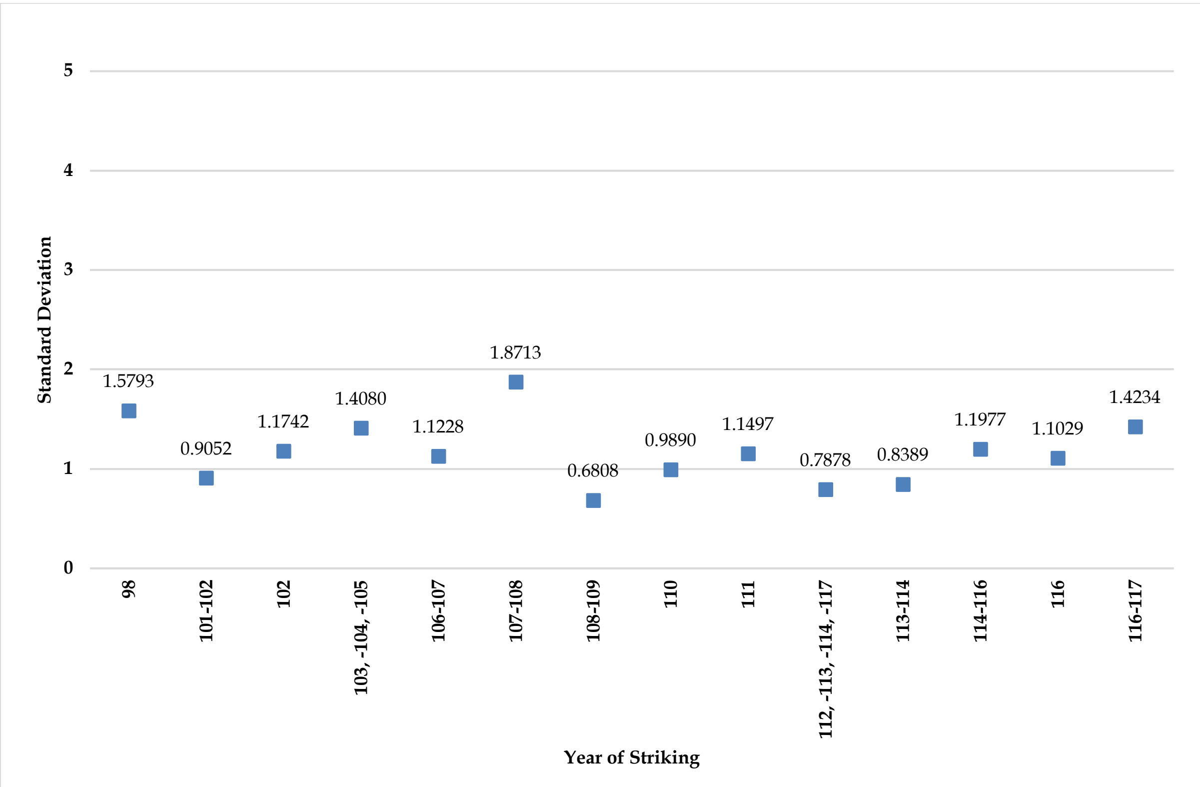

Figure 1.5: Standard deviations at the level of the issue - *denarii* in hoards closing up to 180. Range: 1.1905. Average: 1.1594

Table 1.7: key to standard deviations in Figures 1.2, 1.4, and 1.5			
Period	**Figure 1.2:** ***Denarii*** **in hoards up to** ***c.*** **250**	**Figure 1.4:** ***Denarii*** **in hoards up to 161**	**Figure 1.5:** ***Denarii*** **in hoards up to 180**
98	1.9645	1.3574	1.5793
98-99	0.8924	-	-
100	1.5479	-	
101-102	1.4440	0.9998	0.9052
102	0.7627	0.8150	1.1742
103, 103-104, 103-105	1.7751	1.7364	1.4080
106-107	0.5371	1.0189	1.1228
107	1.0971	-	-
107-108	1.5987	1.8487	1.8713
108-109	0.8018	1.2467	0.6808
110	1.6636	1.0935	0.9890
111	0.6709	1.0668	1.1497
112, 112-113, 112-114, 112-117	1.2210	1.0147	0.7878
113-114	0.6668	0.7874	0.8389
114	1.2697	-	-
114-115	3.6177	-	-
114-116	0.7751	1.5001	1.1977
116	0.7929	1.5603	1.1029
116-117	1.7633	1.3453	1.4234
Range	**1.4274**	**1.0613**	**1.1905**
Average	**1.3085**	**1.2422**	**1.1594**

Comparison of **Figures 1.4** and **1.5** with **Figure 1.2** (all hoards up to *c.* 250) shows that the general ranges of the standard deviations are broadly the same, and that in all three cases the majority of the standard deviations exist within the same general register (between around 0.5 and 2.0). On the strength of this evidence, then, we are not on firm ground: the similarity exhibited by all three groups, regardless of closing date, casts doubt on the notion that any number of the 'early' hoards were indeed compiled nearer the date of their latest coins, rather than simply being *e.g.* early third-century hoards that just happen to close with earlier *denarii.* This might well be true, but it should be pointed out that we are here analysing the spread of issues against hoards that close by 161 at the very earliest. The issue, perhaps, might lie in the fact that we do not have access to a sufficient sample of coins from hoards closing by the end of Trajan's or Hadrian's reigns, which might have afforded a better view of how diffuse the distribution of Trajanic *denarii* once was in comparison to hoards closing between 161 and *c.*

250.[11] It could well be that beginning a phased analysis of distribution with hoards closing by 161 at the earliest is too late a starting point for the Trajanic coinage, and that by this time – up to 44 years after the end of the reign, in 117 – his silver coinage had already mixed to a significant degree. In later chapters, it will be seen that the standard deviations from χ^2 tests on the coinages of Hadrian, Antoninus, and Aurelius exhibit a wider spread for the 161 and 180 subsets (*i.e.*, from hoards closing much nearer to the ends of their reigns) than in the groups of hoards with later closing dates (192, 211, and up to *c.* 250).

None of this is to deny that there are occasional differences in the pattern of distribution at the level of the issue, even if the overall picture is one of relative uniformity. Ten of the 19 issue periods tested by χ^2 returned standardised residuals signifying a degree of over- or under-representation in one region or another. These issue periods are: 98, 100, 103-105, 107-108, 110, 114-115, and 116-117. In each case, χ^2 judged the quantities of coins and the regions in which they were found to be unrelated and independent of one another (see again **Table 1.6**).

Figure 1.6: *denarius* of Trajan struck 114-115. *COS VI P P S P Q R*; Trajan and Jupiter left (*RIC* II 336; *MIR* 513v)

[11] The portion of the Trajanic dataset from hoards closing by 161 is composed of 3,406 *denarii* from 68 hoards. Of these *denarii*, just short of half - 1,564 – come from hoards closing by the end of Hadrian's reign in 138: far too few for χ^2 analysis.

Three of the overrepresented periods – the years 100 (Western Danube), 114-115 (Eastern Danube), and 116-117 (Rhine) – can be explained with reference to regional concentrations of certain designs within those issues. For example: the overrepresentation of *denarii* of 114-115 in the Eastern Danube is entirely down to the fact that χ^2 observed an unusual quantity of the Trajan and Jupiter design (**Figure 1.6**), all but two of which are concentrated in the Reka Devnia hoard (a fuller discussion of the results of χ^2 tests carried out at the level of the design will take place in section *iii.,* below). It is not unusual for Reka Devnia, by dint of its sheer size, to harbour most examples of any given design in purely numerical terms, but the degree of imbalance between Reka Devnia and the rest of the hoards in the dataset in this instance is unusually pronounced – so much so, that it caused the entire issue of 114-115, of which Trajan and Jupiter *denarii* form the largest part of our dataset for those years, to appear overrepresented in the Eastern Danube (**Table 1.5**), and to deviate so much farther from its average than the others presented in **Figure 1.2**. A hint of this imbalance can be seen in Spoerri Butcher and Hellings' chart (see the reproduction above), where *denarii* belonging to *MIR* group 16 (corresponding with 114-115) appear to be commoner to the Reka Devnia hoard than those of northwest Europe. Much the same was observed when the data behind this study were plotted in a manner following Spoerri Bucher and Hellings; see **Figure 1.7**, below – especially the clear difference in the relative frequencies of the 114-115 issue in Reka Devnia (where Trajan and Jupiter *denarii* make up around 3% of its Trajanic total) and all the other hoards used by this study (where it comprises barely 0.3% of the total).[12]

The Trajan and Jupiter type is just the most pronounced example of several overrepresentations at the level of the design, probably signifying a discrete shipment (or shipments) from the mint. The other issue periods to have returned results signifying over- or

[12] The two differ only in respect of how they divide the data: by *MIR* group as opposed to years of issue (although there is considerable overlap), and in its extent; Spoerri Butcher and Hellings did not make use of British or Italian data, for instance.

underrepresentation in one region or another are the years 98 (Spain and the Western Mediterranean, Eastern Danube), 103-105 (Britain), 107-108 (Britain, Italy and the Adriatic), and 110 (Eastern Danube, Eastern Mediterranean): see again **Table 1.6**, above. Apart from the 114-115 issue, none of these overrepresentations could be traced back to a corresponding bulge in the presence of any one design.

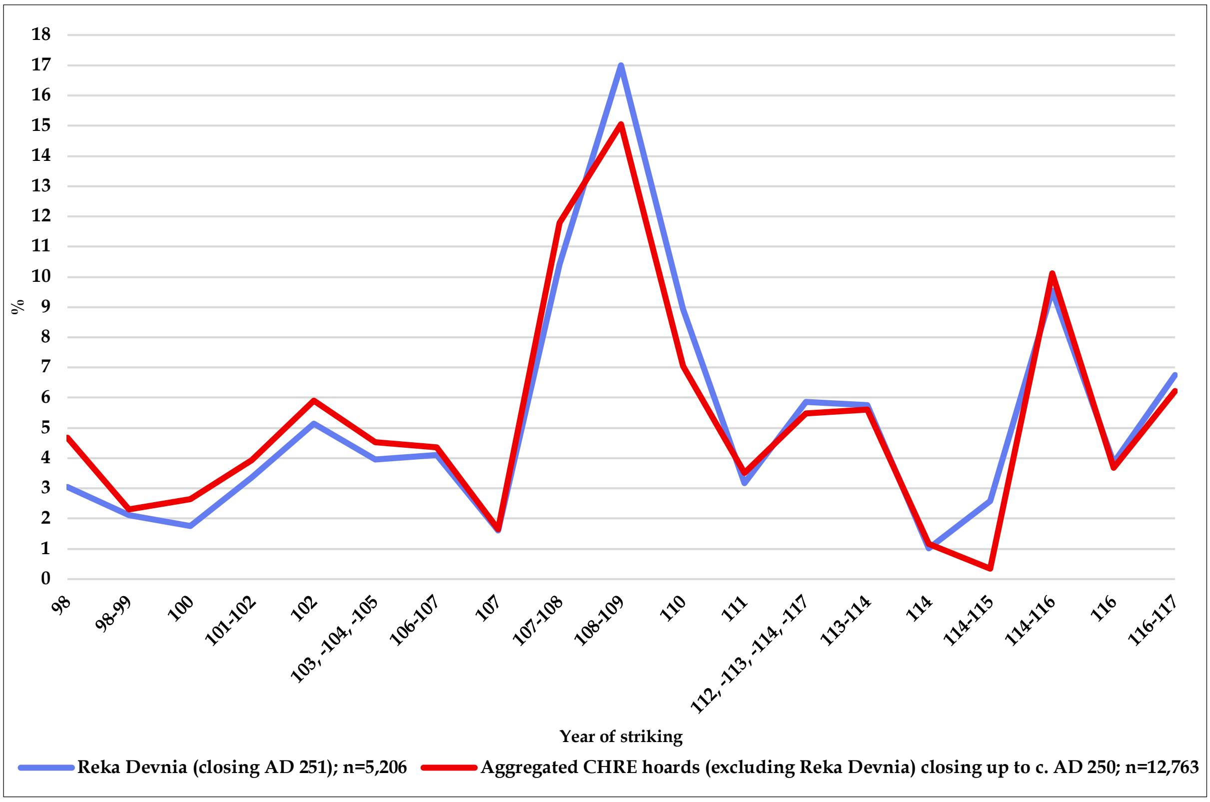

Figure 1.7: Relative frequencies of denarius issues of Trajan, expressed as percentage of the total number of coins in each dataset

These episodes of overrepresentation at the level of the issue are relatively few and should not detract from the overall picture created by the standardised residuals and standard deviations presented in **Figure 1.2**, as well as the close correspondence between the frequency of issues in both Reka Devnia and the rest of the hoards (**Figure 1.7**), which indicate that quantities of coins per region and per issue period are not significantly at variance.

iii. **Results of χ^2 tests at the level of the design**

The same number of *denarii* as were analysed at the level of the issue were subjected to χ^2 testing at the finer level of the design. As explained in the Introductory chapter, the *denarii* of each issue period were divided into categories defined by reverse design. Some of these categories correspond with individual *RIC* or *MIR* references, while others group several *RIC*/*MIR* references together because the reverse types in question were so similar, and because this allowed the creation of groups of a size sufficient for χ^2 testing. Not all designs could be tested, owing to the fact that there were too few to support analysis. In some cases, designs from neighbouring issue periods were merged and analysed together, *e.g.,* the issue two issue periods for the years 100 and 101-102; both contained enough coins to be analysed separately at the level of the issue, but when divided between their constituent designs, the resultant groups were too small to support analysis. Instead of cutting them from the design-level tests altogether, it was decided to merge them into a single group.

A full set of results arising from the χ^2 tests at the level of the design are presented in **Annexe 1** (they are far too large to list here). Examination of these will show that, as with the tests at the level of the issue, χ^2 detected several instances of under- or overrepresentation at different times and in different places. These will be discussed a little later on. The majority of the standardised residuals, however, fall within the band (between -2 and 2) that might be termed 'normal': χ^2 did not detect any significant concentrations in any one region (*i.e.*, in almost no case did the 'observed', or actual number of coins deviate too greatly from the expected value as predicted by χ^2). **Figure 1.8** and **Table 8**, below, present the standard deviations (from the average of the standardised residuals) for design in each issue period.

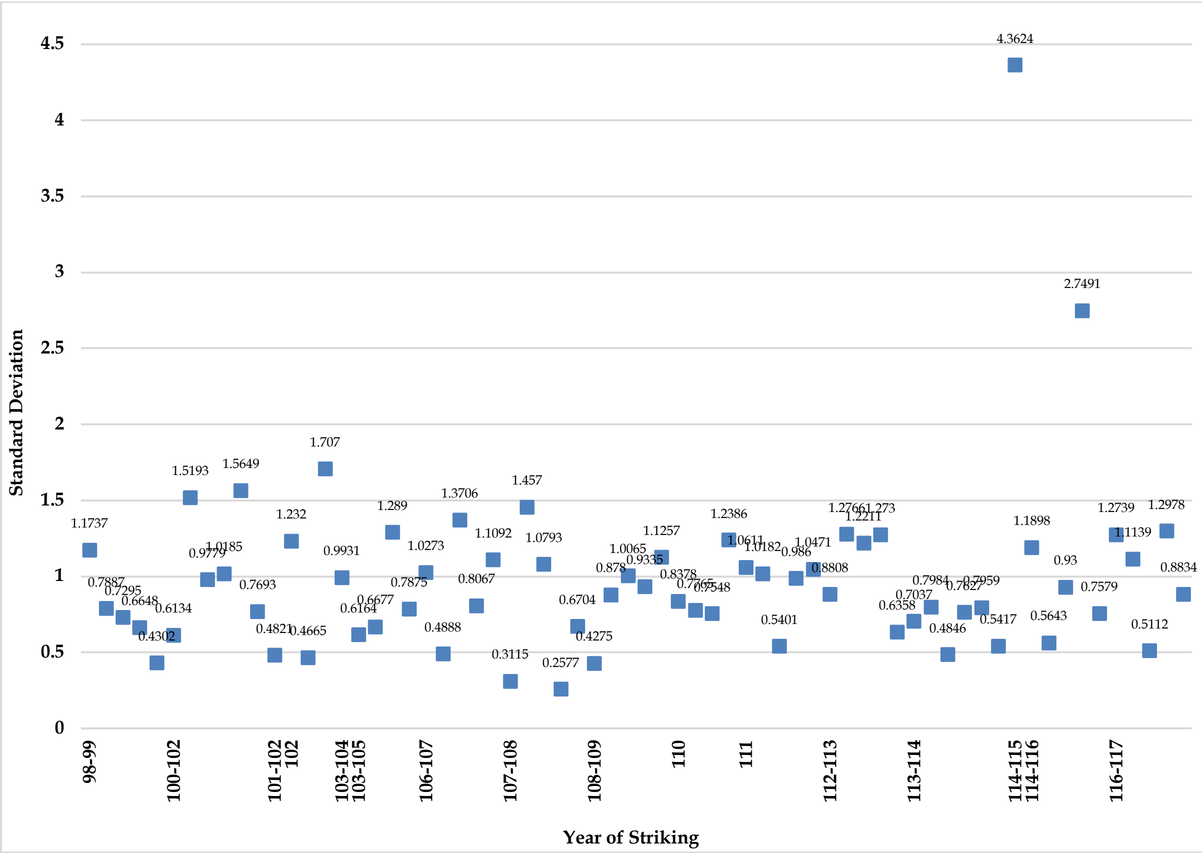

Figure 1.8: standard deviations at the level of the design (*denarii* in hoards closing up to *c*. 250). Range (excl. Jupiter and Mars, 114-115/116): 0.9000. Average: (ditto) 1.4493

Table 1.8: Key to the standard deviations in Figure 1.8			
Period	**Design**	**Average of the standardised residuals for design**	**Standard deviation**
98, 98-99	Abundantia	-0.1253	1.1737
	Concordia	0.0276	0.7887
	Pax	-0.0409	0.7295
	Vesta	0.1584	0.6648
	Victoria	0.0011	0.4302
100, 101-102	Abundantia	0.1304	1.5193
	Concordia	0.0214	0.6134
	Hercules	0.1471	1.0185
	Mars	-0.1429	0.4821
	Pax	0.2665	0.9779
	Vesta	-0.3791	1.5649
	Victoria	-0.0736	0.7693
102	Victoria advancing	-0.2694	1.2320
	Victoria head left	0.0013	0.4665
	Victoria on prow	0.4275	1.7070
103, 103-104, 103-105	Dacian	0.0159	0.6164
	Fortuna	-0.1529	0.6677
	Pax and Dacian	0.2607	1.2890
	Trajan & Victoria	0.1452	0.9931
	Virtus	-0.2266	0.7875
106-107	Abundantia	0.0635	1.0273
	Felicitas	0.0344	0.4888

Table 1.8: Key to the standard deviations in Figure 1.8			
Period	**Design**	**Average of the standardised residuals for design**	**Standard deviation**
	Genius	0.0096	1.3706
	Mars	0.1676	0.8067
	Pax and Dacian	-0.2603	1.1092
107, 107-108	Fortuna	-0.0958	0.3115
	Mars	-0.0999	1.4570
	Spes	0.0675	1.0793
	Trophy	0.0164	0.2577
	Victoria	0.0332	0.6704
108-109	Aequitas	-0.0299	0.4275
	Dacian	-0.2167	0.8780
	Felicitas	-0.0878	1.0065
	Roma	0.1129	0.9335
	Victoria	0.2019	1.1257
110	Arabia	0.2323	0.8378
	Dacian	-0.3368	0.7765
	Felicitas	0.0121	0.7548
	Roma	-0.0647	1.2386
111	Aeternitas	-0.1405	1.0611
	Pax	0.2021	1.0182
	Pietas	0.0322	0.5401
	Vesta	-0.1703	0.9860
	Victoria	0.0960	1.0471
112, 112-113, 112-114, 112-117	*ALIM ITAL*	-0.0513	0.8808
	Arabia	-0.1456	1.2766
	Trajan on horse	0.1366	1.2211
	DIVVS PATER TRAIAN	-0.0379	1.2730
	VIA TRAINA	0.1155	0.6358
113-114, 114	Aquila	-0.0322	0.7037
	Bonus Eventus	-0.0552	0.7984
	Felicitas	0.0118	0.4846
	Fortuna	0.0058	0.7627
	Mars	0.0218	0.7959
	Trajan's Column	0.0479	0.5417
114-115, 114-116	Bonus Eventus	0.1864	1.1898
	Felicitas	-0.2276	0.5643
	Fortuna Redux	0.0247	0.9300
	Mars	0.7061	2.7491
	Trajan and Jupiter	-1.2409	4.3624
	Virtus	0.1005	0.7579
116, 116-117	Felicitas	0.0279	1.2739
	Fortuna Redux	0.0549	1.1139
	Mars	-0.0046	0.5112
	Providentia	-0.1047	1.2978
	Virtus	0.0500	0.8834
		Range (excl. Jupiter and Mars, 114/115-116)	**1.4493**
		Average (excl. Jupiter and Mars, 114/115-116)	**0.9000**

The two exceptions to this relative uniformity come in the form of the Trajan and Jupiter design of 114-115 (already mentioned above) and the Mars design of 114-116 (*RIC* II 337-340; *MIR* 520v). In both cases, the very high standard deviations (4.3624 and 2.7491 respectively) correspond with specific under- or overrepresentations in particular regions. The Trajan and Jupiter design described above in section *i.* is highly overrepresented in the Eastern Danube while being underrepresented everywhere else (**Figure 1.9**). The Mars design is similar: overrepresented in both Britain and the Western Danube, while it is either underrepresented (in the Eastern Danube) or 'normal' everywhere else. In this case, the size of the overrepresentations from both regions were insufficient to register at the level of the issue (see **Table 1.1 and Figures 1.2 1.4-1.5,** and **1.8**) – here, the χ^2 results do not suggest that the overall distribution of coins struck 114-116 displays any significant interregional variance.

Figure 1.9: British single find of a *denarius* of Trajan struck 114-116. *P M TR P COS VI S P Q R*; Mars right (*RIC* II 337; *MIR* 520v)

The extraordinary standard deviations and standardised residuals for the two designs of 114-115/116 aside, the rest of the standard deviations at the level of the design in **Figure 1.8** sit well within a range that signifies a level of distribution that is no more pronounced in one region over another; of the 66 designs under scrutiny, the majority returned a standard deviation somewhere between around 0.4/0.5 and 1.5, with an overall range between the highest and lowest of only around 1.4 standard deviations. This range is only slightly narrower than that of the standard deviations at the level of the issue (**Figure 1.2**), which, it was observed, indicate an appreciable degree of homogeneity in the relative proportions of *denarii* between regions.

1: Trajan

The picture painted by a dataset of hoards closing between 98-*c.* 250, then, is one in which a group of hoards terminating, in the main, in the late second and third centuries, and from such widely separated locations as the eastern reaches of the Danube, Britain, and Spain, are equally likely to contain many of the same designs and in very similar proportions. In so doing, this study has taken the issue-level findings of Spoerri Butcher and Hellings (2017) one step further in showing that Trajanic *denarii* also achieved a high level of mixing at the level of the design, occurring across Britain, northwestern Europe, the Rhine, Italy, Spain (where data are available), the Danubian frontier, and even the Eastern Mediterranean (again, where there are sufficient data) in ways that do not indicate any real degree of regional difference.

Significant difference continues to exist in the scholarly interpretation of coin finds and hoards data and the nature of coin circulation in the second century; in this respect, any result that moves us closer to a truer understanding of the mobility of the *denarius* should be a welcome one – even if, as here, the revelation that the majority of coin designs achieved a fairly uniform coverage of the regions under survey is not particularly surprising given our understanding of how coins appear to have done so at the higher level of the issue.

The caveats to the above are twofold. First, it should be stressed this result is the product of a database of coins that comes from hoards closing as late as the mid-third century, and that the point at which this high level of mixing was achieved is open to debate: the dataset here – as mentioned above – is composed of hoards that close well after Trajan's reign: of the 266 hoards in the dataset that contain Trajanic *denarii*, 20% (54 hoards; 2,238 *denarii*) close up to 120, whereas 43% close in the 40 year period between 161-200 (115 hoards; 6,885 *denarii*), and 37% close 201-*c.* 250 (99 hoards; 8,854 *denarii*). The second caveat regards the matter of how we reconcile this finding with the seeming fact that a smaller number of designs appear to concentrate in certain regions, apparently defying the circulatory forces that led others to achieve a wide circulation across all regions.

1: Trajan

A total of 11 designs belonging to eight issue periods emerged from the χ^2 tests with standardised residuals pointing to overrepresentation in one region or another; these are presented in **Table 1.9**, below:

Table 1.9: Overrepresented designs (≥2 standardised residuals)				
Year	**Design**	**Region in which design is overrepresented**	**No. of coins (Compared to regional total of all designs for same year)**	**Standardised Residual**
100, 101-102	Abundantia	Western Danube	35 (267)	2.5545
	Vesta	Eastern Danube	66 (447)	2.3176
102	Victoria on prow	Western Danube	54 (216)	2.1276
103-105	Pax and Dacian	Italy and the Adriatic	14 (61)	2.1933
108-109	Victoria	Spain & Western Med	18 (71)	2.3818
110	Roma	Britain	66 (167)	2.5155
112-113	Trajan on horse	Spain & Western Med	11 (33)	2.1462
	DIVVS PATER TRAIAN	Britain	29 (105)	2.0292
114-15, 114-16	Mars	Britain	46 (218)	2.7196
		Western Danube	73 (378)	2.7799
	Trajan and Jupiter	Eastern Danube	117 (984)	7.4122
116, 116-17	Felicitas	Rhine	32 (126)	2.1285

At first glance, instances of overrepresentation are fairly well distributed across the reign from its earliest stages to its end, and there does not appear to be a clear patterning of where these occur. No one region looks to be dominant, nor is a broader trend (*e.g.,* an eastern or western bias) apparent, and few – if any – designs bear any justifiable relevance to the regions in which they occur. A lone exception to this comes in the form of the Pax and Dacian design struck *c.* 103-105 (**Figure 1.10**), which is overrepresented in Italy and the Adriatic alone. It was mentioned in section *i.* that there exists a possible correspondence between this overrepresentation and the triumphal *congiarium* held in early 103 to mark victory in the first Dacian war, but this is far from certain, not least because of continued uncertainty on the part of Woytek (*MIR*) as to when, within the years 103-105, these *denarii* were struck.

Figure 1.10: *denarius* of Trajan struck 103-105. *S P Q R OPTIMO PRINCIPI*; Pax left stepping on Dacian *(RIC* III 190; *MIR* 194)

It could further be ventured that seven of the 11 designs (excepting Abundantia, Vesta, Divus Pater Trajan, and Felicitas) are 'martial' in character – some very definitely (*e.g.*, Mars, Trajan & Jupiter, Pax and Dacian), others not (*e.g.*, Vesta, or *DIVVS PATER TRAIAN*).[13] The regions in which these concentrations occur could, likewise, be called 'military': barring the one overrepresented design from Italy and the Adriatic, all those in **Table 1.9** originate in frontier provinces – Britain, the Rhine, the Danubes, and Spain – that were host to major garrisons (the latter, though not a frontier, was garrisoned by one legion).[14] Could this be indicative of how the mint distributed messages on coins, and of the audience (*i.e.*, the army) it considered worthiest of this effort? It is interesting that, of all the Trajanic *denarius* designs under survey, it is these that have turned out to be overrepresented on the frontiers. Virtually all the issue

[13] The Trajan on horseback design has been interpreted by Woytek as a depiction of the equine statue at the centre of Trajan's Forum; see *MIR* 393-394, 435, and 461 (*sestertius*). Marzano (2009, p. 140) looked at other *denarius* designs representing various of Trajan's monuments and building projects, such as the famous *VIA TRAIANA* design. She concluded that the mint officials opted to place design like this on the silver (as well as *aes*) because they wanted to utilise the greater range of the *denarius* to spread the image of Trajan as road builder among provincial populations. This, of course, assumes that a) the mint sought to target messages (a view to which this study qualifiedly subscribes), and b) that the mint was even aware that the *denarius*, by virtue of its greater mobility, was the denomination suited to carry messages of wider appeal to audiences around the empire. Marzano's point, however, enables us to 755make a broader one, in that a design's perception could well depend upon the location and situation of the coin user. A design depicting *e.g.* Trajan on horseback might well have been interpreted differently if the viewer was a soldier in Germany or an inhabitant of the city of Rome (where a statue of the emperor on horseback occupied the central position in his new forum complex).

[14] The *legio VII Gemina*, permanently based at León from the mid-Flavian period: Morillo and García-Marcos 2003; Campbell 1994, pp. 83-85.

periods in question also contain designs with 'non-military' themes (see **Annexe 1**), none of which are overrepresented. Tempting though this interpretation of the data might be, it must be borne in mind that most of our data are from frontier provinces in the first place, and that the existence of this trend (if it exists) largely depends upon one's definition of 'martial' in respect of coin designs. Had we more data for less heavily garrisoned areas like the Gallic interior and Italy, then further comment might perhaps be possible.

Beyond designs that share a possible link with militarised frontier provinces, there is little else in the data to suggest that more examples of regionalised distribution according to reverse design have survived in the coin record. Certainly, there is no suggestion in the results of the χ^2 tests that any of the other regional concentrations described by others have much statistical foundation. Richard Duncan-Jones, in the course of longer arguments on the nature of coin circulation in the second century, claimed that: 1) *denarii* bearing the Hercules design of 100 (*RIC* II 37; *MIR* 73) are found exclusively in the eastern Balkans, western Balkans, Poland and Turkey; 2) that the Trophy design of 107-108 (*RIC* II 147; *MIR* 268) is twice as common in northwestern hoards as in eastern Europe and the Near East; 3) that the Trajan in quadriga design, also of 107 (*RIC* II 138-139; *MIR* 273b, 275b), and multiple designs for Diva Marciana and Matidia Augusta of 112-117, are only to be found among the hoards of eastern Europe.[15]

Duncan-Jones rejected the notion that we can or should interpret regional concentrations of reverse designs from the perspective of audience targeting, arguing that neither mint officials nor the coin-using public paid attention to coin designs, and that any regional concentrations we detect today must "have an industrial rather than a doctrinal explanation, reflecting operational variants in the way that the issues were produced and

[15] Duncan-Jones 2005, pp. 475-478 (for the Hercules and Trajan in quadriga designs; this same article references several more *denarius* designs that are apparently unique to one region or another, but doesn't name them), 1990, p. 41 (Trophy); 1990, pp. 41-42 and Appendix 2.B (Marciana and Matidia).

distributed."[16] Rather, his purpose was to say that extant regional concentrations are *de facto* proof that *denarii* never managed to circulate far from their initial points of distribution, and that long-distance movement of coins in the form of taxes, trade, or rents was low enough that the silver coinage never homogenised.[17] In his view, the mint sent batches of new coins to where they were needed, and only when it was practical to dispatch them; any concentrations of reverse designs we spot in the coin record are, therefore, of no regional significance from an audience targeting perspective.[18] In many cases, it should be conceded that this will be true; regionalised distribution ought not to be automatically equated with targeted distribution. As already mentioned, very few, if any, of the overrepresented reverse designs in **Table 1.9** bear a particularly close relevance to the regions in which they are found – a finding that accords with Hobley's (1998) survey of *aes* denominations across the northwestern empire. He, too, found that many reverse designs appear to have been released on a regional basis (and not just in the reign of Trajan), but that few of these concentrations could be taken as positive evidence for audience targeting.[19]

The veracity of Duncan-Jones's assertions – whatever their motivation – hinge on whether his concentrations can be detected in the present dataset with the assistance of a method like χ^2. The 25 examples of the Hercules design struck *c.* 100 (*RIC* II 37; *MIR* 73) from this study's dataset were merged with the far larger number (320) of Hercules *denarii* of 101-

[16] Duncan-Jones 2005, pp. 477-478.
[17] Duncan-Jones' analyses took place before the advent of large databases like the CHRE. It may be that the complete absence of designs from the regions he surveyed is less an indication of actual distribution than the difficulty of gathering a sufficiently large sample (Spoerri Butcher and Hellings 2017, p. 54). This is not to say that the frequency of *denarius* designs did not vary from region-to-region (because they do), but that, to date, no single *denarius* design has been found to have been trapped in one area alone. Mixing did occur on a substantial scale: see Howgego 1994, pp. 10-*ff.* Howgego (*op. cit.* and 1995b, pp. 108-109), seeking to strike a balance, considered both sides of the Hopkins/Duncan-Jones debate. He noted that Hopkins failed to notice very real variations in the distribution of *denarius* designs (British evidence for which is set out by Creighton 2014), and that Duncan-Jones' model was wrong to say that a lack of homogeneity in the coinage is *de facto* proof of a totally fragmented economy.
[18] Duncan-Jones 1994, pp. 177-178.
[19] See Hobley 1998, pp. 38-49 for a breakdown of the distribution of Trajanic *aes* types.

102 to give χ^2 enough power to reliably calculate estimated values and generate a p-value.[20] Their distribution was not found by χ^2 to be abnormal or overrepresented in any of the regions surveyed (see the full χ^2 test in **Annexe 1**, **Table 2**). It speaks volumes that 25 *denarii* were insufficient for χ^2 to run a reliable test, whereas Duncan-Jones took just seven specimens occurring in Eastern Europe and Turkey as the basis of his claim that Hercules is genuinely more common in that part of the empire (and that, moreover, this justifies the claim that eastern Europe is where the Hercules design was released into circulation). For what it is worth, the 25 specimens from the present dataset appear in hoards from areas other than Duncan-Jones said they should: Britain, the lower Rhine, and even North Africa: see **Table 1.10**. This is a salutary lesson in why it is unwise to make definite claims based on absolute numbers from a small dataset, since the addition of just a few more specimens can radically alter the picture. At no point is it conceded by Duncan-Jones that a design's absence from the west might simply mean that the coin hoard data is incomplete or patchy in its coverage.

Table 1.10: the distribution of Hercules, *denarii* struck *c.* 100 (*RIC* II 37; *MIR* 73)		
Region (*per* Duncan-Jones)	**Duncan-Jones dataset**	**This study**
Western Balkans	3	7
Turkey	1	1
Eastern Balkans	2	8
Poland	1	-
Syria	-	-
Germanies	-	2
Britain	-	2
Italy	1	4
Western Mediterranean	-	1
Qty	**8**	**25**

As for the Trophy design of 107-108 (*RIC* II 147; *MIR* 268): Duncan-Jones alleged on the basis of percentages alone that this design becomes increasingly common the further northwest one moves – a claim grounded in 150 coins from six hoards (see reproduction of Duncan-Jones's table of results in **Table 1.11**, below).

[20] See Introductory chapter, section 6.*iii* for a fuller description of how χ^2 functions.

Table 1.11: Representation of Trajan RIC 147 in hoards (reproduction of Duncan-Jones 1990, p. 41, Table 11)		
Region	**Percentage of denarii of Trajan**	**Location**
Syria	1.3	'Tell Kalak'
Lower Moesia	0.8	Reka-Devnia
Dacia	1.8	La Magura
Rhineland	3.3	Stockstadt
Britain (I)	3.3	Bristol
Britain (II)	4.0	Londonthorpe

χ^2 analysis of the same design was backed by over 400 coins from more than 90 hoards (see **Annexe 1,** Table 6) and found no significant regional variation in the distribution of Trophy *denarii*. The standardised residual for Britain suggests nothing akin to the level of concentration we see in Duncan-Jones's data, which purport to show a British concentration of the Trophy type. Even if we compare the British finds of *RIC* II 147/*MIR* 268 with *all* the Trajanic coins in the British portion of our dataset (as Duncan-Jones did), they still represent no larger a percentage of the total number of *denarii* from Britain than in other regions. See **Table 1.12**, below:

Table 1.12: relative frequencies of Trophy *denarii* struck 107-108 (*RIC* II 147/*MIR* 268) expressed as % of all coins in each region. Compare with reproduction of Duncan-Jones (1990) Table 11 (Figure 2.11)	
Region	**% of *denarii* of Trajan**
Britain	2.607
Spain and the Western Mediterranean	3.150
Rhine	2.516
Italy & Adriatic	2.642
Western Danube	2.168
Eastern Danube	2.172
Eastern Mediterranean	2.256

The remaining designs named by Duncan-Jones are the Trajan in quadriga design of 107-108 (*RIC* II 138-139; *MIR* 273) and the various designs issued for Diva Marciana and Matidia Augusta, all of which are said to appear entirely or mainly in eastern Europe.[21] There is barely

[21] Diva Marciana: Eagle (*RIC* II 743, 745; *MIR* 715, 719), Carpentum (*RIC* II 746; *MIR* 723); Matidia Augusta: Pietas (*RIC* II 758; *MIR* 727), Matidia with infants Sabina and Matidia Junior (*RIC* II 759; *MIR* 729).

any point in testing these claims, since the number of coins in question is far too low to support analysis; this study's dataset contains only 14 *denarii* bearing the Trajan in quadriga design (compared to just three in Duncan-Jones's) and 20 *denarii* of the imperial women. Suffice it to say that the actual distribution of the Trajan in quadriga, Marciana, and Matidia designs observed in the CHRE data does not correspond with Duncan-Jones's view of things, since all occur in hoards as widely dispersed as Britain and the eastern Danube.

The purpose of this excursus on the designs discussed by Duncan-Jones was not only to shed further light on distribution, but also to show how firm conclusions made on the basis of small numbers of coins without recourse to statistical verification are likely to be disproven by the addition of just a few more specimens and, moreover, that methods of reckoning based on absolute numbers or percentages are prone to doubt and sudden change with the addition of even a few extra coins.

Figure 1.11: *denarius* of Trajan struck January-February 98. *TR P COS II P P // PROVID*; Trajan, in armour, receiving globe from Senator (*RIC* II 28; *MIR* 10a)

Before summarising, one further design merits special mention, even though it occurred in such low numbers that it was impossible to subject it to χ^2 analysis. The Senator handing globe to Trajan design (**Figure 1.11**) was struck for a very short time between late January and February 98; its high degree of rarity is reflected in the fact that it exists in the form of just three examples from three hoards: Reka Devnia (Bulgaria), Obererbach (Germany), and Köln Gertrudenstraße 1909 (Germany).[22]

That we should find a coin of a rare design in the Reka Devnia hoard is almost to be expected, given its size. The generally large and plentiful hoards of the Danubian frontier typically return at least one example of every design in the dataset; simple numerical probability means the rarer and less plentiful a design becomes, the likelier it is to occur only, or in greatest numbers, within the hoards of this region. It extremely interesting, therefore, that two of the three examples come from a couple of German hoards (Obererbach and Köln Gertrudenstraße), separated by just thirty miles, on the same sector of the Rhine frontier.[23] The likelihood that this is coincidence shrinks further when we recall that Cologne was Trajan's principal headquarters between his accession on the 28th January 98 and subsequent departure for the Danubian frontier later that year.[24] The relevance of this design to Trajan is obvious, and it is tempting to conclude that the mint earmarked production of *MIR* 10a for dispatch to the new emperor at Cologne, possibly for distribution as part of the customary accessional donative. This is certainly possible; equally likely is that the presence of *MIR* 10a in the Cologne region resulted simply from the authorities in Rome sending Trajan a batch of the first coins to have been struck in his name without necessarily thinking of the reverse type, but either eventuality points to a special shipment sent to Trajan in acknowledgement of his accession. Complementary evidence presented by Hobley shows that the area around Cologne appears to have received the lion's share of new *aes* coins over the same period, *c.* 98-

[22] The old *RIC* II identifies Nerva as the figure handing the globe to Trajan.
[23] None of the four examples of this type on OCRE (one from the ANS, three from the BnF), nor the two in the possession of the British Museum, are provenanced beyond the dealers or donors from whom they were acquired. The same can be said of the small handful on CoinArchivesPro.
[24] Trajan's location and movements at the time of his accession are fairly well documented: Bennett 1997, pp. 49-51; Martial *Epigrams* 10.6-10.7, Pliny *Pan. Traian.* 20-22.

99. As much as one third of all the *aes* to have arrived in the region, by one estimate, had probably arrived by *c.* 100, *i.e.,* during the period concurrent with the emperor's presence.[25]

It must, of course, be borne in mind that the low number of coins involved mean we cannot say for certain that the presence of the two Trajan and Senator *denarii* in Germany are evidence of an early shipment from the mint, and there is no evidence – neither from the CHRE database nor the relevant volumes of the *FMRD* series – that contemporary *aurei* bearing the same type have been found in the region. Added to this is the fact that both of the German hoards in question (Obererbach and Köln Gertrudenstraße) close well into the third century; the two possible responses to this are that a) a relatively small parcel of coins preserved itself in the pool of circulating coins around Cologne for some 150 years, or b) these coins circulated into Germany from elsewhere at a later date, and that their presence in these hoards is nothing more than a coincidence.[26] The answer, if the existence of other regional concentrations of *denarii* in later chapters (which could be verified using χ^2) are borne in mind, might well be the former.

iv. Summary

Broad χ^2 analysis at the level of the issue confirms the findings of Spoerri Butcher and Hellings (2017), who noted a high correspondence between the frequency of issues in Reka Devnia and in massed datasets of hoarded coins from elsewhere in the empire. Comparison of the frequency of *denarii* per annum from Reka Devnia with the rest of the hoards assembled for this study (**Figure 1.7**) found the same to be true. This raises the question of whether this indicates a broadly even level of initial distribution to begin with, or one that was levelled out

[25] Hobley 1998, pp. 38-39, 44; Hellings 2025, p. 66 and figure 3.7.
[26] Obererbach, Köln Gertrudenstraße 1909, and Reka Devnia terminate with coins of 222, 238, and 251 respectively. Kemmers 2009b, p. 149-152 wrestles with a similar – though later – problem, in the form of Severan *denarius* types failing to circulate far from their probable points of release in Gaul and Germany in the 230s.

over time in the course of circulation and redistribution of coins in the form of taxes, trade, *etc.* (*per* Hopkins 1980). The existence of a wide range of regionalised overrepresentations at both the level of the issue and the design could suggest the former.

Standardised residuals and their standard deviations derived from groups of hoards closing by 161, 180, 192, 211 and by *c.* 250 indicate that most issues are evenly distributed across most regions, despite some instances of regional overrepresentation. Overall, coins from hoards closing as late as the mid-third century show that most issue periods are widely and fairly evenly dispersed wherever sufficient data exist. The majority of the standard deviations for the residuals do, in fact, sit within a narrow range of about 1.00 standard deviations - a figure low enough to eschew any idea that most of the standardised residuals indicate a kind of distribution that is in any way significant. An attempt was made to directly compare the standard deviations for the earliest subsets (hoards closing by 161 and 180), but the patterns therein did not appear to differ all that much from the main dataset of hoards closing up to *c.* 250 (**Tables 1.1-1.6** and **Figures 1.2, 1.4-1.5**).

Applying χ^2 analysis at the level of the design to the 17,969 coins in the Trajanic dataset likewise revealed little significant regional differentiation. Over- and underrepresentation of designs is comparatively rare, and most standard deviations fall within a narrow range, indicating distributions that are statistically insignificant. Detailed issue-by-issue tests confirm this general lack of meaningful patterning. In the case of the ten designs that returned overrepresentations (*i.e.,* ≥2 standardised residuals), it was noted that most had a martial flavour (Victoria, Dacian, Pax, Mars, *etc.*), and that this might have something to do with their overrepresentation in these regions, virtually all of which sit on the frontier, rather than the other designs struck in those same years (many of which had a less martial tone). This remains a possibility, but it should be stressed that these concentrations may also attest to batches of coins being dispatched, wholesale, to those locations for any number of reasons, none of them to do with the reverse design.[27] This will be a recurring theme of the analyses to come in later chapters.

None of this comes as a particular shock, since all other attempts at uncovering audience-based distributions to date have produced evidence that suggests targeting was an episodic behaviour rather than standard practice. Hobley (1998), for instance, surveyed the *aes* coinage of the western empire over the course of the second century and uncovered little evidence beyond the known examples (*e.g.,* the *BRITANNIA aes* of the next two reigns, also discussed by Walker (1988) in relation to the Sacred Spring at Bath). None of this is to say that audience targeting did not occur; Kemmers (2009a, 2014) found that designs were occasionally distributed with military and civilian audiences in mind during the Flavian period, as did Elkins in the cases of the Flavians, Nerva, and Trajan (2011, 2017a, 2017b, 2019). As Howgego recently observed, most examples of audience targeting that have been identified to date belong to the Flavian-Trajanic period, possibly as a consequence of the fact that this is the period that saw extensive recall and reminting of older coinage (as well as striking of issues for the east at Rome), which might have resulted in a temporarily greater inclination to match coin designs to end-users.[28]

The outstanding example of a regional overrepresentation at the level of the design is the Trajan and Jupiter type of 114–115/116 (*RIC* II 336; *MIR* 513v), which is overwhelmingly concentrated in the Reka Devnia hoard. The standardised residual signifying the intensity of this concentration is very strong (at 7.4122, many times higher than the rest in **Table 1.9**), as is the p-value generated by the χ^2 test on 114-115/116, which, at <2.2e-16, indicates that the

[27] See Beckmann 2007, pp. 90-91. The gold coinage, being less substantial than Rome's output of silver in the second century, allows for meaningful die studies. Beckmann showed that different parts of the Rhine frontier appear to have been in receipt of separate packages of die-linked *aurei* straight from the mint at different times. Again, none of the designs or types in question appear to have a particular bearing on the region to which they were sent.
[28] Howgego 2024, pp. 90-91.

standardised residual is both significant and highly reliable.[29] Its presence is most plausibly explained as a shipment that occurred during Trajan's reign, with the coins remaining in the region until their burial (most of them belong to the Reka Devnia hoard, which closes by 251). It is possible that the image of Trajan associated with Jupiter might have been selected in order to communicate a message to coin users in the Eastern Danube, *e.g.* the army (although the message is unclear: Trajan is togate, rather than armoured, on this design). On balance, it is hard to positively identify these as an example of audience targeting rather than simply the dispatch of coins intended to service any number of other needs, but in any case, it is hard to see how this concentration is possible unless a distinct parcel of those coins arrived in the region in Trajan's day.

A second, though weaker – but no less interesting – case of regional overrepresentation at the level of the design concerns the Trajan and Senator design of January–February 98 (*RIC* II 28; *MIR* 10a). Only three specimens occur in the entire dataset: one in Reka Devnia and two in the area of Cologne, where Trajan was based at the time of his accession. While statistically insignificant, their presence in Germany in greater numbers even than in the Reka Devnia hoard is suggestive that they might represent the remnants of an early shipment (or shipments; note complementary evidence relating to the *aes* from Hobley, mentioned above) sent north to the new emperor as soon as the mint learned of his accession – in which case the target audiences will not only have included those in receipt of the customary accessional

[29] A p-value of 0.05 or below is how χ^2 alerts the researcher to the fact that the test probably contains at least one standardised residual that is important (*i.e.*, overrepresented). A p-value of <2.2e-16 is unusual, being the notation for a figure that is virtually zero. Such a confident, precise figure is cause for suspicion; could a number of Reka Devnia's coins have been misattributed by Moushmov (1934), who drew up the first catalogue of the hoard's contents? Moushmov's attributions have been checked on at least one occasion (Depeyrot 2004), and again by the CHRE Project when preparing the list that would form the basis of the Reka Devnia's record on the project database: see Spoerri Butcher 2019.

donative, but possibly even the emperor himself.[30] Any such interpretation remains speculative given the number of coins available to us.

The broader significance of these results – and those in the chapters to follow – lies in what they reveal about circulation. These data contradict the Hopkinsian model of complete homogenisation driven by taxation and trade, since clear regional differences persist.[31] At the same time, the results also undermine Duncan-Jones' argument for rigidly separated regional pools: most designs he identified as regionally confined are in fact widely distributed.[32] Instead, the evidence supports a compromise position closer to that outlined by Howgego (1994): coinage did mix while in circulation, but slowly and imperfectly. All of this will be discussed in further depth, and with reference to examples drawn from the succeeding chapters, in the final discussion (**Chapter 6**).

---

[30] It is not beyond reason to suppose that the mint will, on occasion, have considered how the ultimate authority might have received their designs. Some scholars have tried to assert that the emperor might have been *the* most important of the mint's target audiences: see Levick 1982, 1999 and Crawford 1983, both *contra* Sutherland 1951, 1983, 1986.

[31] Hopkins (1980). His proposition, in brief, was that tax imposition was a stimulus to monetisation; people needed the money to pay taxes and money rents and so sold produce and other goods to acquire it. This acted as the stimulus to markets, bankers, long-distance trade and the commercialisation of towns and exchange; the money supply rose correspondingly. Coins existed in a cycle that saw tax revenues from more productive 'inner' provinces exported to 'consumer' regions, primarily the frontiers where they took the form of military pay; these coins were spent and re-entered the cycle, being reclaimed by the state in the form of tax and returned to the soldiers, *etc*.

[32] Duncan-Jones 1990, pp. 38-42; 1999, pp. 71-79.

Chapter 2: Hadrian (117-138)

Introduction

This chapter marks the first general distributional survey of Hadrian's silver over a wide area. Once again, the reader should take note of the disposition of the data (largely) along the frontiers. A total of 19,755 *denarii* recorded to the level of the design from 265 hoards were collected from the CHRE database (**Figure 2.1**). Before testing, they were sorted and re-dated according to Richard Abdy's new *RIC* II.3, which replaces *RIC* II (1926) for the reign of Hadrian.

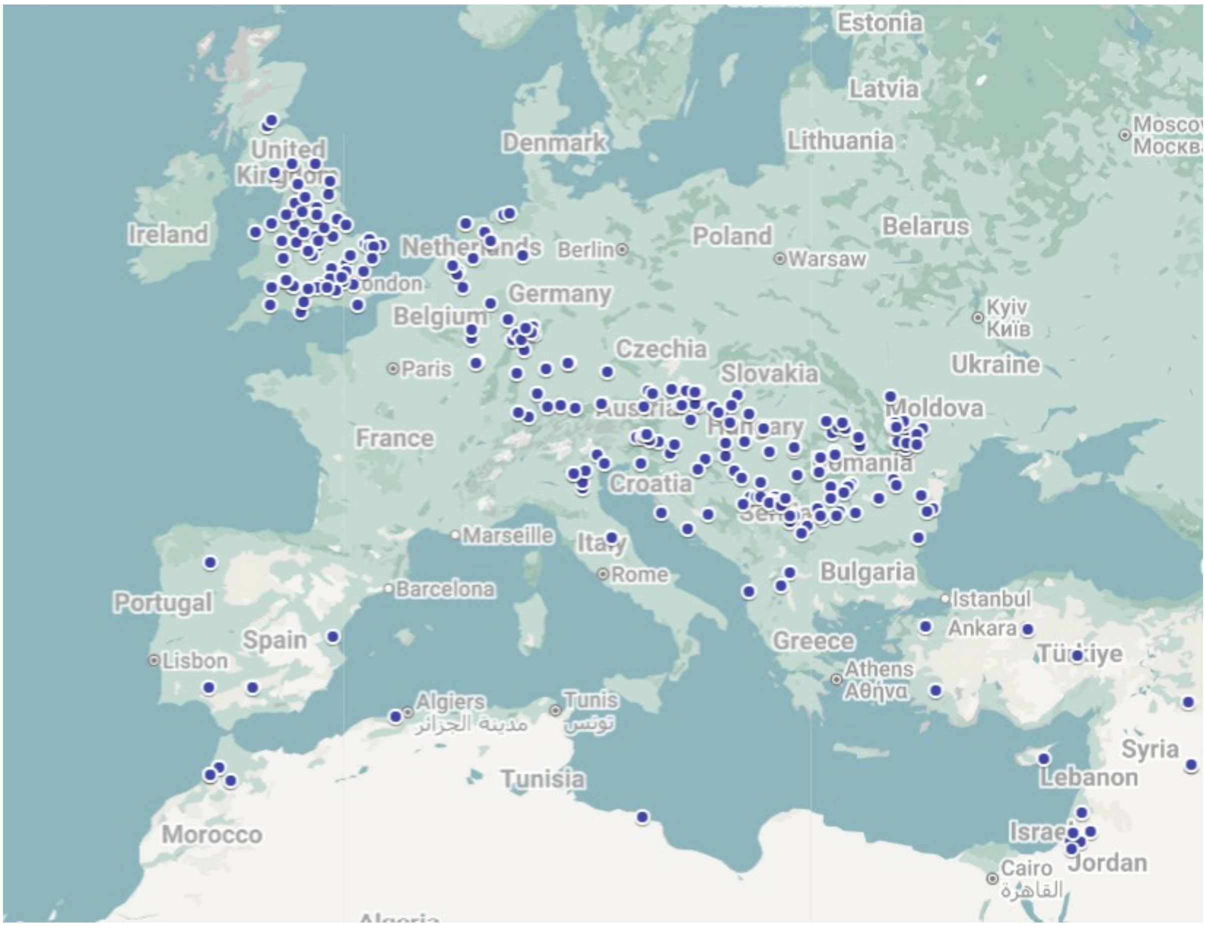

Figure 2.1: hoards containing *denarii* struck under Hadrian in this study's dataset that were recorded to the level of the design on the CHRE database at the time of data collection (n=265). Find an interactive version of this map with links to CHRE records at: https://www.google.com/maps/d/edit?mid=1wxFwwctrdJqYxYJN5vsMP0E4sYS8uTo&usp=drive_link

i. Results of χ^2 tests at the level of the issue

As with **Chapter 1** (Trajan), the dataset was divided into subsets based on the terminal dates of the hoards Each of the subsets, comprising hoards closing up to 161, 180, 192, and 211, were subjected to χ^2 tests, the results of which are presented in **Tables 2.1-2.4**, below. **Table 2.5** presents the results of χ^2 tests carried out on the complete and uncontrolled dataset of hoards closing up to *c.* 250 and later.[1]

Table 2.1: *Denarii* in hoards closing up to 161								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
117	28	1	10	17	72	5	7	**140**
118	50	7	6	24	107	16	12	**222**
119-120	68	4	10	19	86	15	15	**217**
120-121	29	1	2	18	45	7	4	**106**
121	84	3	11	47	160	11	15	**331**
121-123	65	6	16	61	95	20	14	**277**
124-125	31	2	6	31	54	7	12	**143**
124-130 (Eastern mints)	31	0	4	25	27	7	2	**96**
125-127	16	0	5	7	27	5	2	**62**
126-127	53	4	16	67	97	16	12	**265**
128-129, 129-130, 130	39	2	29	9	162	17	12	**270**
130-133	31	2	7	0	60	15	9	**124**
133-135	53	3	9	0	89	5	8	**167**
136	39	1	12	0	65	4	6	**127**
137 (Ael), 137-138, 138 (Ant)	48	2	18	0	52	4	8	**132**
Qty	**665**	**38**	**161**	**325**	**1198**	**154**	**138**	**2679**
Standardised residuals χ^2 = 322.62, df = 70, p-value **< 2.2e-16**								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Avg
117	-1.1832	-	0.5243	-0.0254	1.1267	-1.0907	-0.0976	-0.1243
118	-0.5622	-	-1.9630	-0.4778	0.9591	0.9780	0.2284	-0.1395
119-120	1.9617	-	-0.8283	-1.4086	-1.0804	0.7319	1.1600	0.0894
120-121	0.4980	-	-1.7395	1.4128	-0.3810	0.3545	-0.6346	-0.0816
121	0.1551	-	**-2.0116**	1.0445	0.9193	-1.8580	-0.5166	-0.3778
121-123	-0.3919	-	-0.1280	**4.7881**	**-2.5190**	1.0559	-0.0426	0.4603
124-125	-0.7558	-	-0.8853	**3.2765**	-1.2453	-0.4261	1.7066	0.2784
124-130 (Eastern mints)	1.3886	-	-0.7656	**3.8364**	**-2.5075**	0.5926	-1.3467	0.1996
125-127	0.0983	-	0.6277	-0.2279	-0.2119	0.7282	-0.6887	0.0542
126-127	-1.5689	-	0.0223	**6.1548**	-1.9661	0.2001	-0.4435	0.3997
128-129, 129-130, 130	**-3.4671**	-	**3.1326**	**-4.1756**	**3.6669**	0.3472	-0.5354	-0.1719
130-133	0.0506	--	-0.1603	**-3.8746**	0.6262	**2.9566**	1.0397	0.1063

[1] It was not possible to include Spain and the Western Mediterranean in the analyses of the subsets for 161-211 because it did not produce sufficient coins to support analysis.

2: Hadrian

Table 2.1: *Denarii* in hoards closing up to 161								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
133-135	1.8214	-	-0.3155	**-4.4924**	1.6935	-1.4755	-0.1945	-0.4938
136	1.291	-	1.5582	**-3.9377**	1.0375	-1.2348	-0.2275	-0.2521
137 (Ael), 137-138, 138 (Ant)	**2.6682**	-	**3.5788**	**-3.9997**	-0.9076	-1.3004	0.4631	0.0837

Table 2.2: *Denarii* in hoards closing up to 180								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Westen Danube	Eastern Danube	Eastern Med	Qty
117	49	1	20	46	123	25	7	**271**
118	92	7	25	89	196	53	12	**474**
119-120	112	4	28	61	177	38	15	**435**
120-121	41	1	15	56	95	28	4	**240**
121	128	3	46	106	291	70	15	**659**
121-123	104	6	43	159	209	58	14	**593**
124-125	55	2	20	72	116	31	12	**308**
124-130 (Eastern mints)	42	0	15	60	72	26	2	**217**
125-127	31	0	8	19	52	18	2	**130**
126-127	104	4	46	129	213	65	12	**573**
128-129, 129-130, 130	70	2	51	77	255	66	12	**533**
130-133	76	2	41	59	168	51	9	**406**
133-135	100	3	30	87	200	54	8	**482**
136	81	1	35	65	194	55	6	**437**
137 (Ael), 137-138, 138 (Ant)	85	2	49	82	200	50	8	**476**
Qty	**1170**	**38**	**472**	**1167**	**2561**	**688**	**138**	**6234**
Standardised residuals χ^2 = 147.83, df = 70, p-value = **1.679e-07**								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Westen Danube	Eastern Danube	Eastern Med	Avg
117	-0.2779	-	-0.1252	-0.6806	1.0791	-0.9096	0.4022	-0.0853
118	0.4063	-	-1.7730	0.1110	0.2140	0.1589	0.4957	-0.0644
119-120	**3.3934**	-	-0.8434	**-2.2395**	-0.0858	-1.4249	1.7430	0.0904
120-121	-0.6148	-	-0.7514	1.6372	-0.3809	0.2837	-0.5734	-0.0666
121	0.3707	-	-0.5620	-1.5793	1.2057	-0.3329	0.1018	-0.1326
121-123	-0.6500	-	-0.2567	**4.6068**	**-2.1587**	-0.8893	0.2561	0.1513
124-125	-0.3660	-	-0.6856	1.8922	-0.9318	-0.5108	1.9859	0.2306
124-130 (Eastern mints)	0.1598	-	-0.3764	**2.9920**	-1.8681	0.3879	-1.2886	0.0011
125-127	1.3022	-	-0.6047	-1.1085	-0.2364	0.9382	-0.5262	-0.0392
126-127	-0.3323	-	0.4032	**2.1087**	-1.4466	0.2287	-0.1890	0.1287
128-129, 129-130, 130	**-3.0228**	-	1.6586	**-2.3010**	**2.3976**	0.9165	0.0504	-0.0501
130-133	-0.0329	-	1.8429	-1.9594	0.0784	0.9167	0.0006	0.1410
133-135	1.0041	-	-1.0742	-0.3388	0.1431	0.1113	-0.8169	-0.1619
136	-0.1466	-	0.3099	-1.8891	1.0270	0.9466	-1.1907	-0.1571
137 (Ael), 137-138, 138 (Ant)	-0.4762	-	**2.1453**	-0.7701	0.2915	-0.3628	-0.7870	0.0067

Table 2.3: *Denarii* in hoards closing up to 192								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Westen Danube	Eastern Danube	Eastern Med	Qty
117	56	1	20	47	135	40	11	**310**
118	108	7	30	90	217	62	17	**531**
119-120	128	4	32	62	201	56	25	**508**

Table 2.3: *Denarii* in hoards closing up to 192								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Westen Danube	Eastern Danube	Eastern Med	Qty
120-121	55	1	20	58	107	44	10	**295**
121	171	3	50	106	323	102	24	**779**
121-123	133	6	45	160	246	83	24	**697**
124-125	76	2	22	72	133	42	15	**362**
124-130 (Eastern mints)	59	0	19	62	94	36	7	**277**
125-127	42	0	8	19	63	27	6	**165**
126-127	136	4	52	132	251	100	18	**693**
128-129, 129-130, 130	91	2	55	77	280	100	23	**628**
130-133	96	2	44	59	200	104	16	**521**
133-135	128	3	36	87	229	102	14	**599**
136	112	1	38	67	220	82	19	**539**
137 (Ael), 137-138, 138 (Ant)	116	2	60	87	239	82	23	**609**
Qty	**1507**	**38**	**531**	**1185**	**2938**	**1062**	**252**	**7513**
Standardised residuals $\chi^2 = 161.82$, df = 70, p-value = **3.117e-09**								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Westen Danube	Eastern Danube	Eastern Med	Avg
117	-0.7976	-	-0.4162	-0.2836	1.2294	-0.5887	0.1805	-0.1127
118	0.2294	-	-1.1839	0.7604	0.7696	-1.4425	-0.1582	-0.1708
119-120	**2.6181**	-	-0.6355	**-2.0023**	0.2064	-1.8441	1.9429	0.0475
120-121	-0.5548	-	-0.1936	1.6687	-0.7958	0.3451	0.0281	0.0829
121	1.1636	-	-0.6902	-1.5343	1.0305	-0.7856	-0.4224	-0.2064
121-123	-0.5345	-	-0.5832	**4.8208**	-1.5529	-1.5313	0.1460	0.1274
124-125	0.4016	-	-0.7065	1.9762	-0.7142	-1.2789	0.8219	0.0833
124-130 (Eastern mints)	0.4222	-	-0.1526	**2.7295**	-1.4254	-0.5347	-0.7651	0.0456
125-127	1.5145	-	-1.0868	-1.3994	-0.2299	0.7348	0.1854	-0.0469
126-127	-0.2465	-	0.4367	**2.1790**	-1.2036	0.2133	-1.0847	0.0490
128-129, 129-130, 130	**-3.1337**	-	1.5792	**-2.2323**	**2.1646**	1.1729	0.4127	-0.0060
130-133	-0.8439	-	1.1745	**-2.5661**	-0.2793	**3.5243**	-0.3578	0.1086
133-135	0.7155	-	-0.9740	-0.7698	-0.3432	1.8826	-1.3591	-0.1413
136	0.3395	-	-0.0352	-1.9802	0.5874	0.6364	0.2025	-0.0415
137 (Ael), 137-138, 138 (Ant)	-0.5762	-	**2.5707**	-0.9405	0.0273	-0.4564	0.5607	0.1975

Table 2.4: *Denarii* in hoards closing up to 211								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Westen Danube	Eastern Danube	E Med	Qty
117	56	1	20	47	135	82	11	**352**
118	110	7	32	90	217	129	17	**602**
119-120	129	4	33	62	201	117	25	**571**
120-121	55	1	20	58	108	75	10	**327**
121	172	3	50	106	324	202	24	**881**
121-123	133	6	45	160	248	175	24	**791**
124-125	76	2	22	72	134	95	15	**416**
124-130 (Eastern mints)	59	0	19	62	94	62	7	**303**
125-127	42	0	8	19	63	48	6	**186**
126-127	136	4	54	132	252	172	18	**768**
128-129, 129-130, 130	91	2	56	77	281	194	23	**724**
130-133	99	2	46	59	202	174	16	**598**
133-135	129	3	38	87	230	185	14	**686**

Table 2.4: *Denarii* in hoards closing up to 211								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Westen Danube	Eastern Danube	E Med	Qty
136	115	1	39	67	220	178	19	**639**
137 (Ael), 137-138, 138 (Ant)	119	2	61	87	239	182	23	**713**
Qty	**1521**	**38**	**543**	**1185**	**2948**	**2070**	**252**	**8557**
Standardised residuals χ^2 = 161.05, df = 70, p-value = **3.912e-09**								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Westen Danube	Eastern Danube	E Med	Avg
117	-0.8423	-	-0.5016	-0.2610	1.2282	-0.3560	0.1915	-0.0902
118	0.3655	-	-0.9621	0.7952	0.7735	-1.2954	-0.1431	-0.0777
119-120	**2.7596**	-	-0.5223	-1.8996	0.3419	-1.7697	**2.0089**	0.1531
120-121	-0.4200	-	-0.1709	1.8789	-0.4530	-0.4734	0.1148	0.0793
121	1.2172	-	-0.7971	-1.4596	1.1570	-0.7765	-0.3869	-0.1743
121-123	-0.6044	-	-0.7119	**4.8619**	-1.4348	-1.1399	0.1616	0.1887
124-125	0.2423	-	-0.8542	1.8991	-0.7740	-0.5579	0.7868	0.1236
124-130 (Eastern mints)	0.6664	-	-0.0712	**3.0579**	-1.0599	-1.3547	-0.6556	0.0971
125-127	1.5255	-	-1.1197	-1.3511	-0.1701	0.4171	0.2122	-0.0810
126-127	-0.0347	-	0.7598	**2.4956**	-0.7615	-1.0012	-0.9675	0.0817
128-129, 129-130, 130	-3.3387	-	1.4711	-2.3380	1.9708	1.4015	0.3554	-0.0796
130-133	-0.7184	-	1.2997	-2.6253	-0.2956	**2.4247**	-0.3882	-0.0505
133-135	0.6389	-	-0.8387	-0.8213	-0.4131	1.4779	-1.3801	-0.2227
136	0.1021	-	-0.2612	-2.3083	-0.0524	1.8452	0.0293	-0.1075
137 (Ael), 137-138, 138 (Ant)	-0.7050	-	**2.3293**	-1.1966	-0.4489	0.7027	0.4291	0.1850

Table 2.5: *Denarii* in hoards closing up to *c.* 250								
Period	Britain	Spain & W Med	Rhine	Italy & Adr	W Dan	E Dan	E Med	Qty
117	75	8	44	54	177	261	35	**654**
118	174	35	69	106	279	680	55	**1398**
119-120	167	30	70	73	268	574	68	**1250**
120-121	88	16	35	60	149	263	29	**640**
121	254	43	119	128	424	894	95	**1957**
121-123	193	46	90	171	355	802	79	**1736**
124-125	106	20	45	81	197	380	43	**872**
124-130 (Eastern)	89	21	33	68	145	323	16	**695**
125-127	57	11	17	21	90	192	25	**413**
126-127	204	41	97	142	365	736	66	**1651**
128-129, 129-130, 130	151	39	93	94	366	746	80	**1569**
130-133	160	42	84	74	279	786	54	**1479**
133-135	196	51	76	104	336	923	57	**1743**
136	173	38	74	82	354	905	64	**1690**
137 (Ael), 137-138, 138 (Ant)	194	72	114	107	348	1102	71	**2008**
Qty	**2281**	**513**	**1060**	**1365**	**4132**	**9567**	**837**	**19755**
Standardised residuals χ^2 = 291.75, df = 84, p-value **< 2.2e-1**								
Period	Britain	Spain & W Med	Rhine	Italy & Adr	W Dan	E Dan	E Med	Avg
117	-0.1803	-2.1798	1.4103	1.2074	**3.2500**	-3.3583	1.3016	0.6051
118	0.9775	-0.2163	-0.7022	0.9468	-0.8001	0.0893	-0.5569	-0.0075
119-120	1.8608	-0.4318	0.3406	-1.4559	0.3718	-1.3226	**2.0497**	0.3073
120-121	1.6311	-0.1519	0.1066	**2.3649**	1.2960	-2.6824	0.3564	0.5121

Table 2.5: *Denarii* in hoards closing up to *c.* 250								
Period	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adr**	**W Dan**	**E Dan**	**E Med**	**Qty**
121	1.7997	-1.0969	1.3207	-0.6673	0.6407	-1.8681	1.2870	0.4188
121-123	-0.5183	0.1369	-0.3211	**4.6682**	-0.4151	-1.3197	0.6400	0.4556
124-125	0.4976	-0.5556	-0.2824	**2.6446**	1.0381	**-2.1188**	0.9755	0.4591
124-130 (Eastern)	1.0183	0.6278	-0.6776	**2.9195**	0.0221	-0.6614	**-2.4596**	0.0268
125-127	1.3538	0.0840	-1.0933	-1.4076	0.3955	-0.5568	1.7967	0.0813
126-127	0.9515	-0.2861	0.8822	**2.6002**	1.0364	**-2.2790**	-0.4818	0.4515
128-129, 129-130, 130	**-2.2551**	1.4053	0.9493	-1.3952	**2.0660**	-0.5332	1.6483	0.0800
130-133	-0.7926	0.5797	0.5438	**-2.7671**	-1.6838	**2.6761**	-1.0760	-0.5166
133-135	-0.3229	0.8528	-1.7824	-1.4629	-1.4341	**2.8184**	-1.9349	-0.6865
136	-1.6316	-0.8885	-1.7825	**-3.2507**	-0.0397	**2.9182**	-0.9271	-0.7855
137 (Ael), 137-138, 138 (Ant)	**-2.3432**	**3.6887**	0.7117	**-2.5886**	**-3.3219**	**4.4941**	-1.4398	-0.7479

Table 2.6, below, groups all instances of overrepresentation together to make them easier to visualise. Several points of interest emerge. First: it is clear to see that many instances of regional overrepresentation in the earlier subsets (hoards terminating in the 160s or 180s) continue to appear in hoards with later closing dates. This much was noted in the analysis of Trajan's *denarii* in the preceding chapter, with the interesting difference that, here, there appear to be slightly more examples of overrepresentation than in Trajan's case. Some of these overrepresentations fade or disappear completely in hoards with progressively later closing dates, which is probably a function of circulation: *e.g.*, the overrepresentation of *denarii* struck 128-130 along the Rhine, where the overrepresentations in the subset of *denarii* from hoards closing by 161 cease to register in the subsets dating to 180 and later. It may equally be a sign that the shipments or waves of coins that lie behind those overrepresentations were not as large as those lying behind overrepresentations that persist through the earlier subsets continue to show up in hoards closing near the end of the second century and into the third. The most startling examples of the latter concern the various issues of the 120s, which register strongly in two regions – Italy and the Adriatic, and the Western Danube – from the 160s all the way up to the latest hoards closing into the third century.

Table 2.6 Regional overrepresentations over time *Fields marked ‘ - ‘ indicate where an issue was not present in sufficient numbers for testing to take place.						
Period	**Region**	***Denarii* in hoards up to 161**	***Denarii* in hoards up to 180**	***Denarii* in hoards up to 192**	***Denarii* in hoards up to 211**	***Denarii* in hoards up to *c.* 250**
117	**W Danube**	1.1267	1.0791	1.2294	1.2282	**3.2500**
119-120	**Britain**	1.9617	**3.3934**	**2.6181**	**2.7596**	1.8608
	E Med	1.1600	1.7430	1.9429	**2.0089**	**2.0497**
120-121	**Italy & Adr**	1.4128	1.6372	1.6687	1.8789	**2.3649**
121-123	**Italy & Adr**	**4.7881**	**4.6068**	**4.8208**	**4.8619**	**4.6682**
124-125	**Italy & Adr**	**3.2765**	1.8922	1.9762	1.8991	**2.6446**
124-130 (Eastern mints)	**Italy & Adr**	**3.8364**	**2.9920**	**2.7295**	**3.0579**	**2.9195**
126-127	**Italy & Adr**	**6.1548**	**2.1087**	**2.1790**	**2.4956**	**2.6002**
128-129, 129-130, 130	**Rhine**	**3.1326**	1.6586	1.5792	1.4711	0.9493
	W Danube	**3.6669**	**2.3976**	**2.1646**	1.9708	**2.0660**
130-133	**E Danube**	**2.9566**	0.9165	**3.5243**	**2.4247**	**2.6761**
133-135	**E Danube**	-1.4755	0.1113	1.8826	1.4779	**2.8184**
136	**E Danube**	-1.2348	0.9466	0.6364	1.8452	**2.9182**
137 (Aelius), 137-138, 138 (Antoninus)	**Britain**	**2.6682**	-0.4762	-0.5762	-0.7050	**-2.3432**
	Spain & WM	-	-	-	-	**3.6887**
	Rhine	**3.5788**	**2.1453**	**2.5707**	**2.3293**	0.7117
	E Danube	-1.3004	-0.3628	-0.4564	0.7027	**4.4941**

Second: it is striking that most of the overrepresentations belong to Italy and the Adriatic and the Eastern Danube, and that the times at which these overrepresentations occur do not overlap. The periods for which the Italian hoards returned overrepresentations (*c.* 120/121 to *c.* 127) are mirrored in the Eastern Danube by standardised residuals signifying a dearth of coins for the same period. Conversely, the block of overrepresentations seen in the Eastern Danube's hoards for the period 130-136/138 (see **Tables 2.5-2.6**) is met on the Italian side by a roughly corresponding number of underrepresentations. It is particularly interesting that some of the overrepresentations in both of these regions – particularly those in Italy and the Adriatic for 121-123 and the Eastern Danube for 137-138 – appear to be very strong indeed, sometimes in excess of 4, 5, or even 6 standardised residuals (it should be remembered that any standardised residual greater than 2 signifies an overrepresentation). Many of these very strong overrepresentations are – again – clustered in the early subsets. The diminishment of their strength through hoards of later closing dates might be a consequence of circulation.

Third: Britain is one of the few regions other than Italy and the Adriatic and the Eastern Danube to carry an almost complete set of overrepresentations (for the issue of 119-120) through from the earlier subsets (here, hoards closing by 180) through to the subset of hoards closing by the first decade of the third century (the 211 subset). The standardised residuals for the earliest subset (hoards closing by 161) and the complete Hadrianic dataset (uncontrolled; hoards closing by *c.* 250) are themselves very near the threshold signifying overrepresentation, giving Britain an almost clear run of overrepresented values from start to finish.[2] Reasons for the possible shipment of coins of this date to Britain will be discussed in section *iii.*, below, but it is worth noting here that a peak in the supply of *denarii c.* 119-120 accords with Hobley's finding that Britain appears to have received considerable shipments of *aes* over the same period.[3]

The weakening (or total disappearance) of overrepresented issues elsewhere in the empire, such as those on the Rhine for 128-130 and 137-138, could be explained with reference to the degrading effects of circulation as the second century wore on, or the size of those shipments to begin with (*i.e.*, smaller and more easily dispersed once circulating). Why the Eastern Danube's overrepresentations for the periods 133-135, 136, and 137-138 do not materialise in the earlier subsets might simply be a consequence of the fact that the hoards of this region contain comparatively few coins of these issue periods until after 211, thereby stymying χ^2's ability to pinpoint instances of genuine overrepresentation except in the complete (and largest) dataset of coins from hoards closing *c.* 250. We must also consider the that interregional movement on the Continent is likely to have had a greater and swifter impact on the degradation of regional concentrations than was the case in Britain, which, given its insularity, might have possessed a greater ability to hold on to shipments of silver coins sent there. This is not a controversial statement in regard to the *aes* coinage, shipments of which (Walker 1988) are known to have arrived in Britain and stayed in great numbers.

[2] This could be indicative of an overrepresentation dating as early as 161 (its lower intensity is probably a result of the lower overall quantity of coins underlying the 161 subset); in the latter, as evidence for a weakening of this concentration in the 50 or so years between 211 and the mid-third century.
[3] Hobley 1998, p. 53.

This is one of the first times that specific populations of *denarii* have been tentatively identified as having a British association, too.

Fourth: there is almost no trace in these results of Hadrian's travels about the empire. There are, for instance, no overrepresentations for his visit to Spain in 122/123, nor of his journey to Britain around the same time (unless the concentration of coins dating to 119-120 was brough to the province some years after their striking, which feels unlikely), although other scholars have detected evidence in the form of small *aes* denominations appearing in Britain at this time, suggesting some sort of monetary response to the emperor's presence in other metals: see section *iii.*, below. Of course, the majority of Hadrian's tours took him around Greece and the eastern empire, for which data are lacking and testing was not possible, so the degree to which new *denarii* track his movements about those regions is unknowable for now. Only the standardised residuals for *denarii* of the issues of 124-125 and 125-127 are of any potential interest, since both register a high and consistent degree of overrepresentation among the hoards of Italy and the Adriatic at the same time as Hadrian is known to have been resident at Rome. A possible *congiarium* in 125 is also of interest, given Italy is the only region to return overrepresentations for this year. If a connection between the two can be drawn, then the absence of Italian overrepresentations at the time of Hadrian's six other *congiaria* is a curiosity, but as in the previous chapter (see **pp. 46-47**) the lack of specific overrepresentations for each and every *congiarium* of the reign need not pose a problem.[4]

Fifth: a quirk of these data is the finding that *denarii* struck *c.* 124-130 in the eastern empire appear to concentrate in Italy alone. All the other overrepresentations seen in **Tables 2.1-2.6** concern *denarii* that were struck in Rome and moved to the provinces; it is curious, therefore, to see Italy as the recipient, rather than sender, of an apparently large number of *denarii* struck elsewhere. It has long been known that Hadrianic *denarii* were also struck in the

[4] Hadrian's *congiaria*: Kienast 2017, p. 124.

east, although many types now known to be of eastern issue were mistakenly attributed to Rome by the authors of the old *RIC* II (1926).[5] Only recently, with the publication of *RIC* II.3, were these reassigned either to Antioch (*c.* 117-119) or decentralised mints in Asia Minor (*c.* 123-135) on the grounds of metallurgical analysis and stylistic similarities with locally minted *cistophoroi*.[6] *RIC* II.3, following *RPC* III, posits that their striking was stimulated by the presence of the emperor, and that his movements likely lie behind the number of decentralised mint locations that were set up between his arrival around 123 and departure in 132/133.[7]

Eastern *denarii* vary in date and mintage, but the years 128-130 appear to have been the most productive, since it to this period that the majority (492) of the eastern coins in this study's dataset belong. Most of these bear one of three designs: Concordia (*RIC* II.3 3036; 210 *denarii*), Minerva (*RIC* II.3 3057-3060; 93 *denarii*), and Victoria (*RIC* II.3 3072-3077; 107 *denarii*).[8] Were the quality of finds reporting and publishing better in the countries of the former Roman east, a greater number of these coins would surely be available for analysis.

As can be seen in the results of the phased analyses (**Tables 2.1-2.5**) and the grouped view of these results in **Table 2.6**, eastern *denarii* returned standardised residuals indicating overrepresentation among the hoards of Italy and the Adriatic from the earliest subset (hoards closing up to 161) through to the uncontrolled group of hoards closing up to *c.* 250. Italy and the Adriatic was the only region out of the seven under survey – including the Eastern

---

[5] See also Strack 1933, pp. 192-196; Hill 1966.

[6] *RIC* II.3, pp. 30-31 lays out a chronology of the eastern *denarii* which, alongside those struck *c.* 128-130, include products of Antioch dated *c.* 117-119 (among which are some of the earliest coins in Hadrian's name; not represented in this dataset) and others of decentralised mintage *c.* 123/124-127 and *c.* 130-135.

[7] Army pay was also likely a factor. Van Heesch (2014) looked at the quantity of hoarded and singly found *denarii* from eastern contexts and reasoned that a far greater proportion of the eastern army's pay would have been met in silver (in the form of *denarii* from Rome and eastern mints) than had previously been acknowledged, as well as some gold. See esp. pp. 149-*ff.* for an outline, illustrated with known examples from the first and second centuries, of what paying the army in Roman *aurei* and *denarii* might have looked like from the state's perspective.

[8] Abdy based his estimations of a design's rarity not only on its occurrence amongst coins on the market and in museum collections, as was the practice in the older volume of *RIC* II (1926), but also on its frequency among the contents of certain larger hoards.

Mediterranean – to have done so. The hoards in question range widely in their locations within the Italy and the Adriatic region, from Castagnaro (closing 129-130) in the Veneto, to Durrës (Dyrrachium; closing 175) on the Albanian coast to the south. The overrepresentation of eastern *denarii* in hoards from the north and the south of this region could be telling of a generally higher representation of these coins in general Italian circulation, but without available hoards from the central part of Italy, we are able unable to absolutely confirm or deny this.

It is natural to question the data in this case – *i.e.*, are there enough coins for us to be certain that χ^2 is telling us of a real overrepresentation of eastern *denarii* in Italy? – and the answer must be 'yes'. Tests like χ^2 are assumed to be reliable in their predictions as long as the underlying sample of data is sufficiently numerous for the test to run (the indicator of this being the 'expected value' placed on each datapoint by χ^2 prior to the test). Not only were the expected values for the Italian data acceptable, but the p-values produced by each of the tests carried out on the subsets in **Tables 2.1-2.5** strongly indicate that the standardised residuals are statistically reliable.[9] Only the addition of more data would confirm or deny the robustness of these results, but the comparative rarity of eastern *denarii* elsewhere in the empire (reflecting, presumably, their scarcity outside of the east in antiquity) must be borne in mind.[10] This rarity could even be a factor in favour of the χ^2 results: for *denarii* that are so uncommon to appear overrepresented in a region so far from their place of origin, and in a hoard like Castagnaro, which closes so soon after their date of striking (*c.* 130), is a curiosity (although

[9] The p- (or 'probability') value is an indicator of how reliable χ^2 believes the results of the test to be. A value of ≤ 0.05 indicates the presence of standardised residuals that are both significant (*i.e.*, denoting an under- or overrepresentation of some kind) and highly reliable. A fuller explanation of χ^2 is given above, in section 6.*iii* of the Introduction.
[10] The majority of the coins that make up this study's dataset for *c.* 128-130 (Concordia, Minerva, and Victoria) are rated by *RIC* II.3 as R (rare) and R2 (very rare). These categorisations are necessarily subjective, but they are better than nothing when an indication of a type's rarity is sought. In *RIC* II.3's case, at least, we can be reassured that they are the product of more recent thought and consideration. Abdy (*RIC* II.3, pp. xxiii-xxiv) explains the system as an amalgam of the one seen in *RIC* II (with some adjustments) and that employed by the compilers of the *RPC* volumes.

we cannot, of course, know whether a hoard's closing date is indicative of the date at which it was finally sealed or deposited).

What might have brought about an overrepresentation of eastern *denarii* in the Italian region is hard to say. That smaller numbers of *denarii* struck in the east should be present in Italy, as the centre of empire, and other regions of the west is no great surprise, although natural westward drift in the course of circulation is hardly likely to have caused a specific overrepresentation in one region alone. The export to the east of coins struck at Rome is increasingly well documented and understood, but at this stage it feels unlikely that the reverse – that is, eastern mints shipping product to western coin users – took place on any appreciable scale.[11] A later example of eastern *denarii* moving westward was outlined by Howgego, who argued that the increasing presence in the west of early Severan *denarii* struck in the east (relative to contemporary examples struck in the west) evidences the active relocation of these coins, rather than a mere westward drift brought about by circulation.[12] The terminal date of the Castagnaro hoard (130) might, as stated above, support a direct arrival of eastern *denarii* only shortly after they were originally struck. Various scenarios present themselves, from direct movement at the behest of the authorities (although this is hard to rationalise), to the possibility that substantial quantities of *denarii* accompanied the emperor and court upon their homecoming from the east in 132, or even the arrival in Italy of legionary and auxiliary units that had a hand in the suppression of the Bar Kochba Revolt, *c.* 136, in a similar manner to the way coins struck in Syria and Caria moved into western Europe and the Danube with soldiers returning from Trajan's eastern campaigns.[13]

[11] Woytek and Butcher 2018, pp. 265-*ff.* provide an invaluable overview of the reasons for the centralised minting of provincial coinages at Rome in the late first century *AD* and up to the time of Trajan.
[12] Howgego 1996 and 2002.
[13] On Hadrian's return from the east in 132: Kienast 2017, p. 123; *RIC* II.3, p. 27. On long-distance troop movements making themselves visible in the coin record, see Howgego 1985, p. 30. See also Walker 1988, p. 285, on pre-conquest coins moving into Britain with the Claudian invasion.

Figures 2.2-2.4: *denarii* of Hadrian struck at decentralised eastern mints, *c.* 128-130
2.2: *COS III*; Concordia left (*RIC* II.3 3036)
2.3: *COS III*; Minerva left (*RIC* II.3 3059)
2.4: *COS III*; Victoria left (*RIC* II.3 3072)

ii. Distribution at the level of the issue

As in the previous chapter, the standardised residuals that emerged from the χ^2 tests (presented in **Tables 2.1-2.5**, above) were averaged out and their standard deviations calculated. **Figure 2.5**, below, presents the standard deviations on the final, uncontrolled group of *denarii* from hoards closing as late as *c.* 250 and beyond.

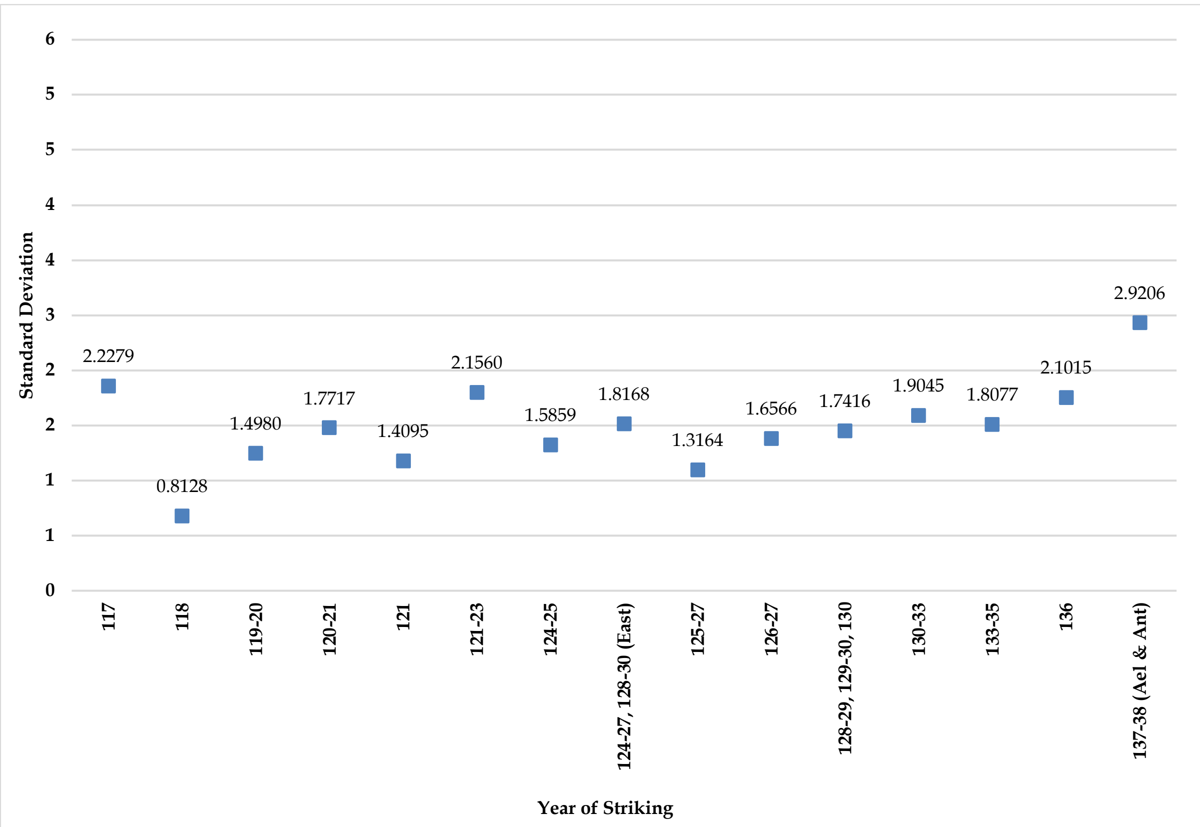

Figure 2.5: standard deviations at the level of the issue - *denarii* in hoards closing up to *c.* 250. Range: 1.4150. Average: 1.7818

Some of the standard deviations indicate a very low level of interregional difference. Predictably, all the issue periods where χ^2 detected no examples of over- or underrepresentation in any region (the years 118, 121, and 125-127) have the lowest standard deviations of all, ranging from a low point of 0.8128 (for the year 118) to 1.409 (for 121), indicating a great degree of similarity between the standardised residuals generated by the χ^2 test. The remaining standard deviations for all other issue periods are not much larger, sitting within a narrow range between around 1.3 and 1.9 standard deviations. These tell us that most of the standardised residuals for each of these issue periods do not stray that far from their averages, and that little in the way of important regional difference exists in the distribution of the *denarii*.

Only four issue periods sit above this range, having returned standard deviations equal to or greater than 2: these being the years 117, 121-123, 136, and 137-138. Of these, the standard deviations for the first three do not go much above 2, whereas the fourth (for 137-138) is much higher, at nearly 3. All four of these values can be tied to specific instances of under- and/or overrepresentation in particular regions: the high standard deviation for 117 can be accounted for by the significantly under- and overrepresented χ^2 standardised residuals for the Western Danube and Eastern Danube respectively (see **Table 2.5**). The high standard deviation for 121-123 is caused by a χ^2 standardised residual for Italy that signifies a quite pronounced degree of overrepresentation for this period. One under- and one overrepresented standardised residual in Italy and the Eastern Danube respectively lie behind the high standard deviation for 136, and a series of underrepresented standardised residuals coupled with one highly overrepresented value for the Eastern Danube are why the standard deviation for 137-138 is so much larger than all the others.

So far, so good: low standard deviations (around 1.5-2.0) indicate where interregional difference is generally low, while high standard deviations (≥2) can be shown to have been caused by one or more under- or overrepresentations within the χ^2 tests from one region or another. Why, then, do some of the standard deviations sit within the 'normal' range of 1.5-2.0 standard deviations when we know that the issues they represent contain at least one χ^2 result signifying under- or overrepresentation? Take the 126-127 issue period, for instance: here, the standard deviation of 1.656 suggests a low level of interregional variance, even though the χ^2 results for Italy and the Eastern Danube indicate separate instances of over- and underrepresentation. The answer is simple and applies to almost all the other issue periods where this phenomenon can be observed: Though there *are* instances of under- and/or overrepresentation in one region or another, the *majority* of the standardised residuals are sufficiently close to their collective average that the standard deviation for the entire issue remains low.[14]

The overall degree of interregional similarity at the level of the issue can best be visualised by looking at how Reka Devnia compares with the aggregated total of *denarii* from the rest of this study's hoards dataset (see **Figure 2.6**, below). This is the first time such a visualisation has been presented for the silver coinage of Hadrian, and continues the work of Spoerri Butcher and Hellings (2017) on the coinages of Nerva and Trajan (see above, **Figures 1.3** and **1.7**). It can be seen that the frequencies for both Reka Devnia and the wider hoards dataset proceed more or less in tandem (despite differences in the actual totals of coins) until *c.* 126, from which time onward they diverge – reflective of the fact that the Eastern Danube is the only region to have returned overrepresentations for these issue periods (see **Table 2.6**, above). All of this is interesting for two reasons. First, the frequences seen in **Figure 2.6** are the product of hoards closing as late as the mid-third century; the implication, therefore, is that in a geographically diverse group of hoards with no control placed on their closing dates, the empire-wide distribution of *denarii* at the level of the issue will be broadly similar wherever one looks, presumably on account of circulation. This much has already been seen in the

[14] These being the years 119-120, 120-121, 124-125, 124-130 (eastern mint), 128-130, 130-133, and 133-135.

coinage of Trajan in the previous chapter. If circulatory processes are the cause of such similarity, it is of interest that slight differences remain, *e.g.* in the way the issues from *c.* 130 onward are better represented in the Reka Devnia hoard than in the aggregated dataset. This suggests that local or regional differences could persist in the hoard record (even though the degree of difference in this case is not all that great).

What this shows is that that the actual level of interregional difference in the spread of *denarii*, despite the odd instances of under- or overrepresentation in each, is largely insignificant, and that, by the early- to mid-third century (when most of the hoards close), the silver coinage had achieved a high but not total degree of integration. If proof were needed that this process was indeed at work, **Table 2.7** and **Figures 2.7-2.10**, below, show the range of the standard deviations at the level of the issue becomes narrower in each of the subsets closing 161, 180, 192, and 211. The contrast between the range of the standard deviations in **Figure 2.7** (for the subset of coins from hoards closing up to 161) and those in **Figures 2.8-2.10** (for the 180-211 subsets) is clear: in the 161 subset, the standard deviations occupy a range as wide as 2.7087, indicating that for some issue periods, the level of interregional difference was quite stark. By the 211 subset, it is likely that circulation had taken its toll: in **Figure 2.10**, it can be seen that the highest level of deviation is lower (~2.3), and that the majority now sit within a much tighter range, between ~0.7/0.8 and ~1.3 standard deviations. The smaller size of these deviations is a crucial indicator that the regional sets of standardised residuals for each issue period in the 211 group bear a far greater resemblance to their averages than in the 161 group. This, in turn, could indicate that, over time, there was a general decrease in the differences between each region's stock of circulating coins (at the level of the issue, at least). Differences still existed, of course – discussion in section *i.* showed that some issue periods continued to be better represented in some parts of the empire than others, *e.g.*, coins of 119-120 in Britain. The general picture, however, is one in which circulation had, by about the 192 subset, caused many regional differences that once existed to diminish to the extent that a group of *denarii*

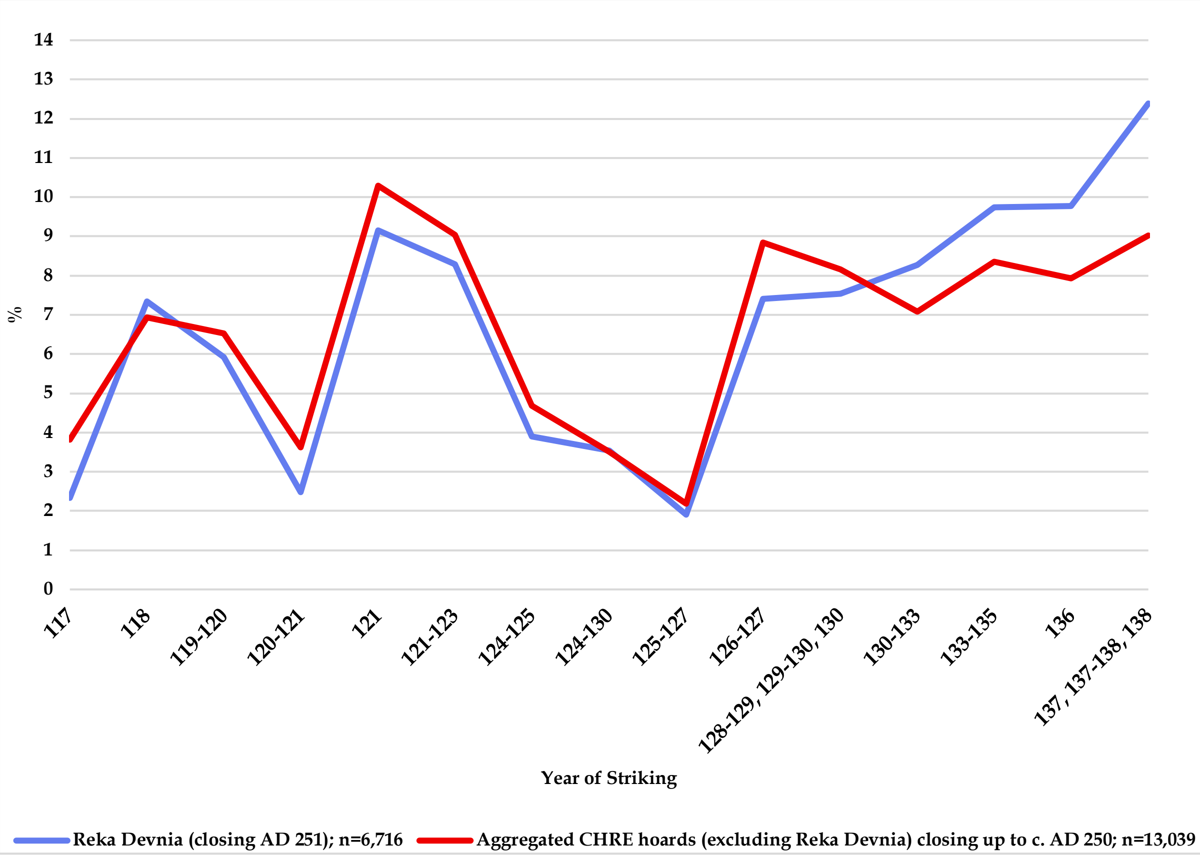

Figure 2.6: Relative frequencies of *denarius* issues of Hadrian, expressed as percentage of the total number of coins in each dataset

on, say, the Rhine frontier, bears a greater resemblance to a similarly sized group from the Eastern Danube. This was a gradual process that did not happen quickly and never entirely succeeded in obliterating every last trace of all the interregional differences that might have existed in Hadrian's day. This was a gradual process that did not happen quickly and never entirely succeeded in obliterating every last trace of all the interregional differences that might have existed in Hadrian's day.

Table 2.7: key to standard deviations in Figures 2.7-2.10				
Period	Figure 2.7: *Denarii* in hoards up to 161	Figure 2.8: *Denarii* in hoards up to 180	Figure 2.9: *Denarii* in hoards up to 192	Figure 2.10: *Denarii* in hoards up to 211
117	0.9002	0.7303	0.7355	0.7284
118	1.1144	0.8501	0.9546	0.8891
119-120	1.3798	2.1104	1.9221	1.9309
120-121	1.0866	0.9112	0.8766	0.9101
121	1.3319	0.9399	1.0758	1.1097
121-123	2.4202	2.3277	2.3895	2.3530
124-125	1.8039	1.3371	1.2121	1.0801
124-130 (Eastern)	2.2559	1.6983	1.4521	1.6206
125-127	0.5455	0.9481	1.0998	1.0598
126-127	2.9492	1.1663	1.2374	1.3627
128-129, 129-130, 130	3.2541	2.1799	2.1693	2.2233
130-133	2.2445	1.2621	2.0607	1.7436
133-135	2.3332	0.7510	1.2201	1.0723
136	2.0916	1.1754	0.9817	1.3226
137 (Ael), 137-138, 138 (Ant)	2.7790	1.1188	1.2739	1.2672
Range	**2.7087**	**1.5974**	**1.6540**	**1.6246**
Average	**1.8993**	**1.3004**	**1.3774**	**1.3782**

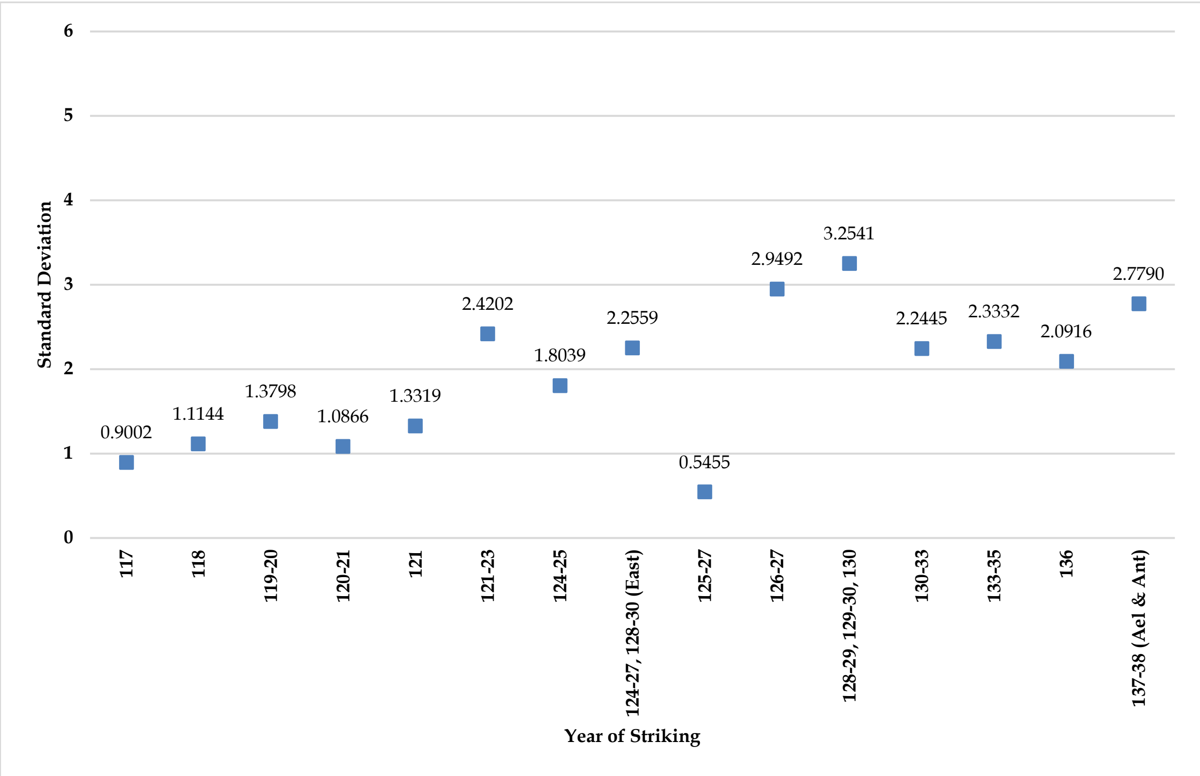

Figure 2.7: standard deviations at the level of the issue - *denarii* in hoards closing up to 161. Range: 2.7087. Average: 1.8993

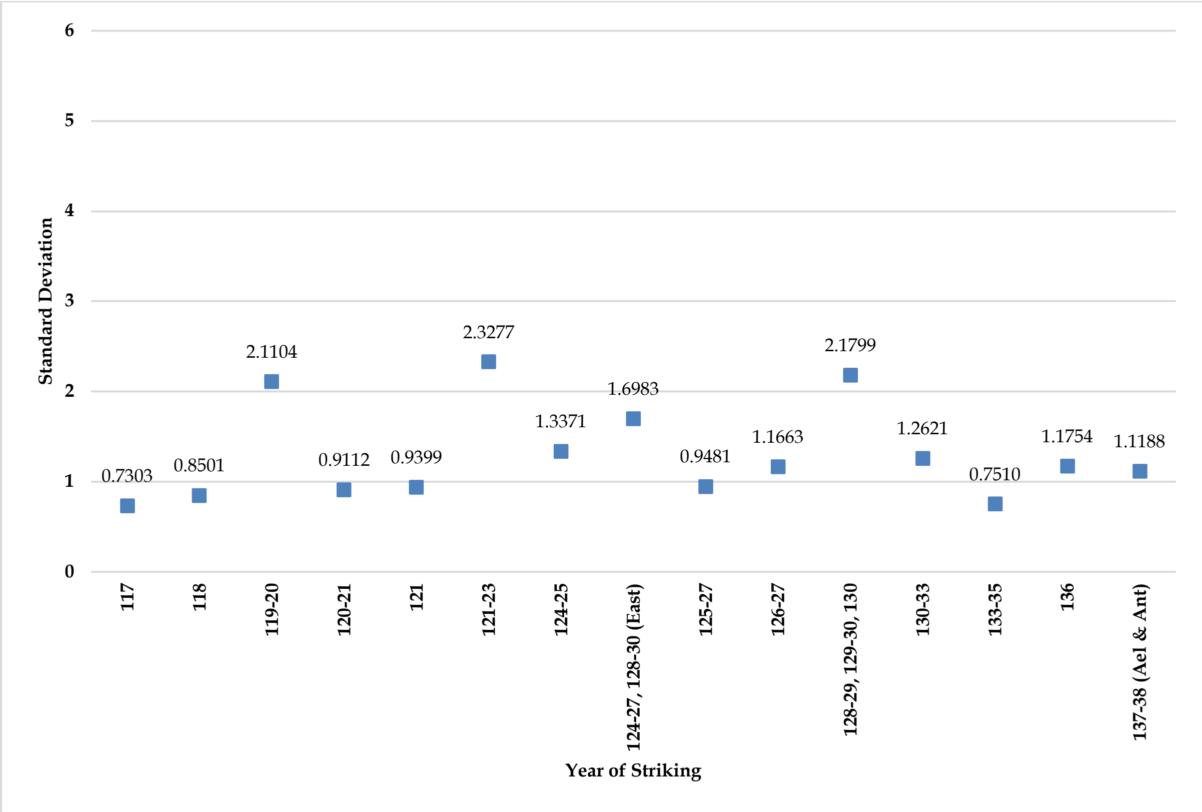

Figure 2.8: standard deviations at the level of the issue - *denarii* in hoards closing up to 180. Range: 1.5974. Average: 1.3004

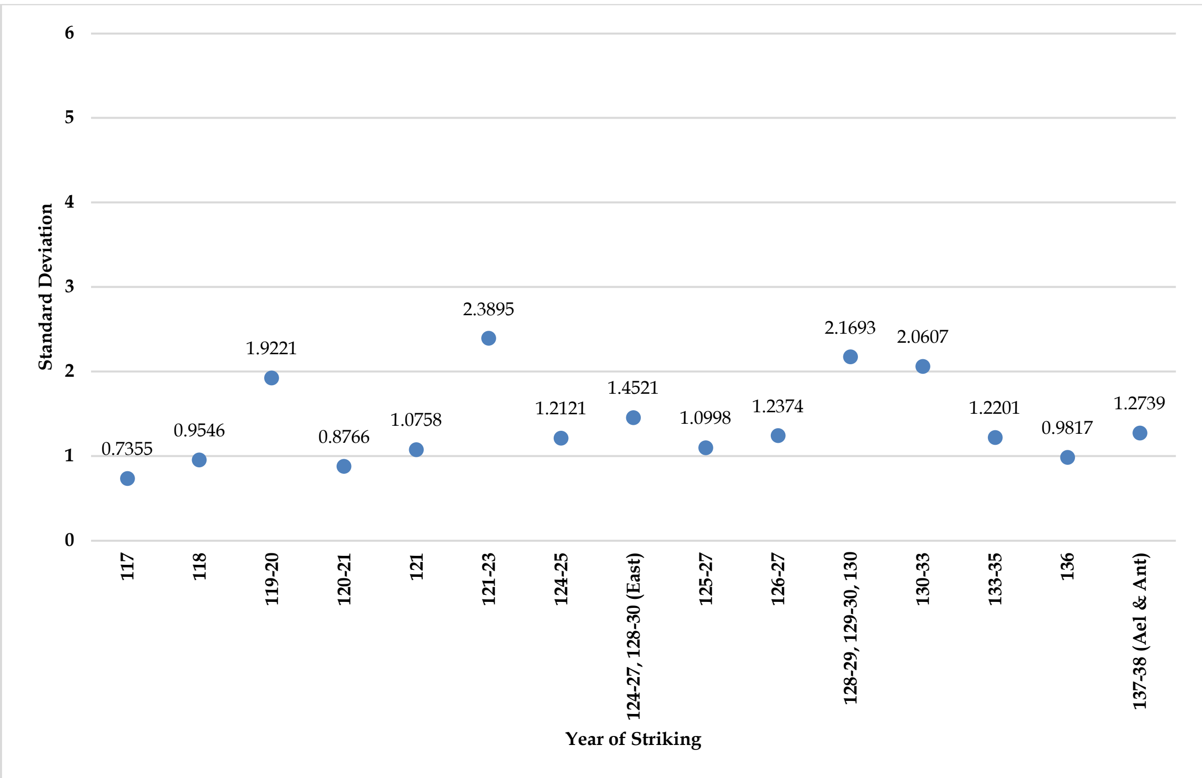

Figure 2.9: standard deviations at the level of the issue - *denarii* in hoards closing up to 192. Range: 1.6540. Average: 1.3774

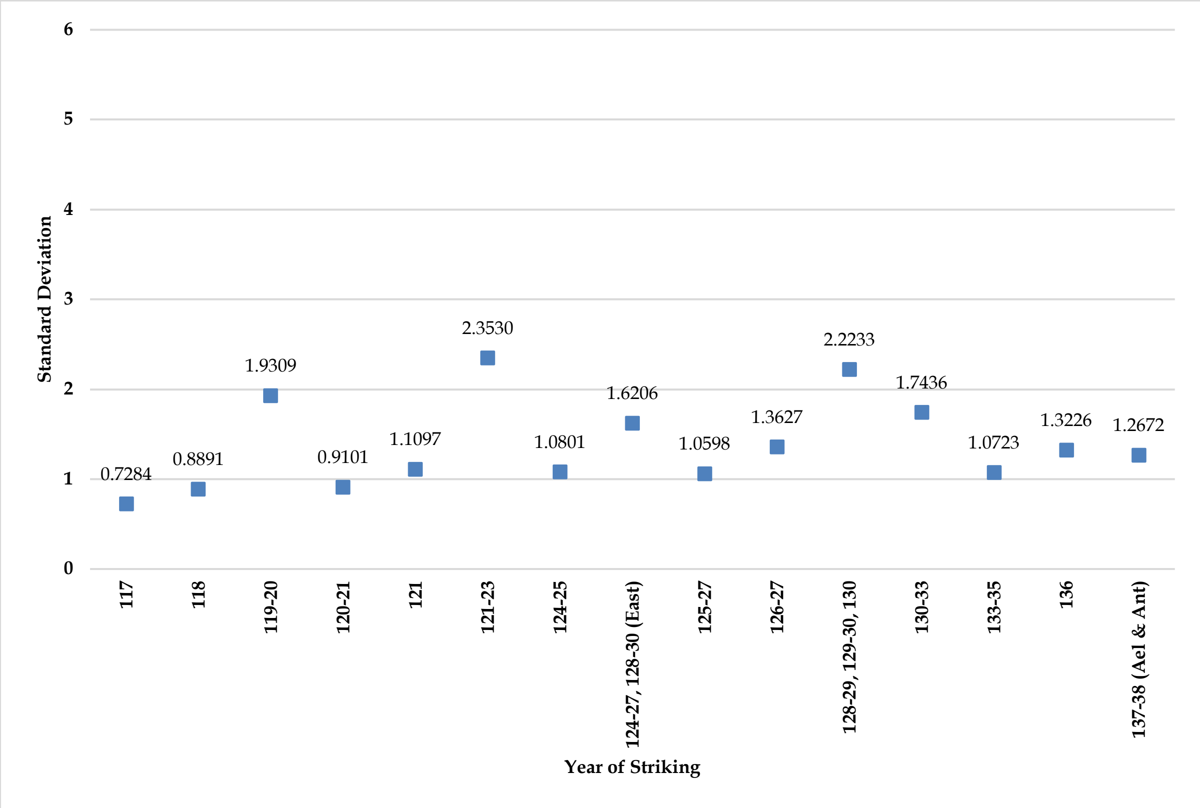

Figure 2.10: standard deviations at the level of the issue - *denarii* in hoards closing up to 211. Range: 1.6246. Average: 1.3782

iii. Results of χ^2 tests at the level of the design

The 19,755 Hadrianic *denarii* under survey were further subdivided into categories based on their reverse designs so that their interregional distribution could be tested using χ^2. As with the *denarii* of Trajan, these categories either directly correspond with single *RIC* types or are groupings of several *RIC* types with identical or similar reverse designs. A full set of tables giving complete, design-by-design totals and χ^2 results for each of the subsets and in the final group of hoards closing up to *c.* 250 can be found in **Annexe 2**. **Table 2.8** (below) presents the average of the standardised residuals for each design in each issue period (in the third column) and the standard deviations from these averages (in the fourth column). The standard deviations are also plotted in **Figure 2.11**.

Table 2.8: Average of standardised residuals and standard deviations for each design			
Period	**Design**	**Average of the standardised residuals for design**	**Standard deviation from Average**
117	Concordia	0.1537	1.0912
	Fortuna Redux	-0.1792	1.2987
	Justitia	0.1773	0.7791
	Pax	-0.1069	0.9608
	Pietas	-0.0387	1.3244
	Trajan & Hadrian	-0.1181	0.8789
118	Concordia	0.1278	0.5971
	Fortuna Redux	-0.3840	0.9565
	Justitia	0.0962	1.0242
	Pax	0.1093	0.7319
	Pietas	0.2564	0.9507
	Salus	-0.2799	0.6822
119-120	Aeternitas	0.2108	0.9816
	Concordia	0.0090	1.1828
	Felicitas	-0.1654	1.1028
	Pax	0.1206	0.9670
	Pietas	-0.1748	0.6971
	Salus	-0.0297	1.6097
120-121	Felicitas	0.0065	0.3444
	Congiarium (*LIBERAL AVG III)*	0.0086	1.0198
	Hilaritas	-0.0918	0.4799
	Mars	0.0512	0.4545
121	Aequitas-Moneta	0.3610	1.2084
	Fortuna	-0.1627	1.1302
	Libertas	-0.1288	0.8896
	Salus	-0.0905	1.1484
	Victoria	-0.0955	1.3865
121-123	Clementia	0.2050	1.0349
	Concordia	-0.1356	1.1456
	Hadrian-Fortuna	0.1236	0.8402
	Pax	0.1645	1.0532
	Roma	-0.1417	1.0187
124-125	Diana	0.0590	0.7844
	Genius	-0.1598	0.6001
	Hercules	0.0527	0.8661
	Roma	0.0376	0.4876
	Spes	0.0672	0.3554
126-127	Annona-Abundantia	0.0680	1.0306
	Pudicitia	-0.0111	0.8411
	Star(s) in crescent	-0.0600	0.9683
	Victoria	-0.1766	0.9333
	Virtus	0.1745	0.8426
128-129	Annona-Abundantia	-0.0857	1.0392
128-130 (East)	Clementia	0.2839	1.3177
129-130	Fortuna Redux	-0.1968	0.9473
130	Indulgentia	-0.1738	0.6554
	Justitia	0.1659	0.6795
	Liberalitas	-0.0344	0.9166
	Pietas	-0.3540	1.1672
	Pudicitia (Sabina)	-0.2320	0.8915
	Roma	-0.1095	1.1584
	Romulus	-0.0570	0.9433
	Tranqullitas	0.5109	1.5963
	Virtus	-0.1479	0.9626
	Concordia (Eastern mint)	0.0828	1.2614
	Minerva (Eastern mint)	-0.0228	0.4100

Table 2.8: Average of standardised residuals and standard deviations for each design			
Period	**Design**	**Average of the standardised residuals for design**	**Standard deviation from Average**
	Victoria (Eastern mint	-0.0876	1.4366
130-133	Africa	0.0377	1.3119
	Aegyptos	0.1069	1.0592
	Concordia (Sabina)	0.0201	0.4823
	Hispania	-0.2170	0.7206
133-135	Concordia (Sabina)	-0.5500	1.4661
	Felicitas	0.4383	1.1605
	Hadrian & Roma	0.4213	1.2494
	Juno (Sabina)	-0.5852	1.4387
	Salus	0.2217	0.8594
	Tellus	0.1571	1.2773
	Vesta (Sabina)	-0.1597	1.1015
136	Concordia (Sabina)	-0.0510	0.9796
	Fides	0.0428	0.8079
	Moneta	-0.1430	0.6880
	Nemesis-Victoria	0.2884	0.8998
	Victoria	-0.1436	1.0100
137-138	Aelius	-0.0514	1.3059
	Antoninus Caesar	0.2584	0.8618
	Fortuna	-0.0638	1.3025
	Hadrian *VOTA PVBLICA*	-0.0767	0.9905
	Modius	-0.0175	1.0749
	Providentia	0.0179	0.9257
	Salus	0.1620	0.9133
	Venus (Sabina)	-0.1669	1.1173
		Average:	**0.9735**
		Range:	**1.2653**

What, upon first inspection, looks like an amorphous mass of datapoints can easily be made sensible. The range between the highest and the lowest of the standard deviations for the 80 designs represented in **Figure 2.11** is 1.2653 (min: 0.3444; max: 1.6097). The great majority sit within a comparatively narrower band, between about 0.80-1.20 standard deviations, giving a range of around 0.40, which is hardly significant. The similarity of these values suggests, as it did in the same analyses at the level of the issue period in section *ii.*, above, that by the later second and early third centuries, most designs were present in most regions in quantities that do not indicate a very great degree of interregional variance.

The smaller the standard deviation, the smaller the degree to which the standardised residuals from the χ^2 tests vary from their average. *Ergo*, we see that the most of the 80 standard deviations in **Figure 2.11** are of ~1 or below, and that only a small minority are of ~1.20 or more – *i.e.*, they strongly indicate a low level of interregional variance in the spread of most coin designs. The smaller number of standard deviations that are greater than ~1.20 have been inflated by either: a) a single standardised residual (from the χ^2 tests) indicating a degree of under- or overrepresentation for that particular design in one region or another, or b) the standardised residuals for each region being rather widely spread within the range χ^2 deems to be normal, thereby giving the false impression that something of interest has occurred in the distribution of the design in question. **Table 2.9**, below, gathers all these examples together in one place.

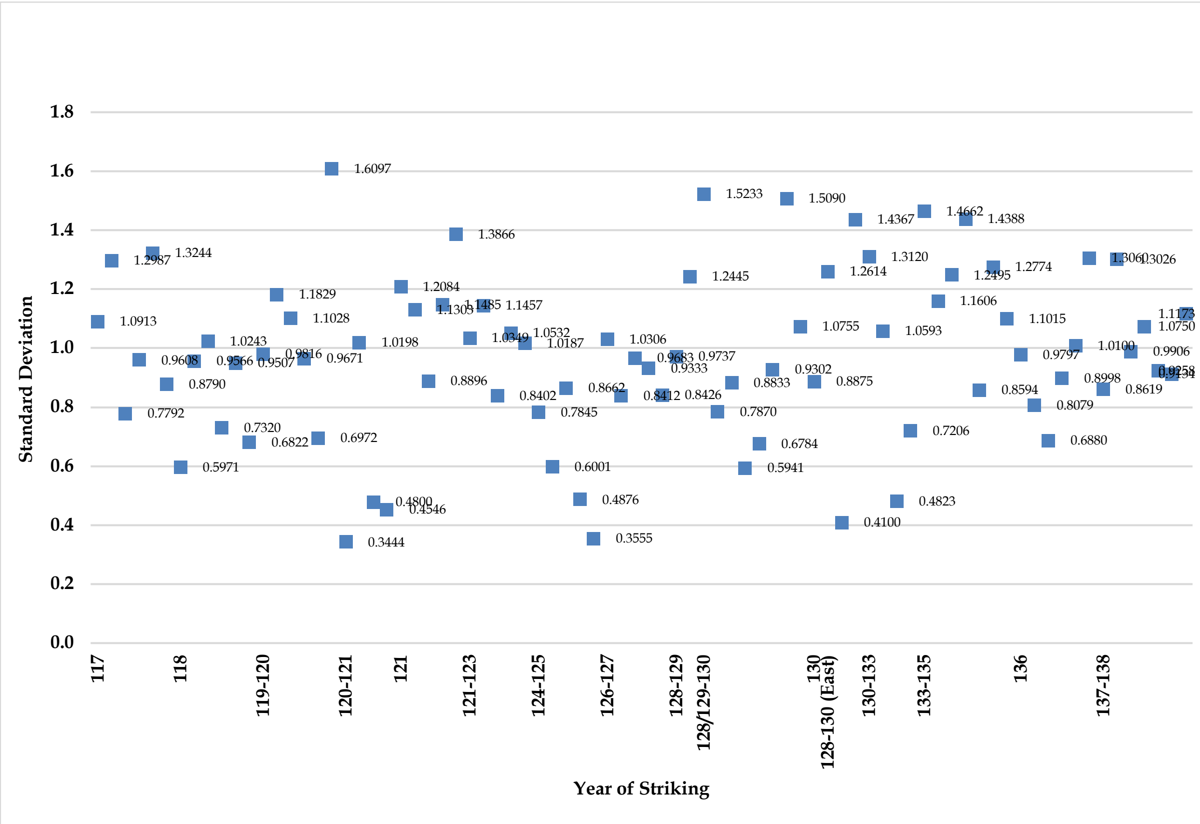

Figure 2.11: standard deviations at the level of the design (*denarii* in hoards closing up to *c.* 250). Range: 1.2653. Average: 0.9735.

The overall picture created by the standardised residuals and their standard deviations, then, is that the broad, interregional distribution of most designs – as in the case of most issues – exhibits little substantive variation. Here we are speaking of a dataset composed of hoards that close, in the main, toward the end of the second century and the first half of the third.

Table 2.9: Standard deviations greater than ~1.20			
Design	**Period**	**Standard deviation**	**Reason for greater-than-normal standard deviation**
Fortuna Redux	117	1.2987	Standardised residuals within normal band for χ^2, but the range between min and max greater than usual (min -1.7977/max 1.2503).
Pietas	117	1.3244	Standardised residuals within normal band for χ^2, but the range between min and max greater than usual (min -1.4810/max 1.4041).
Salus	119-120	1.6097	Standardised residuals indicating overrepresentation in Western Danube (2.6251) and underrepresentation in Eastern Danube (-1.9566).
Victoria	121	1.3865	A single standardised residual indicating underrepresentation in Italy & Adriatic (-2.7504).
Tranquillitas (Sabina)	128-129, 129-130	1.5963	Standardised residuals within normal band for χ^2, but the range between min and max is greater than usual (min -1.4372/max 1.776).
Concordia (Eastern mint)	128-130	1.2614	A single standardised residual approaching the threshold for overrepresentation in Italy & Adriatic (1.8761 standardised residuals). This – and the result of Victoria, below – appear to underlie the overrepresentation seen for Italy and the Adriatic at the level of the issue.
Victoria (Eastern mint)	128-130	1.4366	A single standardised residual approaching the threshold for overrepresentation in Italy & Adriatic (1.9046 standardised residuals).
Africa	130-133	1.3119	A single standardised residual indicating overrepresentation in Spain & Western Med (2.0294).
Concordia (Sabina)	133-135	1.4661	Standardised residuals within normal band for χ^2, but the range between min and max greater than usual (min -1.9687/max 1.8322).
Hadrian & Roma	133-135	1.2494	Standardised residuals within normal band for χ^2, but the range between min and max greater than usual (min -0.9234/max 1.6388).
Juno (Sabina)	133-135	1.4387	Standardised residuals within normal band for χ^2, but the range between min and max greater than usual (min -1.9184/max 1.4176).
Tellus	133-135	1.2773	A single standardised residual indicating overrepresentation on the Rhine (2.0322).
Aelius	137	1.3059	A single standardised residual indicating underrepresentation in Western Danube (-2.3249).
Fortuna	137-138	1.3025	Standardised residuals within normal band for χ^2, but the range between min and max greater than usual (min -1.5824/max 1.6644).

A more nuanced impression of coin distribution at the level of the design can be observed in **Table 2.10**, below, which presents a selection of the results of phased χ^2 analyses of subsets from hoards that close up to 180, 192, 211, and, finally, the entire dataset of coins from hoards closing up to and beyond *c.* 250. It was not possible to subject the 161 subset to design-level testing because the per-design totals were too small for χ^2 to function properly. In lieu of this, **Table 2.10** presents the number of coins per design as a percentage of the overall number from the region in question. These come with the obvious caveat that they are less reliable and should, at most, be viewed as a complement to the more dependable results of the χ^2 tests from 180 onward.

Table 2.10: under- and overrepresented designs from subsets closing with coins of 161-*c.* 250							
Period	**Region**	**Design**	%	χ^2 standardised residuals			
			Denarii in hoards up to 161	*Denarii* in hoards up to 180	*Denarii* in hoards up to 192	*Denarii* in hoards up to 211	*Denarii* in hoards up to *c.* 250
119-120	**Britain**	Concordia	**8.82**	**2.2384**	**2.7420**	**2.9202**	**2.1590**
	Western Danube	Salus	24.42	0.6924	0.50981	1.1394	**2.6251**
	Eastern Danube		26.67	-0.7031	-0.8199	**-2.2023**	-1.9566
121	**Italy & Adriatic**	Aeq-Moneta	40.43	0.9133	0.9948	1.1514	**2.0081**
		Victoria	0.00	-1.8597	-1.8912	**-2.0451**	**-2.7504**
121-123	**Britain**	Pax	1.54	**-2.5253**	-1.9412	-1.2230	-1.4954
	Rhine	Clementia	12.50	1.6664	1.5921	1.0798	**2.0776**
	Italy & Adriatic	Concordia	11.48	-1.3023	-1.6173	-1.8367	**-2.1302**
124-125	**Rhine**	Genius	16.67	-1.8447	**-2.0198**	-1.9095	-0.7055
128-129, 129-130, 130	**Western Danube**	Annona-Abundantia	**5.46**	**3.0884**	0.4576	0.6263	-0.5203
	Eastern Danube		0.00	**-2.4001**	-0.5128	-0.7509	0.7544
	Rhine		12.50	1.7999	**2.2991**	1.9625	1.2779
	Britain	Clementia	8.33	1.0548	1.1688	1.4404	**2.2027**
	Western Danube	Fortuna Redux	9.84	**-3.0199**	1.0286	0.5181	1.3590
	Eastern Danube		4.35	**3.9357**	0.8374	1.5085	-0.0621
	Western Danube	Roma	11.48	**-3.4090**	1.6913	1.7454	1.8393
	Eastern Danube		**8.70**	**5.0421**	0.0509	-0.4627	-0.5538
	Western Danube	Romulus	3.83	**-2.5305**	-0.2874	-0.2914	-0.9734
	Eastern Danube		**8.70**	**2.6107**	0.8944	1.9338	0.7959
	Italy & Adriatic		0.00	-1.0211	-1.2066	**-2.4541**	-0.8217
	Western Danube	Virtus	**5.46**	**2.9213**	0.2813	0.1271	-0.8576
	Eastern Danube		4.35	**-2.2735**	0.1815	0.0098	1.0882
130-133	**Rhine**	Africa	0.00	-1.7250	**-2.0705**	-1.9141	-1.8027
133-135	**Rhine**	Tellus	**33.33**	**2.1366**	**2.9583**	**2.7375**	**2.0322**
137, 137-138	**Italy & Adriatic**	Aelius	0.00	-1.0250	-0.8505	-1.3716	**-2.3249**
	Italy & Adriatic	Fortuna	0.00	**2.1477**	1.4921	1.7866	1.6644
	Eastern Danube		0.00	1.8639	**2.2972**	1.2405	0.6558
	Rhine		0.00	-1.9840	-1.8255	**-2.0452**	-1.5824
	Britain	Venus	**12.50**	**2.0103**	1.2473	1.2497	0.8957
	Italy & Adriatic		0.00	**-2.3625**	**-2.3689**	**-2.4455**	**-2.3860**

Among the mass of figures, a number of patterns and consistencies can be identified. The first and most obvious feature of these data is the fact that the 180 subset contains more instances of under-/overrepresentation than the three later ones – a likely signifier that regional concentrations became less prominent as time wore on and circulation took effect. See, for instance, Pax *denarii* of 121-123 in Britain, which work their way from being overrepresented in the 180 subset to 'normal' in the succeeding ones; the various under- or overrepresented designs of the 128/129-130 group from the Western and Eastern Danube, which do likewise;

and the various designs of 137-138 from Britain, the Rhine, and the Eastern Danube. In every one of these cases, the design in question is either under- or overrepresented in the 180 subset, but not in the final, uncontrolled group of hoards closing up to *c.* 250, probably indicating that in the intervening years circulation had largely ironed out any irregularities in their distribution. The speed at which this levelling process occurred appears to have differed from case-to-case. For example, the British underrepresentation of the Pax design of 121-123 (-2.5253) increases in strength (*i.e.*, it moves into the band indicating a 'normal' level of distribution, comparable with other regions) only gradually, from the 192 subset onward. The overrepresentation of the Fortuna design (137-138) on the Eastern Danube, likewise, gradually softens and moves into a band of standardised residuals indicating normal distribution as of the 211 subset. By contrast, the various under- and overrepresentations of designs struck 128/129-130 among the hoards of the Western Danube and Eastern Danube appear to correct themselves as soon as the 192 subset. Some of these corrections are quite dramatic – take, for example, the complete disappearance, by the 192 subset, of the pronounced overrepresentation of Roma (129-130) among the hoards from the Eastern Danube, which, in the preceding 180 subset, was as strong as 5.0421 standardised residuals.

An interesting coda to the above is that many of the overrepresentations that disappear as time goes by appear to have roots at least as far back as the 161 subset, which for statistical reasons could not be tested by χ^2.[15] See, for instance, the overrepresentations of the Annona-Abundantia and Virtus designs (both 128-129) on the Western Danube, and the Fortuna Redux, Roma, and Romulus designs (128-129, 129-130, 130) on the Eastern Danube. In each case, the percentages for these designs were found to be the highest of any region in the 161

[15] It is important to qualify the phrase 'at least': of the total number of coins from all hoards closing up to 161 from all regions (2,504), just under half (1,381) come from deposits with even earlier closing dates (up to 145). Of these, 1,068 come from hoards that close on or before the death of Hadrian in 138. It is likely, therefore, that any number of these concentrations could reflect where *denarii* were originally sent – for whatever reason – in Hadrian's day.

subset, matching their overrepresentations in later subsets that were tested using χ^2. It would be incautious to see these percentages as proof that these concentrations date back as far as 161, but their pairing with definitely overrepresented χ^2 values for the 180 subset raises the possibility that had we enough data to test the earlier subset of coins closing up to 161 using χ^2, then the results would likewise indicate overrepresentation.

Just as interesting as the disappearance of regional concentrations over time are the handful of instances in which under- or overrepresentations of some designs do not go away, but continue to crop up in the χ^2 results for each subset from 180 all the way through to the uncontrolled group of hoards closing as late as *c.* 250. Similar cases were noted in the analysis of the interregional distribution of Trajanic reverse designs, where it was speculated that the ability of these concentrations to weather the destructive effects of circulation shows that not *all* regional difference in the empire-wide distribution of *denarii* should be assumed to have disappeared. The clearest examples in Hadrian's reign, in chronological order by date of striking, are:

1. **Britain, 119-120**. χ^2 showed the Concordia design (*RIC* II.3 217-219; *P M TR P COS III*) to be overrepresented, without a break, from the 180 subset all the way up to the hoards closing as late as *c.* 250. Here, the percentage given for the earlier subset of coins closing up to 161 indicates that this design might occupy a higher proportion of the British coins than it does in any other region from an earlier date.
2. **Italy and the Adriatic, 121**. χ^2 showed *denarii* bearing the Victoria reverse design (*RIC* II.3 396-402; *PM TR P COS III*) to be nearly or actually underrepresented for the whole period 180-*c.* 250.
3. **Rhine, 130-133**. The various Africa designs (*RIC* II.3 1467-1500; *AFRICA*, and RIC II.3 1569 1571-1572; *RESTITVTORI AFRICAE*) are either nearly or actually underrepresented in each of the hoard groups 180-*c.* 250. A corresponding overrepresentation of Africa *denarii*

occurs in Spain and the Western Mediterranean in results of tests on the complete and uncontrolled dataset of *denarii* closing up to *c.* 250. Unfortunately, we cannot see whether this overrepresentation also occurs in Spanish hoards of an earlier closing date because that region produced nothing that enabled it to be included in tests on the earlier subsets of *denarii* from hoards closing between 161-211.

4. **Rhine, 133-135.** The χ^2 tests returned standardised residuals pointing to an overrepresentation of the Tellus design (*RIC* II.3 2052-2058; *TELLVS STABIL*) from the 180 subset through to the hoards closing up to *c.* 250. Once again, the percentage figure for the earlier 161 subset indicates a possible overrepresentation of Tellus in that group, too.
5. **Italy and the Adriatic, 137-138.** Here, the Venus designs struck for Hadrian and Sabina (*RIC* II.3 2367-2369; *VENERIS FELICIS*, and *RIC* II.3 2576-2577; *VENERI GENETRICI*) are consistently underrepresented from the 180 subset all the way through to the uncontrolled group of hoards closing up to *c.* 250.

The existence of clear evidence for isolated over- or underrepresentations of some designs at the same time as the wider body of evidence tells us that most designs achieved a fairly wide distribution is an issue that emerged during the analysis of Trajan's *denarii* in the previous chapter. Richard Duncan-Jones expressed this dilemma best when he said:

"…on the one hand, [there are] coin-issues whose representation is relatively consistent in most areas; and on the other, coin-issues whose representation is subject to major geographical anomalies. The undoubted existence of both phenomena argues that the configuration must reflect patterns in the transmission of new coin, and that the mint's procedures caused some issues to be distributed evenly, and others much less evenly."[16]

The conclusions Duncan-Jones made on the back of this observation (that the existence of regional concentrations of *denarii* evinces a fragmented coinage and economy), though

---

[16] Duncan-Jones 1990, p. 40.

problematic, are not under debate at the present.[17] What is clear is that the observable distribution of some designs (and, as was seen in section *i,* some coin issues, too) very probably reflects where discrete batches of *denarii* were sent for release into circulation, or (as in the case of the eastern *denarii* of *c.* 128-130, which appear to concentrate in Italy, also discussed in section *i*) the subsequent movement of coins already released into circulation elsewhere. It is particularly interesting that several of the regional concentrations noted in **Table 2.10** and the list above appear to trace their origins to the earlier subset of hoards closing up to 161, strengthening the possibility that they are indeed Hadrianic in origin.

The number of overrepresented designs listed above is small in comparison to the total number of designs surveyed. Whether this is an accurate reflection of how often the state sent batches of newly struck *denarii* for release at specific locations, or whether the distribution of most issues or designs commonly occurred on a more or less regionalised basis, is a moot point. The answer, based on the evidence presented here, is probably a mixture of both: most of the regions under survey returned standardised residuals indicating overrepresentation in the case or one-or-another issue period or design, suggesting that the release of new coins often occurred in a highly regionalised manner, even if it was uncommon for the mint to use reverse designs to target audiences with messages, but it would also appear that coins bearing the same design were dispatched in many directions. At every turn it must be stressed that we are here talking of newly struck *denarii*: there was presumably variation in the degree to which new and/or pre-mixed coins were sent out from Rome or provincial treasuries.

How we account for the fact that only a few issues and designs still appear to concentrate in the regions where they were first sent, whereas other concentrations fade away to nothing, is an interesting question. It is possible – as hinted at earlier on – that the answer

[17] Though considerable disagreement centres on Duncan-Jones's observation that coin populations with distinctive profiles necessarily have a direct bearing on the sophistication and unity (or not) of the Roman economy: see **Introductory chapter**, **footnote 13**.

might partially be a matter of geography. Of the seven examples of under- and overrepresentation lasting from *c.* 161 to *c.* 250 listed above, the three most trustworthy (on the grounds that the standardised residuals are based on the largest samples of coins) are from only two of our regions: Britain on the one hand, and Italy and the Adriatic on the other, both of which share insular geographies characterised by sea borders and (in the Italian region's case) mountain ranges that created a degree of separation which might, in turn, have bolstered the ability of these places to retain coins rather than shed them to other parts of the empire. In the case of the underrepresented designs, the same force could have worked in the other direction to militate against significant quantities of *denarii* circulating into these places from the outside. This is simply speculation, of course, and the degree to which we can feasibly label any of these regions (not least Italy, and therefore Rome) as fiscally 'insular' is open to question.

Any such theory would have to address the degree to which coins did or did not- move out of these regions by sea, rather than land routes, *e.g.* in the course of trade or at the behest of the state. In both cases, the quantities of coins being moved are ultimately unknowable, and in order for coins to enter insular provinces like Britain or the Mediterranean islands, maritime routes will of course have accounted for 100% of all arrivals. That said, the size or value of chests and purses moving about with merchant ships is not likely to have been high – perhaps sufficient to act as a cash float to fund purchases and other expenses at the various ports and harbours along their journey, if the scant number of coins recovered from Mediterranean shipwrecks is to be taken as a general indicator. Only a very small proportion of the hundreds of Hellenistic, Roman republican, and Roman imperial wrecks analysed by Tselekas and Strauss contained any coins.[18] Some ships produced large numbers of coins, in which case

[18] Tselekas 2016, pp. 148-150 and 153-154: 27 out of 403 wrecks contained coins. Strauss 2017: 30 out of 483 wrecks of the republican and imperial periods. See also Parker's 1992 gazetteer of more than 400 known wrecks and their contents. We must, of course, remind ourselves that the seeming dominance of 'coinless' wrecks might have been created by the ease with which small quantities of coins can be

they might or might not represent official movement (it is hard to say). In the main, however, the totals are small, and most deposits are predominantly composed of copper-alloy denominations.[19] As for the official movement of coins, it is reasonable to argue that the state will have preferred to avoid exposing itself to the risk of entrusting large sums of money to rivers or seas where overland routes were viable (and off-season, it is unlikely that sail was even considered an option), but the line was not clear-cut; there are plenty of references in ancient texts to the risks associated with sea transportation of coins and other important cargoes, thereby implying that people did take this route, and it is clear that large sums of money were still committed to the holds of ships.[20] It is, nevertheless, hard to get a handle on how many wreck site deposits might represent state activity.[21] Transport by road was likely to have been costlier, but this might have been a trade-off that officials were willing to accept given the potential dangers inherent in the overland transportation of coinage (*e.g.*, banditry or thievery) were, unlike those associated with maritime transport, something that the state

---

missed or overlooked by marine excavators, or the numbers recovered by salvage in antiquity, or removal by crew or passengers at the point they abandoned ship.

[19] Coins from six of the wrecks covered by Strauss (*op. cit.*), being mast-step depositions dating to the time of construction, do not even represent circulating coinage.

[20] Marcus Aurelius quotes a speech delivered by Fronto, who – with some hyperbole – advised against transporting important documents such as wills by ship if it could be avoided: Fronto *Correspondence* 1.6.5. Cato the Younger shipped substantial revenues from Cyprus to Rome aboard ship, but not before tagging the cargo with cork buoys in case of disaster; for this and other examples of official movement of coins by sea in the Republican period see Duncan-Jones 1990, p. 45. Arrian, by contrast, used his voyage between ports along the coastline of Turkey to transport pay to garrisons stationed along his route. His account contains multiple references to the perils of sudden changes in the weather: Arrian, *Periplus Ponti Euxini*, 6.ii. On the seasonality and variability of sailing times in the ancient Mediterranean, see Duncan-Jones *op. cit.*, pp. 7-29.

[21] Some (*e.g., RIC* II.3, pp. 46-48) have postulated that the Garonne hoard of second-century *sestertii* were bound for Britain, perhaps as part of an official effort to top up the province's coin stock with *aes* denominations, but 3,997 *sestertii* is hardly an astronomical sum of money, and we might just as easily be looking at some other kind of public or private shipment. It is not even certain that the great hoards of *nummi* found aboard fourth-century wrecks like Syrna I (*c.* 35,000 tetrarchic *nummi*; CHRE no. 6803) or Arzachena (at least 30,000 Constantinian *nummi* up to *c.* 340; possibly as many as 50,000; CHRE no. 20935) necessarily represent the official movement of coins, even though it is likely; the means by which we can identify state-sanctioned cargoes of coins aboard private ships that were also carrying other goods, for instance, is not apparent.

could hope to mitigate.[22] Much of this is speculative, and it remains hard – if not actually impossible – to comprehend the true scale of shipborne movement of coins. Even so, the quantities at play might not have been so great as to greatly impact the strength of on-the-ground concentrations in antiquity, given that χ^2 has shown itself capable of detecting them in the modern-day.

An emerging picture of episodic regionalised coin distribution from the mint at Rome is becoming clearer. However, the extent to which the distribution and release of new *denarii* was organised on a targeted basis – *i.e.,* by matching reverse designs to end-users – is still up for debate. Most of the regional concentrations of reverse designs outlined above do not bear an immediate relevance to the regions in which they appear; it is not obvious, for instance, what resonance the Tellus or Annona-Abundantia designs would have had among coin users along the Rhine, where both these designs were found to concentrate (**Table 2.10**). In cases such as these, it is more likely that large sections of particular production runs, perhaps distinguished by reverse design, were isolated and dispatched to pre-identified regions for fiscal purposes alone. Exceptions exist: it is probably safe to assume that nearly all shipments of new coins were undertaken to fulfil a fiscal need, but the evidence occasionally allows us to speculate that the mint, in consultation with decision-makers at Rome, used the opportunity presented by a shipment to target certain reverse designs at certain audiences.

[22] ORBIS calculates that the fastest summertime route for a loaded oxcart moving from Rome to Trier likely involved a degree of coastal sailing in order to leave Italy, but that the remainder of the 39-day journey probably took place on a combination of road and river. On the costs of transportation by road, see Duncan-Jones 1974, pp. 367-369, quoting Doiocletian's Price Edict, gives cost ratios for transport by sea *versus* river (for shipments of grain) that are in the order of 1:49; for sea *versus* road transport, this rises to at least 1:28.

Figure 2.12: British single find of a *denarius* of Hadrian struck 119-120. *P M TR P COS III*; Concordia left (*RIC* II.3 218)

One contender for a targeted shipment emerged in the results from Britain. The χ^2 tests carried out at the level of the issue in section *i* strongly suggest that the coinage of the 119-120 issue was overrepresented in Britain within the subset of *denarii* from hoards closing by 180. This was matched by similar χ^2 tests carried out at the level of the design, which showed that *denarii* bearing the Concordia design of 119-120 (**Figure 2.12**: *RIC* II.3 217-219; *P M TR P COS III*) are particularly overrepresented among British hoards. This design was found to be consistently overrepresented in Britain from the 180 subset onward (**Table 2.10**).

Tables 2.11-2.14, below, show the results of χ^2 analyses undertaken on *denarii* of the 119-120 issue period at the level of the design. Three groups of *denarii* from subsets of hoards closing up to 180, 192, and 211 were tested, as was the uncontrolled group of hoards closing up to *c.* 250 and beyond.[23] As previously mentioned, it was not possible to test coins from the 161 subset because the per-region and per-design totals were so low that the tests would not have delivered trustworthy results. As can be seen, Concordia *denarii* register overrepresentations in Britain – and Britain alone – from the 180 subset through to the final group of hoards closing up to *c.* 250.

[23] Two regions – Spain and the Western Mediterranean and the Eastern Mediterranean – were eliminated from tests on the designs of 119-120 because the low numbers of coins from these places prevented their reliable testing at the level of the design.

Table 2.11: reverse designs of 119-120 from *denarii* in hoards closing up to 180 (n=404)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Aeternitas	17	5	16	30	9	**76**
Concordia	12	1	2	8	1	**24**
Felicitas	14	3	12	30	11	**70**
Pax	17	4	10	31	6	**68**
Pietas	22	5	9	28	4	**68**
Salus	25	7	12	46	7	**97**
Qty	**107**	**25**	**61**	**173**	**38**	**404**

χ^2 standardised residuals χ^2 = 8.68, df = 20, **p-value = 0.5427**					
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**
Aeternitas	-0.7514	0.1077	1.2827	-0.5177	0.6530
Concordia	**2.2384**	-0.3980	-0.8529	-0.7103	-0.8369
Felicitas	-1.0543	-0.6398	0.4400	0.0045	1.7209
Pax	-0.2379	-0.1013	-0.0834	0.3486	-0.1565
Pietas	0.9402	0.3861	-0.3955	-0.2073	-0.9474
Salus	-0.1362	0.4071	-0.6914	0.6924	-0.7031

Table 2.12: reverse designs of 119-120 from *denarii* in hoards closing up to 192 (n=421)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Aeternitas	19	5	16	34	13	**87**
Concordia	16	2	2	9	2	**31**
Felicitas	16	2	2	9	2	**31**
Pax	20	4	10	36	12	**82**
Pietas	23	6	9	37	7	**82**
Salus	30	7	12	49	10	**108**
Qty	**124**	**26**	**51**	**174**	**46**	**421**

χ^2standardised residuals χ^2 = 20.827, df = 20, **p-value = 0.4074**					
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**
Aeternitas	-0.8177	-0.1731	1.3092	-0.4457	0.7948
Concordia	**2.7420**	0.0540	-1.0428	-1.1274	-0.8907
Felicitas	-1.1725	0.0998	0.8686	-0.0845	0.9104
Pax	-0.3437	-0.4839	-0.2686	0.2395	0.6910
Pietas	0.3018	0.4023	-0.5717	0.4095	-0.9034
Salus	0.2914	0.1132	-0.6175	0.5098	-0.8199

Table 2.13: reverse designs of 119-120 from *denarii* in hoards closing up to 211 (n=594)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Aeternitas	24	7	16	40	31	**118**
Concordia	21	3	2	15	8	**49**
Felicitas	15	7	13	38	20	**93**
Pax	22	7	11	36	35	**111**
Pietas	24	9	9	39	28	**109**
Salus	30	7	13	49	15	**114**
Qty	**136**	**40**	**64**	**217**	**137**	**594**

χ^2 standardised residuals χ^2 = 30.239, df = 20, **p-value = 0.06608**					
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**
Aeternitas	-0.5804	-0.3356	0.9216	-0.4733	0.7254
Concordia	**2.9202**	-0.1649	-1.4272	-0.6855	-0.9820
Felicitas	-1.3637	0.2946	0.9413	0.6905	-0.3129
Pax	-0.6772	-0.1736	-0.2774	-0.7145	1.8576

Table 2.13: reverse designs of 119-120 from *denarii* in hoards closing up to 211 (n=594)					
Pietas	-0.1914	0.6126	-0.8007	-0.1299	0.5704
Salus	0.7631	-0.2442	0.2046	1.1394	**-2.2023**

Table 2.14: reverse designs of 119-120 from *denarii* in hoards closing up to *c.* 250 and later (n=1,250)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aeternitas	30	10	17	49	105	**237**
Bonus Eventus	4	3	0	4	41	**56**
Concordia	23	5	5	17	49	**109**
Felicitas	20	14	13	45	83	**182**
Pax	25	13	15	46	113	**238**
Pietas	26	13	10	42	105	**211**
Salus	36	11	13	64	74	**208**
Qty	**167**	**70**	**73**	**268**	**574**	**1250**

χ^2 standardised residuals
χ^2 = 20.827, df = 20, **p-value = 0.4074**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Aeternitas	-0.0499	-0.7670	0.9599	-0.0411	-0.0217
Bonus Eventus	-1.2670	-0.0785	-1.8223	**-2.3375**	**2.9590**
Concordia	**2.3336**	-0.3993	-0.5260	-1.2738	-0.0526
Felicitas	-1.0196	1.0570	0.5453	0.6445	-0.4571
Pax	-0.9823	0.0564	0.3968	-0.5005	0.7078
Pietas	-0.4002	0.3395	-0.7116	-0.5593	0.7340
Salus	1.4241	-0.2755	0.0996	**2.6096**	**-2.4897**

This apparent concentration of *denarii* of the 119-120 issue in Britain might be explained alongside the arrival of the first *aes* coins bearing the image of Britannia (*RIC* II.3 241-242; **Figure 2.13**), which were also struck in these years. There is good evidence from Bath and other places to suggest that the Britannia coins were preferentially sent to Britain, where they still occur at a higher rate than anywhere else in the empire. Other batches of *aes* coins, bearing distinct reverse designs, were also sent to Britain at intervals throughout the reign of Hadrian, prominent among which are the Fortuna (*RIC* II.3 646-650; struck 121-123), Salus (*RIC* II.3 881-886; struck 126-127), Ceres (*RIC* II.3 2475; struck 127-128) and Vesta designs (*RIC* II.3 2477; struck 127-128).[24] All of this sits comfortably within Walker's 'Period of Regular Supply',

[24] Walker 1988, pp. 290-293 for the Britannia *asses* and other types of British association from Bath; Hobley (1988, pp. 110, 118) made further claims on *aes* designs that were common to Bath, Coventina's Well, and Britain more generally. Abdy summarises the current state of knowledge pertaining to the British supply of Hadrianic *aes* in the introduction to *RIC* II.3, pp. 46-48. See also Moorhead (2015), who builds on Walker's list of coins of British association with the aid of examples recorded by the PAS since the late 1990s.

spanning the years *c.* 96-197.[25] Recent work has even raised the possibility that there were one or more shipments of rare *semisses*, on the grounds that the majority of identified examples belong to the same issue and bear a common reverse design of 121-123 (*RIC* II.3 627-628).[26] Their presence is likely to be the result of an official decision to introduce them into British circulation, probably in conjunction with the imperial visit of 122, in much the same way – as shown by Kemmers – that Domitian's visit to the Rhineland brought about the arrival of a run of freshly struck *quadrantes*. All of the above sit in the company of older, mixed *aes* coins that must have been scooped out of continental circulation and sent over the Channel to top up Britain's pool of coinage at semi-regular intervals.[27]

This is the context in which the British overrepresentation of *denarii* dating to 119-120, and in particular the overrepresentation of the Concordia design, should be understood. If the state could – and did – regularly supply *aes* denominations (some of them on a targeted basis, some in conjunction with other factors, *e.g.* an imperial visit) then it is entirely reasonable to hypothesise that these would have been complemented, on an episodic basis, by mirroring shipments of *denarii*. Here, it is worth recalling Creighton's research on the structure of *denarius* hoards in Britain, which showed that the state in Hadrian's day (and prior) moved new coins into specific areas of Britain to meet its financial commitments – primarily to the army in the north and west of the province.[28] As with the *aes*, the state was probably the primary force behind the arrival of most *denarii*; it is not hard to imagine, therefore, that

---

[25] Walker 1988. The start of this period might be evidenced in the appearance in Britain of a shipment of Nerva's Neptune design: Shotter 2013.

[26] *Pers. comm.* Andrew Brown (PAS, British Museum) and presentations given by the same at the 2022 International Numismatic Congress and the 2023 meeting of the European Coin Finds Network in Sofia. It can hardly have been the case that these small and lesser-mobile coins made their way to Britain *en masse* in private purses, moneyboxes, or in any context that was not affiliated with the state.

[27] See Clay 1989, pp. 218-219. The shipment of older coins from elsewhere in the empire must have been substantial. If all imports of coin had come to Britain straight from the mint, *per* Walker, then many more die links would be observable among Britain's *aes* coin finds than is actually the case. The Garonne hoard, for instance, was aboard a ship possibly bound for Britain; it was composed of mixed older coins and newer specimens with extensive die-linkages: see *RIC* II.3, pp. 46-48 and Etienne and Rachet 1984.

[28] Creighton 2014, pp. 16-19.

significant numbers of (if not all) the Concordia *denarii* of *RIC* II.3 217-219 could have been earmarked for dispatch at roughly the same time as the more famous *BRITANNIA* asses of the same issue period. The way in which Concordia continues to register as overrepresented in the British results arising from the χ^2 tests supports the notion that they arrived in great numbers, and never circulated away from the province such numbers as to eradicate all evidence of their arrival. In this respect, they behave much like the less mobile *aes* denominations, although to a slightly lesser extent. *BRITANNIA* asses almost never appear on the Continent, whereas Concordia *denarii* of 119-120 did circulate widely (quite possibly a sign that they were not all sent to Britain in the first place).

Figure 2.13: British single find of an *as* of Hadrian struck 119-120. *PONT MAX TR POT COS III // BRITANNIA*; Britannia left (*RIC* II.3 242)

The overrepresentation of these Concordia *denarii* belongs to the only issue (119-120) that is χ^2 tells us is overrepresented in Britain. This design – and the coins of this issue overall – therefore stand as one of the lone credible examples of a large injection of new *denarii* into Britain (contrast with the regular shipments of *aes*). It is true that other designs appear to be overrepresented in Britain at a later time (e.g. *denarii* bearing Clementia and Venus reverses dating to *c.* 128-130 and 137-138 respectively), but these are single designs, and the overall quantity of coins they represent has not been confirmed by *e.g.* a die study (and it is unlikely that *all* coins of these types were dispatched to Britain, further limiting their numbers).

2: Hadrian

The fact that Concordia - and the 119-120 issue more widely – stands as one of the lone credible examples of a truly substantial injection of silver coinage into Britain during the reign of Hadrian can be accommodated in one of two ways. The first is that χ^2 failed to detect shipments that occurred at other times in Hadrian's reign. This can never be discounted, but the p-values attached to the results of the χ^2 tests on all other reverse designs of all other issue periods (see tables in **Annexe 2**) indicate a high degree of confidence in their results. The second possibility is the simpler one: no other comparably large shipments of new *denarii* took place over the rest of the reign. It is worth repeating here what was said in regard to Trajanic supply in the previous chapter: *i.e.*, that the logical framework behind the dispatch of fresh batches of coins to the provinces – outside of times of war, when an increase in supply might be expected – is now lost to us, and that we are only speaking of shipments made predominantly or entirely in new coins. It might be that injections of *denarii* equal to the shipment of those struck 119-120 took place at various times, but in the form of older mixed stocks of coins either from Rome or treasuries elsewhere in the western provinces of the empire.

Why the state chose the years 119-120 to send *denarii* to Britain, and why it settled on the Concordia design, is harder to fathom.[29] As far as the timing of the shipment is concerned, it might be that a date near the beginning of the reign was considered an opportune moment to send fresh *denarii* bearing the new emperor's image to the province. This might have been considered doubly appropriate given the fact that 119-120 sat in the aftermath of a recently suppressed insurrection. This episode of violence has been identified as the motivation behind

[29] It cannot be discounted, of course, that they came to Britain in the year 122, upon the occasion of the imperial visit, but χ^2 detected no sign of them concentrating in any other part of the empire, so if they did come later (*e.g.*, with Hadrian) the majority of them must have been drawn from some sort of reserve in order that they could be moved to Britain. There is, besides, little evidence in the data assembled by this study that we can trace Hadrian's movements about the empire in the pattern of new *denarii*.

the striking and shipment of the Britannia asses of the same period.[30] In this context, the image of Concordia, in league with that of a restful Britannia, makes a degree sense as a iconographic 'package', especially if the two were shipped to the province at more or less the same time. Whether the pairing was deliberate is, of course, impossible to say for certain: either the mint chose Concordia to complement the message inherent in the Britannia design, or it was simply a matter of chance that Concordia *denarii* were available for shipment at the same time as officials a) needed to send silver to Britain and; b) planned on sending the *BRITANNIA aes* to Britain. All that can be said for certain is that Britain, for some reason (probably connected to the unrest of *c.* 117/118), obviously occupied a position of some importance in the minds of those behind the selection of coin designs, and that they had a desire to target British coin users with designs relevant to the province, as evidenced by the Britannia asses.[31] It is impossible to say with certainty that *denarii* bearing the Concordia design were selected for shipment to Britain with equal care and attention to their messaging, but in the context of the *BRITANNIA* coinage and Britain's obvious importance at this time, it cannot be ruled out.[32] If the design of Concordia was deliberately chosen for coins to be sent to Britain, then it is

[30] *RIC* II.3 pp. 46-48. The nature of the unrest in Britain around the time of Hadrian's accession in *c.* 117/118 is murky; see Birley 1997, pp. 80, 90, 101, 104. Rumours of violence and of the suppression of an insurrection in Britain at this time means the precise meaning of Britannia on the *aes* at this time has been questioned (defeated enemy, or peaceful personification?), though it is likeliest that her posture is one of semi-vigilant repose (as *RIC* II.3 p. 47, Walker 1988. pp. 295-296) rather than a province in mourning (as per Toynbee 1924, p. 152, and Todd 1966).

[31] Something of the importance the regime attached to Britain at this early stage in the reign can be observed in the fact that the only other place-specific design to have appeared on the coinage up until this time was the Oriens reverse of 117 (*RIC* II.3 49-51, 87), doubtless struck in recognition of Hadrian's continued presence in the east (where he would remain until mid-118). It was after this, in 119-120, that Britain, unique among all provinces, appears on the coinage (there can be no link with Hadrian's British visit, since this did not occur for another two years: Kienast 2017, p. 122), probably because of the recently suppressed insurrection of *c.* 117/118 (see previous footnote). A near-contemporary imperial visit to Gaul in 121, by contrast, passed without commemoration. Britain remained the lone province to be depicted on the coinage until the issue of the so-called 'provincial' series from 130.

[32] Walker (1988. pp. 293-296) theorised along similar lines when talking about the slightly later Britannia *aes* of Antoninus Pius, which are die-linked to coins bearing the Libertas design that are also predominantly found in Britain (*RIC* III 932-933, struck 150-154).

arguable that their shipment and release would perforce have been organised along different lines (and in unison with the *BRITANNIA* asses) to shipments of older, mixed *denarii* if the state wanted them to have any visual impact before they entered general circulation.

iv. Summary

The *denarii* of Hadrian were seen to behave very much as in the previous chapter: coins of most issue periods and designs move toward, but never fully achieve, homogeneity through circulation. Phased χ^2 analyses of hoards closing up to 161, 180, 192, and *c.* 250 illustrate this process. The affinity between the frequency of issues in the Reka Devnia hoard (closing by 251) compared to the amalgamated dataset of CHRE hoards (closing up to *c.* 250) was particularly striking, attesting to a generally low level of interregional variance at the level of the issue (see **Figure 2.6**).

The same analyses showed that some issue periods and designs defy the majority in that they follow distinctive regional distribution patterns, most likely Hadrianic in origin, reflecting where those coins entered circulation. Many of the concentrations at the level of the issue first appeared in the earliest hoard subsets to be tested and continued to return χ^2 results signifying overrepresentation for the later subsets and into the complete and uncontrolled dataset of hoards closing up to *c.* 250. Continued regional difference, even in hoards of third-century date, evidences an uneven coin supply, and that regional concentrations could – and did – defy the homogenising forces of circulation.

Two cases of overrepresentation at the level of the design and the issue stand out: Concordia *denarii* of 119-120 in Britain, and eastern *denarii* of 128-130 in Italy and the Adriatic. The strength of the British overrepresentations for Concordia *denarii* were distinct among the χ^2 results at the level of the design in that they did not fade away over time. Rather, they first occurred in the 180 subset and continued into the complete dataset of hoards closing up to *c.* 250. Almost no other region produced an overrepresentation for a single design that did not fade away (barring the Rhine, 133-135, for the Tellus design but these results are grounded on a comparatively smaller dataset). As discussed above and in **Chapter 1**, this again raises the possibility that Britain's insularity limited the flow of *denarii* back across the Channel, thereby enabling it to hold on to shipments in ways that other regions do not. The concentration of Concordia *denarii* of 119–120 coincides with the first shipments of *BRITANNIA aes* to the province; whether this reflects deliberate iconographic pairing of Britannia and Concordia in the wake of an insurrection in the early reign, or simple availability for shipment, remains unclear.

In Italy and the Adriatic, the consistent overrepresentation of *denarii* of 128-130, struck at decentralised eastern mints, is a particularly striking feature. The presence of these eastern *denarii* in the large Castagnaro hoard, which closes unusually early (in the year 130), combined with their general rarity in western circulation, supports the possibility of early introduction into Italy, possibly as a result of the westward movement of soldiers or officials, though further Italian hoard evidence is required.

It is reasonable to ask whether Hadrian's imperial tours prompted shipments of new *denarii* to the regions he visited. We know that Domitian's visit to the Rhine frontier can be tied to the appearance of newly minted *quadrantes* (Kemmers 2003, 2005), and even more recent research on Britain suggests that the same occurred in Hadrian's time (*pers. comm.* A. Brown; see this chapter, **footnote 26**), but these patterns were not, by-and-large, evident in the *denarii* tested here. Possibilities are the concentration of *denarii* of 119-120 in Britain, which might have accompanied the emperor in 122 rather than being shipped in 119-120 (although this was considered less likely), or the overrepresentation of *denarii* of 124-127 in Italy, the striking of which corresponds with emperor's presence in Rome and one possible *congiarium* in 125, but the connection here is, admittedly, tenuous. This is not to say that the movement of the emperor would not have brought about the movement and distribution of large sums of silver coins (the opposite is probably true); rather, the data analysed here do not evidence this. It would be particularly interesting to see how far Roman- and eastern-made *denarii* track Hadrian’s movements around the eastern provinces, for example.

Chapter 3: Antoninus Pius (138-161)

Introduction

At 31,841 *denarii* from 272 hoards, the reign of Antoninus Pius is the best represented of all those in this study's dataset (see **Figure 3.1**).

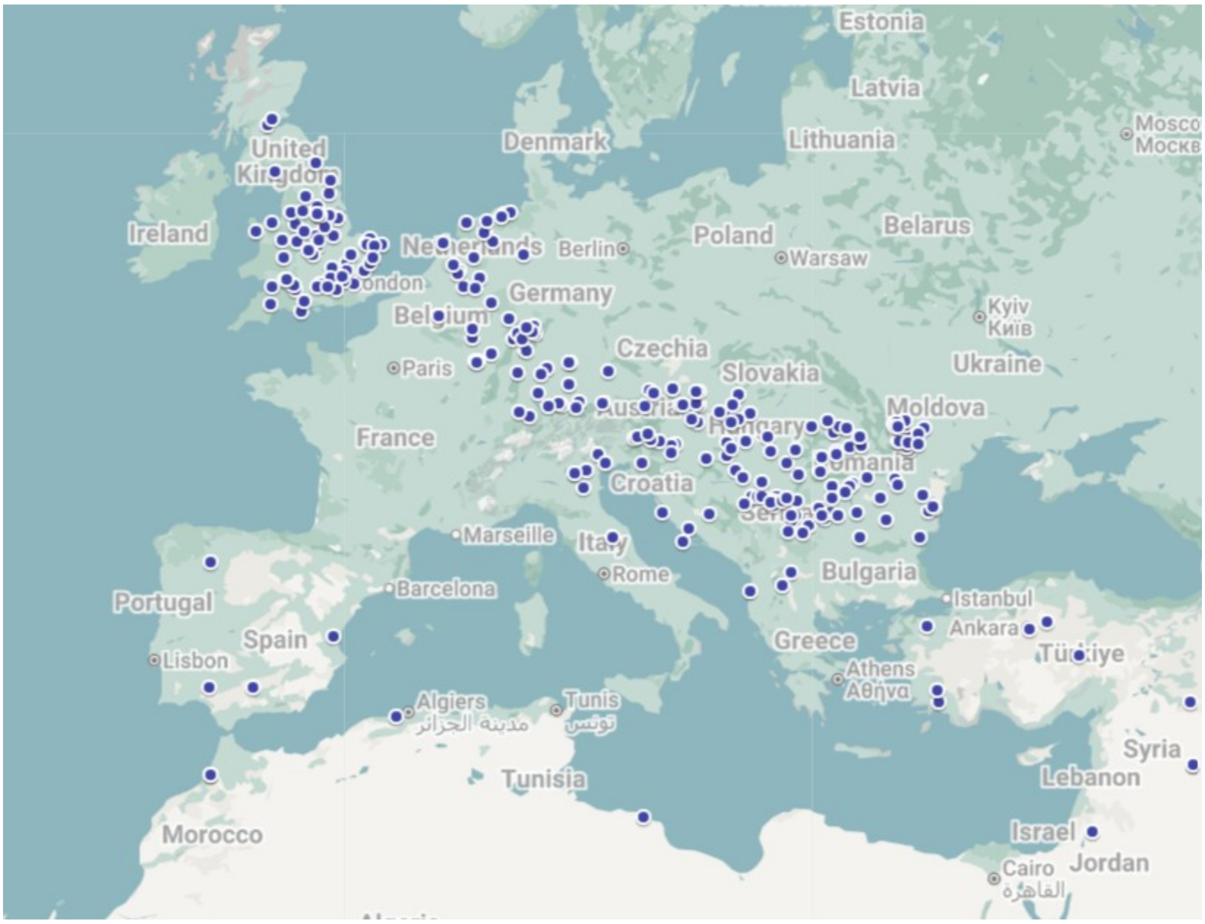

Figure 3.1: hoards containing *denarii* struck under Antoninus Pius in this study's dataset that were recorded to the level of the design on the CHRE database at the time of data collection (n=272). Find an interactive version of this map with links to CHRE records at: https://www.google.com/maps/d/edit?mid=1NxzMZW3PlyMssO9IAVckhGAW2aX4_7g&usp=drive_link

It is possible that events like the Marcomannic War (*c.* 166-180), in the next reign, could have resulted in a disproportionate number of Antoninus' *denarii* finding their way into hoards.[1]

[1] Găzdac 2010, pp. 69-74.

This can never be discounted, but other evidence points to the fact that Antoninus' reign marked a second-century highpoint in the output of *denarii*.[2] This would mean that the comparatively large size of the dataset under analysis here is, in fact, a reflection of the size of Antoninus' coinage relative to those of Trajan, Hadrian, Aurelius, and Commodus.

χ^2 analysis of the coinage, first at the level of the issue and then at the level of the design, will progress in the same manner as before. As was seen in the chapters dealing with the coinages of Trajan and Hadrian, the CHRE data are far from even in their coverage of the empire. In particular, the number of coins from the region of the Eastern Mediterranean was too low to support χ^2 analysis at the level of the design and, for the most part, at the level of the issue; we know precious little about the circumstances leading up to the outbreak of war between Rome and Parthia in 161, for instance, so it would have been of interest to see how far the numismatic evidence for the eastern empire could flesh out this story. This period of gradual escalation must surely have been marked by an increase in the number of soldiers assigned to the eastern frontier. It is an open question as to when, if ever, we might look to a time when the numismatic data for eastern Turkey, the Caucasus, Syria, and parts of the Levant might be up to a standard required of studies such as this.[3]

Spain and the Western Mediterranean were also excluded from the greater part of this analysis because of a similar lack of data. This region encompasses the Iberian Peninsula as well as the North African coastlines of Morocco, Algeria, and Tunisia. Here, the number of

---

[2] See section *ii.* of **Chapter 5** (Commodus), where this issue is discussed at length with reference to the hoard profile.

[3] Our understanding of the causes of the war comes from a small collection of literary references and a few suggestive pieces of numismatic-archaeological evidence. *SHA* 9.6-10 alleges that Antoninus appointed kings to rule client kingdoms in the east, and that he compelled one unnamed king to hand hostages over to another to ensure some sort of peace in the Black Sea region. He refused to return the throne of the Parthian kings captured by Trajan when this was requested of him, and sent troops eastward. *SHA* 12.7 also mentions that, on his deathbed, Antoninus spoke in a state of delirium about kings with whom he was angry. This suggestion of mounting conflict and dispute on the Parthian frontier finds some corroboration in Alexandrian tetradrachms bearing designs showing either a group of suppliant kings presenting wreaths to Antoninus (struck 156/157; *RPC* IV.4 1824-1826), or Eirene being crowned by a figure wearing a Phrygian cap (struck 160/161; *RPC* IV.4 2192).

coins is particularly low: just seven *denarii* from hoards closing 161-192, rising to 1,408 *denarii* in the full dataset of hoards closing up to *c.* 250. Most of these belong to the Llíria hoard (closing 209; CHRE no. 12824) from eastern Spain, which contains 1,393 of the 1,408 *denarii* we have for this entire region.[4]

With the near complete exclusion of the Eastern Mediterranean and Spain and the Western Mediterranean from all but the broadest issue-level analysis, this chapter is, in effect, a study of the distribution of the *denarius* across five regions: Britain, the Rhine, Italy and the Adriatic, the Western Danube, and the Eastern Danube (see again **Figure 3.1** for the distribution of all hoards containing *denarii* of Antoninus Pius in the dataset). It is natural to see the exclusion of certain hoards and regions in exclusively negative terms, but, in actual fact, the removal of regions, issue periods, or designs for which there are insufficient coins only has the effect of improving χ^2's ability to draw out patterns in those for which sufficient data does exist.

The *denarii* of Diva Faustina II have been dated here to *c.* 141-161. Faustina's posthumous coinage must surely have been spread out over a much longer period than the year-or-so following her death (*RIC* III places them in 141): the enormous quantity of Diva Faustina *denarii* in this study's dataset – some 9,200 coins – make little sense if their production was confined to just a couple of years. Such a number would imply a production run that vastly outnumbered the quantity of *denarii* struck for the emperor himself had their striking been confined to *c.* 141 (for comparison, the entire period *c.* 140-144 returned just 1,622 *denarii* of Antoninus).[5]

---

[4] On hoards from the area of Hispania, see the new period-by-period breakdown and commentary published by David Martínez Chico (2025).

[5] Rowan (2011, pp. 994-995), citing an increase in the proportion of coins struck for Diva Faustina I in hoards closing after 161, raises the possibility that her posthumous coinage could have been struck well past the year of her death, probably up to *c.* 161, and possibly even into the reign in Marcus Aurelius.

i. Results of χ^2 tests at the level of the issue

As in the last two chapters, the *denarii* were arranged by issue period and subjected to χ^2 tests in order to expose instances of over- or underrepresentation at the broad, regional level. As before, the coins were divided between subsets based on the terminal dates of the hoards: 161 (1,876 *denarii*), 170 (3,485), 180 (6,675), 192 (8,494), 211 (12,657), and, finally, the complete dataset comprising all the coins from the early subsets plus those from hoards closing up to *c.* 250 and beyond (31,841 *denarii*). Phased analyses on each of these groups present the opportunity to gain a picture of what 'original' distribution might have looked like, allowing us to track the effects of circulation upon the intensity of any regional concentrations that emerge, and to speculate on the factors lying behind decisions to send batches of new coins for release in those regions. As will be seen, the results paint a similar picture to those of Trajan and Hadrian (*i.e.,* a process of gradually increasing integration that takes hold over time, with a few regional concentrations of interest), but with a few key differences – *e.g.*, a lower degree of overall mixing/integration than the previous two reigns, possibly as a result of the shorter time Antoninus' *denarii* were in circulation before many of them were withdrawn and hoarded (*e.g.,* during the Marcomannic Wars or in the early third century).

Tables 3.1-3.4, below, present the results of χ^2 tests on the subsets outlined above. It was not possible to subject the coins of the 161 subset to analysis because the overall numbers of coins per issue period and per region were too low, resulting in estimated values that were far too small for χ^2 to carry out reliable tests.[6] In the case of two regions (Spain and the Western

[6] Although the dataset for Antoninus contains more *denarii* than those of Trajan and Hadrian, most of the coins belong to the later subsets composed of hoards closing by 180 onwards. This is not to say that there are no hoards terminating between *c.* 161 and 180. Găzdac 2010, pp. 69-74 and 2022, pp. 133-136 points to number of hoards along the Danubian frontier that might relate to rumoured disturbances during Antoninus' reign or the Marcomannic War in Aurelius' day. Many of these, however, have not been recorded to the level of the design on the CHRE database (nor was the information readily available elsewhere when this study was in preparation, *e.g.,* in the form of printed lists), meaning they could not be considered here.

Mediterranean and the Eastern Mediterranean), only the groups comprising hoards closing up to 211 and/or *c.* 250 returned enough *denarii* to be tested at the level of the issue.

It should also be noted that issue periods with an insufficient number of coins were combined with others of a similar date in order to make testing possible: *e.g.*, the merger of the 138 and 138-139 issue periods. Likewise, the smaller numbers of *denarii* struck for Aurelius Caesar in 146-147 were merged with those of 145-147 to create a single, large group of *denarii* that is much better suited to testing.

Table 3.1: *Denarii* in hoards closing up to 180

Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
138, 138-139	20	1	14	10	33	14	3	**95**
139	31	1	18	17	66	18	2	**153**
139-141 (Faustina I)	12	0	1	9	23	10	1	**56**
140	12	1	8	15	29	4	3	**72**
140-143	64	2	38	64	143	34	7	**352**
140-144 (Aurelius Caes)	17	0	13	29	26	13	2	**100**
141-161 (Diva Faustina I)	182	0	160	293	1110	207	7	**1959**
143-144, 144	13	2	11	23	46	7	2	**104**
145/146-147 (Aurelius Caes)	28	0	8	42	50	25	1	**154**
145-161	92	0	84	140	435	127	0	**878**
147-148	17	0	5	11	35	11	0	**79**
148-149	37	0	29	63	156	46	0	**331**
149-150, 150-151	8	0	4	29	43	24	0	**108**
151-152	11	0	7	38	57	33	0	**146**
152-153	20	0	11	39	133	31	0	**234**
153-154	12	0	13	21	306	27	0	**379**
154-155	14	0	4	26	504	15	0	**563**
155-156	17	0	19	27	106	21	0	**190**
156-157	17	0	17	24	105	40	0	**203**
157-158	7	0	16	22	62	38	0	**145**
158-159	11	0	12	26	67	19	0	**135**
159-160, 160-161	11	0	20	58	124	26	0	**239**
Qty	**653**	**7**	**512**	**1026**	**3659**	**790**	**28**	**6675**

Standardised residuals
χ^2 = 768.34, df = 84, p-value **< 2.2e-16**

Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Avg
138, 138-139	**3.6940**	-	**2.6362**	-1.0830	**-2.4212**	0.9643	-	0.7580
139	**4.2305**	-	1.8917	-1.2831	-1.8322	0.0363	-	0.6086
139-141 (Faustina I)	**2.8340**	-	-1.5737	0.1720	-1.3274	1.3511	-	0.2911
140	**2.0543**	-	1.2038	1.3860	-1.3839	-1.4380	-	0.3644
140-143	**5.2115**	-	**2.2462**	1.5110	**-3.3467**	-1.0658	-	0.9112
140-144 (Aurelius Caes)	**2.3715**	-	1.9801	**3.5610**	**-3.8106**	0.3925	-	0.8989
141-161 (Diva Faustina I)	-0.7193	-	0.7730	-0.4962	1.0471	-1.6562	-	-0.2103

3: Antoninus Pius

Table 3.1: ***Denarii*** **in hoards closing up to 180**

Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
143-144, 144	1.0094	-	1.1844	1.9202	-1.2265	-1.4198	-	0.2935
145/146-147 (Aurelius Caes)	**3.3393**	-	-1.1056	**3.7757**	-3.7367	1.5930	-	0.7731
145-161	0.6085	-	1.9808	0.3720	-2.2197	**2.2052**	-	0.5893
147-148	**3.3117**	-	-0.4422	-0.3454	-1.2933	0.5221	-	0.3505
148-149	0.7796	-	0.6882	1.6576	-1.9546	1.0547	-	0.4451
149-150, 150-151	-0.8042	-	-1.4996	**3.0138**	-2.1406	**3.1106**	-	0.3360
151-152	-0.8862	-	-1.2689	**3.2508**	-2.6148	**3.7500**	-	0.4461
152-153	-0.6279	-	-1.6581	0.4727	0.3569	0.5988	-	-0.1715
153-154	-4.1395	-	-3.0011	-4.9084	**6.7224**	-2.6942	-	-1.6041
154-155	-5.5594	-	-5.9816	-6.5394	**11.0003**	-6.3515	-	-2.6863
155-156	-0.3898	-	1.1363	-0.4352	0.1270	-0.3376	-	0.0201
156-157	-0.6633	-	0.3404	-1.3154	-0.6489	**3.2247**	-	0.1874
157-158	-1.9225	-	1.4412	-0.0855	-2.0028	**4.9954**	-	0.4851
158-159	-0.6247	-	0.4929	1.1254	-0.8570	0.7331	-	0.1739
159-160, 160-161	-2.5791	-	0.3659	**3.4672**	-0.6711	-0.4566	-	0.0252

Table 3.2: ***Denarii*** **in hoards closing up to 192**

Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
138, 138-139	34	1	17	10	50	18	3	**133**
139	40	1	20	17	83	30	2	**193**
139-141 (Faustina I)	23	0	1	10	27	15	1	**77**
140	15	1	9	15	38	9	3	**90**
140-143	97	2	42	65	184	52	7	**449**
140-144 (Aurelius Caes)	24	0	15	29	39	18	2	**127**
141-161 (Diva Faustina I)	332	0	189	302	1288	358	8	**2477**
143-144, 144	25	2	13	23	57	15	2	**137**
145/146-147 (Aurelius Caes)	43	0	11	42	67	38	1	**202**
145-161	176	0	96	142	521	196	0	**1131**
147-148	25	0	8	15	49	20	0	**117**
148-149	81	0	38	68	201	75	0	**463**
149-150, 150-151	13	0	9	30	63	27	0	**142**
151-152	21	0	13	40	76	43	0	**193**
152-153	39	0	13	39	150	44	0	**285**
153-154	24	0	19	22	331	40	0	**436**
154-155	18	0	7	27	525	23	0	**600**
155-156	34	0	28	27	130	31	0	**250**
156-157	41	0	22	26	136	59	0	**284**
157-158	27	0	22	23	93	47	0	**212**
158-159	21	0	13	27	86	28	1	**176**
159-160, 160-161	30	0	22	60	163	45	0	**320**
Qty	**1183**	**7**	**627**	**1059**	**4357**	**1231**	**30**	**8494**

Standardised residuals

$\chi^2 = 723.55$, df = 84, p-value **< 2.2e-16**

Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Avg
138, 138-139	**3.7559**	-	**2.4044**	-1.5310	-2.0190	-0.1793	-	0.4861
139	**2.6034**	-	1.5755	-1.3924	-1.5046	0.4456	-	0.3455
139-141 (Faustina I)	**3.7934**	-	-1.9524	0.1566	-1.9424	1.1838	-	0.2477

Table 3.2: *Denarii* in hoards closing up to 192								
Period	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
140	0.8562	-	1.0391	1.2892	-0.9474	-0.9943	-	0.2485
140-143	**4.5187**	-	1.6420	1.3340	**-2.8351**	-1.5052	-	0.6308
140-144 (Aurelius Caes)	1.5579	-	1.8830	**3.3736**	**-3.1650**	-0.0457	-	0.7207
141-161 (Diva Faustina I)	-0.7196	-	0.4396	-0.4079	0.4481	-0.0731	-	-0.0625
143-144, 144	1.4827	-	0.9997	1.5548	-1.3917	-0.9908	-	0.3309
145/146-147 (Aurelius Caes)	**2.8068**	-	-1.0108	**3.3547**	**-3.5921**	1.6162	-	0.6349
145-161	1.4144	-	1.3266	0.0314	**-2.5554**	**2.4450**	-	0.5324
147-148	**2.1340**	-	-0.2289	0.0911	-1.4525	0.7195	-	0.2526
148-149	**2.0171**	-	0.6269	1.3162	**-2.4303**	0.9264	-	0.4913
149-150, 150-151	-1.5399	-	-0.4708	**2.8975**	-1.1875	1.3924	-	0.2183
151-152	-1.1542	-	-0.3460	**3.2204**	**-2.3499**	**2.8124**	-	0.4365
152-153	-0.1373	-	-1.7686	0.5543	0.2615	0.3905	-	-0.1398
153-154	**-4.7364**	-	**-2.3436**	**-4.411**	**7.0975**	**-2.9453**	-	-1.4678
154-155	**-7.1965**	-	**-5.6200**	**-5.5530**	**12.2788**	**-6.8842**	-	-2.5950
155-156	-0.1642	-	**2.1985**	-0.7694	0.1058	-0.8935	-	0.0954
156-157	0.2019	-	0.2057	-1.6035	-0.8527	**2.7468**	-	0.1396
157-158	-0.4876	-	1.5846	-0.6884	-1.5521	**2.9056**	-	0.3524
158-159	-0.7033	-	0.0070	1.0865	-0.4380	0.5006	-	0.0905
159-160, 160-161	**-2.2065**	-	-0.3540	**3.1482**	-0.1450	-0.2313	-	0.0422

Table 3.3: *Denarii* in hoards closing up to 211								
Period	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
138, 138-139	36	16	21	10	52	49	3	**187**
139	47	30	24	17	89	84	2	**293**
139-141 (Faustina I)	30	14	2	10	31	34	1	**122**
140	17	11	12	15	39	29	3	**126**
140-143	121	71	60	65	200	141	7	**665**
140-144 (Aurelius Caes)	32	12	21	29	43	49	2	**188**
141-161 (Diva Faustina I)	490	366	314	303	1344	874	8	**3699**
143-144, 144	35	19	20	23	62	42	2	**203**
145/146-147 (Aurelius Caes)	55	36	17	42	78	81	1	**310**
145-161	248	213	166	142	547	432	0	**1748**
147-148	35	34	22	15	57	44	0	**207**
148-149	105	86	53	68	226	159	0	**697**
149-150, 150-151	21	39	20	30	69	54	0	**233**
151-152	27	40	24	40	88	109	0	**328**
152-153	58	41	20	39	169	107	0	**434**
153-154	26	51	28	22	334	81	0	**542**
154-155	18	30	20	27	529	63	0	**687**
155-156	52	52	36	27	138	92	0	**397**
156-157	65	64	31	26	141	132	0	**459**
157-158	56	44	40	23	101	78	0	**342**
158-159	36	46	24	27	92	64	1	**290**
159-160, 160-161	50	81	39	61	170	99	0	**500**
Qty	**1660**	**1396**	**1014**	**1061**	**4599**	**2897**	**30**	**12657**
Standardised residuals								
χ^2 = 984.79, df = 105, p-value **< 2.2e-16**								

Table 3.3: *Denarii* in hoards closing up to 211								
Period	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Avg**
138, 138-139	**2.4013**	-0.9627	1.6191	-1.3888	-1.8343	1.0442	-	0.1464
139	1.4136	-0.3829	0.1306	-1.5069	-1.6501	**2.1094**	-	0.0189
139-141 (Faustina I)	**3.5334**	0.1702	**-2.4755**	-0.0524	-1.9688	1.1841	-	0.0651
140	0.2063	-0.7046	0.6753	1.4510	-0.8664	0.1468	-	0.1514
140-143	**3.7090**	-0.2047	0.9849	1.3059	**-2.5616**	-0.8109	-	0.4037
140-144 (Aurelius Caes)	1.5263	-1.8884	1.5688	**3.3822**	**-3.0063**	0.9684	-	0.4251
141-161 (Diva Faustina I)	0.2163	**-2.0823**	1.0221	-0.4054	-0.0091	0.9339	-	-0.0540
143-144, 144	1.6682	-0.6834	0.9604	1.4869	-1.3099	-0.6059	-	0.2527
145/146-147 (Aurelius Caes)	**2.2558**	0.3144	-1.5686	**3.1470**	**-3.2561**	1.2003	-	0.3488
145-161	1.2006	1.4204	**2.1631**	-0.4024	**-3.5532**	1.5458	-	0.3957
147-148	1.4927	**2.3233**	1.3188	-0.5738	**-2.1183**	-0.5066	-	0.3226
148-149	1.3966	1.0186	-0.3972	1.2326	-1.7486	-0.0721	-	0.2383
149-150, 150-151	-1.7401	**2.6087**	0.2980	**2.3553**	-1.7219	0.0742	-	0.3123
151-152	**-2.4548**	0.6206	-0.4558	**2.3694**	**-2.8786**	**3.8902**	-	0.1818
152-153	0.1250	-1.0079	**-2.5157**	0.4193	0.8692	0.7443	-	-0.2276
153-154	**-5.3610**	-1.1525	**-2.3531**	**-3.4885**	**9.7218**	**-3.8875**	-	-1.0868
154-155	**-7.6094**	**-5.2727**	**-4.7349**	**-4.0440**	**17.6239**	**-7.5365**	-	-1.9289
155-156	-0.0264	1.2239	0.7295	-1.1008	-0.5484	0.0960	-	0.0622
156-157	0.5996	1.8606	-0.9651	**-2.023**	**-2.0245**	**2.6010**	-	0.0079
157-158	1.6463	1.0065	**2.3920**	-1.0701	**-2.1112**	-0.0524	-	0.3018
158-159	-0.3233	**2.4854**	0.1644	0.5512	-1.2923	-0.2830	-	0.2170
159-160, 160-161	-1.9404	**3.4595**	-0.1818	**2.9292**	-0.8973	-1.4672	-	0.3170

Table 3.4: *Denarii* in hoards closing up to *c.* 250								
Period	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
138, 138-139	48	16	28	12	73	222	16	**415**
139	67	31	43	22	132	473	31	**799**
139-141 (Faustina I)	38	15	3	15	43	201	10	**325**
140	28	11	20	16	46	244	5	**370**
140-143	165	71	98	83	292	837	75	**1621**
140-144 (Aurelius Caes)	45	12	35	21	66	282	30	**491**
141-161 (Diva Faustina I)	724	370	472	374	1878	5078	302	**9198**
143-144, 144	49	19	33	28	102	284	11	**526**
145/146-147 (Aurelius Caes)	79	36	32	46	135	539	29	**896**
145-161	387	215	242	165	802	2441	114	**4366**
147-148	51	34	33	22	104	347	22	**613**
148-149	142	87	89	87	351	1015	60	**1831**
149-150, 150-151	33	40	32	37	110	416	29	**697**
151-152	57	41	48	44	144	611	33	**978**
152-153	101	42	43	47	264	597	26	**1120**
153-154	47	51	38	33	407	565	25	**1166**
154-155	31	30	32	27	559	447	11	**1137**
155-156	107	52	63	34	234	603	22	**1115**
156-157	108	64	58	35	234	631	30	**1160**
157-158	106	44	55	28	170	435	15	**853**
158-159	69	46	46	33	157	361	27	**739**
159-160, 160-161	88	81	71	69	246	837	33	**1425**
Qty	**2570**	**1408**	**1614**	**1278**	**6549**	**17466**	**956**	**31841**

Table 3.4: *Denarii* in hoards closing up to *c.* 250

Standardised residuals

χ^2 = 1153.2, df = 126, p-value **< 2.2e-16**

Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Avg
138, 138-139	**2.5060**	-0.5488	1.5183	-1.1410	**-1.3374**	-0.3740	1.0028	0.2322
139	0.3125	-0.7287	0.3927	-1.7781	**-2.5224**	1.6583	1.4313	-0.1763
139-141 (Faustina I)	**2.2976**	0.1658	**-3.3196**	0.5414	**-2.9165**	1.7020	0.0775	-0.2073
140	-0.3410	-1.3254	0.2874	0.2982	**-3.4505**	**2.8807**	-1.8328	-0.4976
140-143	**2.9867**	-0.0803	1.7466	**2.2238**	**-2.2675**	-1.7498	**3.7743**	0.9476
140-144 (Aurel)	0.8529	**-2.0842**	**2.0268**	0.2912	**-3.4816**	0.7718	**3.9739**	0.3358
141-161 (Diva Faustina)	-0.6754	-1.8213	0.2667	0.2508	-0.3179	0.4582	1.5547	-0.0405
143-144, 144	1.0044	-0.8832	1.2273	1.4990	-0.5948	-0.2667	-1.2060	0.1114
145/146-147 (Aurel)	0.7855	-0.5752	-1.9909	1.6737	**-3.6306**	**2.1430**	0.4045	-0.1699
145-161	1.8433	1.5787	1.3908	-0.7733	**-3.2032**	0.9416	-1.4922	0.0408
147-148	0.2164	1.3240	0.3457	-0.5249	-1.9664	0.5860	0.8380	0.1169
148-149	-0.4759	0.6705	-0.3957	1.5758	-1.3190	0.3353	0.6778	0.1526
149-150, 150-151	**-3.1007**	1.6533	-0.5603	1.7062	**-2.7860**	1.7219	1.7647	0.0570
151-152	**-2.4691**	-0.3416	-0.2235	0.7575	**-4.0297**	**3.2177**	0.6710	-0.3454
152-153	1.1149	-1.0694	-1.8278	0.3052	**2.2164**	-0.7004	-1.3152	-0.1823
153-154	**-4.8563**	-0.0780	**-2.7450**	**-2.0171**	**10.7954**	**-2.9495**	-1.6914	-0.5060
154-155	**-6.3437**	**-2.8597**	**-3.3765**	**-2.7586**	**21.261**	**-7.0749**	**-3.9600**	-0.7302
155-156	1.7924	0.3838	0.8621	-1.6073	0.3082	-0.3485	-1.9835	-0.0846
156-157	1.4853	1.7739	-0.1042	-1.6939	-0.2969	-0.2102	-0.8181	0.0193
157-158	**4.4774**	1.0226	1.7887	-1.0658	-0.4109	-1.5210	**-2.0966**	0.3134
158-159	1.2109	**2.3303**	1.3954	0.6130	0.4058	**-2.2037**	1.0215	0.6819
159-160, 160-161	**-2.5191**	**2.2659**	-0.1449	1.5609	**-2.7506**	1.9791	-1.4958	-0.1578

The data above clearly reveal over- or underrepresentations of *denarii* belonging to several issues in one region or another. As in the previous reigns, many of these appear to originate in the earliest testable subset – which, here, is the subset of hoards closing up to 180. In the majority of cases, irregularities in patterns of distribution that first appear in the 180 or 192 subsets appear to endure through the succeeding subsets, frequently remaining visible up to hoards closing by 211 and even *c.* 250.[7] All the instances of overrepresentation laid out in the tables of results above have been gathered together in **Table 3.5**, below.

[7] This statement does not apply to Spain and the Western Mediterranean and the Eastern Mediterranean because only the 211 and *c.* 250 groups were there only ones that contained enough coins to support testing by χ^2. It might well be that the handful of under- and overrepresentations seen in these regions have their origins in earlier decades, but the evidence in its current state does not support proper analysis.

Table 3.5: Regional overrepresentations over time *Fields marked ' - ' indicate where a design was not present in sufficient numbers for testing to take place.					
Period	**Region**	***Denarii* in hoards up to 180**	***Denarii* in hoards up to 192**	***Denarii* in hoards up to 211**	***Denarii* in hoards up to *c.* 250**
138, 138-139	**Britain**	**3.6940**	**3.7559**	**2.4013**	**2.5060**
	Rhine	**2.6362**	**2.4044**	1.6191	1.5183
139	**Britain**	**4.2305**	**2.6034**	1.4136	0.3125
	E Danube	0.0363	0.4456	**2.1094**	1.6583
139-141 (Faustina I)	**Britain**	**2.8340**	**3.7934**	**3.5334**	**2.2976**
140	**Britain**	**2.0543**	0.8562	0.2063	-0.3410
	E Danube	-1.4380	-0.9943	0.1468	**2.8807**
140-143	**Britain**	**5.2115**	**4.5187**	**3.7090**	**2.9867**
	Rhine	**2.2462**	1.6420	0.9849	1.7466
	Italy & Adr	1.5110	1.3340	1.3059	**2.2238**
	E Med	-	-	-	**3.7743**
140-144 (Aurelius Caes)	**Britain**	**2.3715**	1.5579	1.5263	0.8529
	Rhine	1.9801	1.8830	1.5688	**2.0268**
	Italy & Adr	**3.5610**	**3.3736**	**3.3822**	0.2912
	E Med	-	-	-	**3.9739**
145/146-147 (Aurelius Caes)	**Britain**	**3.3393**	**2.8068**	**2.2558**	0.7855
	Italy & Adr	**3.7757**	**3.3547**	**3.1470**	1.6737
	E Danube	1.5930	1.6162	1.2003	**2.1430**
145-161	**Rhine**	1.9808	1.3266	**2.1631**	1.3908
	E Danube	**2.2052**	**2.4450**	1.5458	0.9416
147-148	**Britain**	**3.3117**	**2.1340**	1.4927	0.2164
148-149	**Britain**	0.7796	**2.0171**	1.3966	-0.4759
149-150, 150-151	**Spain & WM**	-	-	**2.6087**	1.6533
	Italy & Adr	**3.0138**	**2.8975**	**2.3553**	1.7062
	E Danube	**3.1106**	1.3924	0.0742	1.7219
151-152	**Italy & Adr**	**3.2508**	**3.2204**	**2.3694**	0.7575
	E Danube	**3.7500**	**2.8124**	**3.8902**	**3.2177**
152-153	**W Danube**	0.3569	0.2615	0.8692	**2.2164**
153-154	**W Danube**	**6.7224**	**7.0975**	**9.7218**	**10.7954**
154-155	**W Danube**	**11.0003**	**12.2788**	**17.6239**	**21.261**
155-156	**Rhine**	1.1363	**2.1985**	0.7295	0.8621
156-157	**E Danube**	**3.2247**	**2.7468**	**2.6010**	-0.3485
157-158	**Britain**		1.6463	1.6463	**4.4774**
	Rhine	1.4412	1.5846	**2.3920**	1.7887
	E Danube	**4.9954**	**2.9056**	-0.0524	-1.5210
158-159	**Spain & WM**	-	-	**2.4854**	**2.3303**
159-160, 160-161	**Spain & WM**	-	-	**3.4595**	**2.2659**
	Italy & Adr	**3.4672**	**3.1482**	**2.9292**	1.5609

Especially notable – though by no means alone in this regard – are the results for Britain, where the standardised residuals signify a consistent level of overrepresentation for the issue periods of the early part of the reign, between *c.* 138-139 and *c.* 143/144. This prolonged period of overrepresentation concurs with the dates of the Roman campaign to conquer and occupy the Scottish lowlands, and would appear to signal the arrival of large quantities of new silver coins to finance military activities in the north of the province at this time. Uncritical eyes would read the passage in the *SHA* and conclude that Antoninus' decision to occupy the lands north of Hadrian's Wall, which culminated in the construction of a new 'Antonine' wall on the Forth-Clyde isthmus, as an unplanned reaction to barbarian incursions across the frontier: "Lollius Urbicus, his legate, overcame the Britons and built a second wall, one of turf, after driving back the barbarians."[8] Many scholars have, rightly, suggested that the campaign to take the lowlands was a wholly premeditated act of expansion – an interpretation of events that fits entirely with the fact that the χ^2 results indicate outsized quantities of new *denarii* were being sent to Britain from the very moment that operations commenced in 139, indicating a degree of pre-planning.[9] This finding complements research carried out by Creighton, who noted that hoards from the far north of Britannia – especially those near the new Antonine frontier – have a distinctively 'modern' profile (*i.e.,* they are significantly composed of newer coins), in spite of the fact that hoards across Britain at this time tended to be composed of a more balanced mixture of old and new coins.[10]

The evidence strongly points to repeated shipments of *denarii* to support the state's actions in Britain from *c.* 138/139 to *c.* 143/144, almost exactly coincident with the beginning and end of the war, and Antoninus' acclamation as *imperator* for the second time in 142/143 (*IMP II* appears on the coinage from 143 onwards).[11] This timing, at the very outset of the

[8] *SHA* Antoninus Pius 5.4. A far less precise reference to disturbances in Britain was made by Pausanias (8.43.4), who blames the Brigantes for starting a war against the people of Genunia, the location of which has never been ascertained.

[9] Frere 1973, pp. 150-151; Mattingly 2007, p. 121. Breeze and Ferris 2016, p. 25, point to epigraphic evidence attesting to the governor's presence at Corbridge on Hadrian's Wall, directing construction projects as early as 139. The conquest and construction of the new 'Antonine' wall required, among other things, manpower and labour drawn from all three of Britain's resident legions: the II *Augusta*, VI *Victrix*, and XX *Valeria Victrix.* See de la Bédoyère 1999, pp. 40-41, 46-47, and 57-58 for epigraphic evidence in the form of dedicatory stones and distance markers.

[10] A function, so Creighton says, of very rapid circulation in the mid-second century serving to move new coins from their points of distribution to civil areas of the south where they might mix with older issues. See Creighton 2014, pp. 15, 18-19 and figures 6 and 9. Fulford 2000, p. 565 gives a brief sketch of the potential scale and costliness of the operation.

[11] Shipments may even have continued up to 145/146-147 if the strong set of overrepresentations for this period seen in **Table 3.5** are to be believed.

reign, suggests the sort of military expedition intended to bolster the new emperor's reputation, much as the Claudian invasion of Britain, a century earlier, had served to enhance that emperor's position – an anniversary that might not have been lost on decision-makers at the time.[12]

Figure 3.2: *sestertius* of Antoninus Pius struck 143-144. *BRITANNIA // S C*; Britannia left (*RIC* III 742)

At the same time as χ^2 suggests Britain was being favoured with large and repeated shipments of new *denarii*, the first of Antoninus' *BRITANNIA sestertii* (**Figure 3.2**), dated 143-144 (*RIC* III 742-745), were being struck at Rome. Interestingly, quantitative data from Walker (1988; the Bath Sacred Spring), Hobley (1998), and the PAS database – do not indicate that these *sestertii* were sent to Britain alongside the *denarii* in ways similar to earlier targeted shipments of *BRITANNIA* asses under Hadrian in 119-120 (discussed in the previous chapter), nor as later shipments of *dupondii* and asses bearing the *BRITANNIA* type were sent to Britain *en masse* around 154-155 (*RIC* III 930, 934).[13] This could be down to any number of factors, but the finds-based evidence and quantities of these *sestertii* existing in museum collections do suggest that they were of a relatively short and restricted mintage, especially when compared to the later

[12] Breeze and Ferris 2016, p. 26.
[13] See Walker 1988, pp. 290-291, and 294-298 for his convincing interpretation of the Hadrianic and later (154-155) *aes* coins from the Bath assemblage.

BRITANNIA dupondii of 154-155, which appear in British contexts in far greater numbers.[14] This nevertheless brings to mind Walker's observation that the supply of *aes* in general does not appear to have been influenced by the intense activity in the north between 138-143.[15] It is possible this imbalance in the supply of *denarii* and *aes* at this time is sign that those in charge at Rome did not think Britain's stock of *aes* required topping up. It might equally be an indicator that the state's preference in respect of military finance was ever so slowly tending toward the abandonment of *aes* in favour of silver. This switch was certainly complete by the time of the Severan reform of army pay in 197, when virtually all shipments to the northwestern provinces were dominated by debased *denarii*.[16]

Other than Britain, the most interesting series of overrepresentations in **Table 3.5** come from Italy and the Adriatic (over several years: 140-144, 145-147, 146-147, 149-150, 150-151, 151-152, 159/160-161) and both Danubian regions: for the Western Danube, the years 153-154 and 154-155; for the Eastern Danube, 145-161, 151-152, 156-157, and 157-158. It is interesting to note that the various periods of regional overrepresentation appear to follow on from each another rather than overlap: *e.g.,* where Britain's overrepresentations drop off, around 140-143/144, is where Italy and the Adriatic's begin. These, in turn, endure for a consecutive run

[14] Hobley's study, though flawed in some respects (see below, **footnote 50**), found no evidence that *BRITANNIA sestertii* of 140-144 (*RIC* III 742-745) were any commoner to Britain than to the Rhineland provinces: see Hobley 1998, pp. 65-66, 73-74 and Table 9.5. At present (December 2025), there are only five securely identified examples of these *sestertii* recorded on the PAS database. The mere eight specimens on OCRE, split between the British Museum, the American Numismatic Society, the Kunsthistoriches Museum, Vienna, and the University of Freiburg, were found by the author of this study to share a number of obverse and reverse dies.

[15] In contrast to the large and repeated shipments of Hadrianic *aes* that might be associated with the construction of Hadrian's Wall: Walker 1988, p. 293.

[16] The gradual switch to *sestertii* and *denarii* over smaller module *aes* of the first and earlier second centuries is well known: Walker (*ibid.*) notes a slight increase in the proportion of *sestertii* being sent to Britain in the Antonine period – a fact that finds confirmation in the PAS data, where the 1,216 *sestertii* of Pius are nearly 1.5 times as common as the combined total of *dupondii*/asses (863), while in Aurelius' reign, *sestertii* appear at a rate nearly five times greater than smaller denominations. On the Severan supply of silver and questions concerning circulation in the third century arising from the near-wholesale switch to silver, see Kemmers 2009b, 2009c, and 2014, pp. 237-239, as well as Duncan-Jones 2001, 2002, Howgego 1994, 1995a, 2002, and Hellings 2016.

of years until about 151-152 (with one reprise in 159/160-161), after which time the overrepresentations concentrate in both the Western Danube and the Eastern Danube. The same tendency was observed in the results of similar χ^2 tests carried out on Hadrian's coinage (**Chapter 2, Table 2.6**); there, the first set of overrepresentations occur in Britain alone (for the years 119-120), after which various other regions appear to have received the lion's share of consecutive issues from 121 until the end of the reign. All of this echoes observations made by Kemmers and Wigg-Wolf on the seemingly cyclical nature of the coin supply to the provinces in the first and second centuries – an arrangement whereby different regions of the empire would essentially take it in turns to receive the bulk of one year's *aes* production from the centre.[17] We now have evidence from the reigns of both Hadrian and Antoninus to say that the same practice might have applied to the silver, although it is clear that external factors (*e.g.*, the immediate requirements of war in one province or another) could and did mean that coinage was not shipped on a strictly rotating pattern of annual alternation.

If what we are observing is the state distributing silver in a manner similar to the *aes,* then it is natural to wonder whether the order of distribution we see in **Table 3.5** (Britain, then Italy, then the Danubes) reflects we what we know of the state's fiscal priorities over the course of the reign. An obvious case can be made for prioritising shipments to Britain in the late 130s and 140s because of the war. Turning to Italy, it is striking that the years of Italy's overrepresentation correspond with the dates of six of the nine *congiaria* known to have taken place over the course of Antoninus' reign. This joins evidence from the previous two reigns (see **pp. 46-47** and **83**) both of which have produced overrepresentations of *denarii* struck in the same year as other known *congiaria.* **Table 3.6**, below, shows where the Italian overrepresentations overlap with *congiaria* for the reign of Antoninus.

[17] Kemmers 2006, pp. 212-215; Wigg-Wolf 2014, p. 163. On apparent fluctuations in the supply of Flavian silver to Lower Germany and northwest Europe, see Kemmers 2006, p. 207 and Hellings 2022, pp. 288-291.

Table 3.6: *congiaria* in the reign of Antoninus Pius[18]		
Congiarium	Date of *congiarium*	Issue period overrepresented among Italian hoards
I	Early 139	No overrepresentation
II	January 140	140-144 (Aurelius Caesar)
III	142 (?)	140-144 (Aurelius Caesar)
IV	Early 145	145/146-147 (Aurelius Caesar)
V	10th July 148 (?)	No overrepresentation
-	No *congiarium*	149-150
VI	22nd May 151	150-151
VII	152	151-152
VIII	10th July 158 (?)	No overrepresentation
IX	January 161	159-160/161

There could, in fairness, be any number of reasons, not connected to the *congiarium,* for an abundance of *denarii* in Italy in any one year. It should not pass notice, for instance, that these Italian overrepresentations span almost the entire length of a reign in which – famously – the emperor and his court did not leave Italy.[19] Factors like this may have played their part, but the repeated coincidence of overrepresentations with known or postulated *congiaria*, as well as events at Rome such as the games and celebrations surrounding the 900th anniversary of the city's foundation (148-149, correspondent, perhaps with the overrepresentation we see for 149-150) merit serious consideration.[20] Especially interesting is *congiarium* IV, held to celebrate the marriage of Aurelius and Faustina II in 145, which coincides with an overrepresentation of *denarii* struck in the name of Aurelius between the years 145/146-147. It is possible that the overrepresentation of *denarii* also struck for Aurelius between 140-144 is also linked to this event (rather than the two *congiaria,* nos. II and III, before it).

[18] Dates of *congiaria* sourced from Kienast 2017, p. 129. See also Pöschl 1941.

[19] Edmund (2020, pp. 35, 50, 175) draws attention to evidence for considerable imperial investment in monumental building projects around Italy. Dedicatory inscriptions at several locations style Antoninus *restitutor Italiae.*

[20] This calls to mind Duncan-Jones' own observation (1994, pp. 79-82 and figures 5.7-5.9) that the frequency and quantity of Italian hoards through the first and second centuries seems to increase in line with the ever-greater amounts doled out at successive *congiaria*. Games celebrating Rome's 900th anniversary were celebrated with types on the *aes* (*RIC* III 862-863), which Hobley found to be at their commonest in Italy (Hobley 1998, p. 76: see below, **footnote 50** for comment on Hobley's data and methods).

Figure 4.3: *aureus* of Antoninus Pius struck in 140 in honour of the emperor's second *congiarium*, of the same year. *LIBERALITAS / AVG II*; Antoninus watches as Liberalitas pours coins into the folds of citizen's toga (*RIC* III 74b)

Acceptance of a link between the Italian overrepresentations and the dates of known *congiaria* raises three issues. The first is that these concentrations remained evident in the results of the χ^2 tests up to the subset of hoards closing by 211 (see **Table 3.5**), after which time they appear to level off somewhat. Their endurance into hoards of such a late date argues against a Hopkinsian view of things, in which taxes and other payments coming to the centre served to thoroughly homogenise the stock of circulating coin across the empire.[21] It is clear that complete homogenisation of the circulating silver coinage was never a viable prospect, and that discrete groups of *denarii* can (and do) exhibit regional tendencies long after their release. Italy has already shown itself capable of holding on to *denarii* that appear to have arrived from the east in Hadrian's reign, *c.* 130 (see **Chapter 2**, **Table 2.6** and **pp. 83-87**); the explanation offered in that case of both Britain and Spain in previous chapters (see **pp. 45-46** and **103-106**) might well apply here, too – *i.e.*, that Italy's geography, hemmed in by both mountains and sea, served to prevent the escape of *denarii* that might otherwise have dispersed over time.

The second issue arises from the fact that the χ^2 tests carried out here are on the lookout for where coins of the year under survey were being sent. The fact that each of the *congiarium* years shown above is matched by a definite overrepresentation among the hoards from the

---

[21] Hopkins 1980. For the countervailing view see Duncan-Jones 1990, pp. 38-42 and, for balance, Howgego 1994, pp. 10-*ff.*

Italian group implies that the state was making use of a great number of new *denarii* to meet each of these enormous payments to the populace.[22] It cannot be true that the entirety of this cash gift will have been accommodated in new coin, but, as will be seen in section *iii.*, there is evidence to suggest that some *denarii* bearing types specific to particular *congiaria* (*e.g.*, the Liberalitas design for *c.* 145/146) were released into circulation in Italy around the same time as these events are supposed to have taken place.

The third and final curiosity concerns the empire-wide military *donativa* that are supposed, by some scholars, to have taken place in-step with *congiaria* at Rome.[23] The *SHA*, for instance, records that the *congiarium* of 145, held in celebration of the marriage of Aurelius and Faustina, was accompanied by a similar *donativum* for the soldiers.[24] If a neat connection can be drawn between observed overrepresentations in Italy and the occurrence of *congiaria*, then we must address the seeming absence of evidence for simultaneous *donativa* in the χ^2 results for frontier regions like Britain, the Rhine, or the Danubes. If, however, the poorly evidenced relationship between the two was not as strong as scholars like Duncan-Jones might suppose, then χ^2's failure to produce evidence for *donativa* at noticeable intervals is easier to understand. By the same token, it is perfectly reasonable to accept that cash donations to the military <u>did</u> take place while also acknowledging that traces of these payments might

---

22 The importance of *denarii* to the *congiarium*, both as the medium for *congiarium*-related types, *e.g.* Liberalitas, and as one of the actual means of payment, has long been recognised. See Metcalf (1993) for the beginning of a debate on the specific placement of Liberalitas on precious metal *versus* denotative *congiarium* scenes on *aes*, and Rowan (2013, pp. 229-232) for discussion on the theme of liberality on the coinage of Antoninus Pius, with reference to differences in depiction between *aurei/denarii* and *aes*. Duncan-Jones (1990, pp. 248-250) speculates on the enormous sums that could be doled out at *congiaria* in the first and second centuries, and is joined by Beckmann (2015, pp. 195-196) in advocating for the *denarius* as the prime means of payment.

23 Duncan-Jones (1990, p. 78) argued for a close relationship between *congiaria* and *donativa*, and that *donativa* can be used to explain patterns of hoarding in the frontier regions.

24 At a push, one might understand *ad donativum militum* to mean only those soldiers in Italy and/or the Praetorians: *Nuptias filiae suae Faustinae, cum Marco Antonino eam coniungeret, usque ad donativum militum celeberrimas fecit*. (*SHA* 10.2). For topic of military *donativa* in general, see Bastien 1988.

not survive in the coin record in such a way that they are observable by χ^2.[25] For instance, the fact that it is comparatively easier to point to a link between *congiaria* and the Italian overrepresentations could well be telling of differences between frontiers and the centre in respect of hoarding and coin circulation being exacerbated, on this occasion, by the greater use of new *denarii* in Italy (as hinted at above) *versus* the use of older coins for the payment of *donativa* in the provinces.[26] It is not unreasonable to suppose that latter might well have been sourced from the coinage of the very regions in which the *donativa* were paid, on top of whatever came from Rome in the form of new coin.[27] Another possibility is that all or much of the *donativum* was credited to a soldier's account rather than being paid in cash, there to be redeemed at the next pay parade or written off against deductions and expenses.[28] As an aside, it is interesting that virtually no coin types directly reference the *donativum*, despite its obvious importance to the relationship between emperor and army. Soldiers do, of course, make frequent appearances on the coinage, but this aspect of their existence is never explicitly acknowledged in the same way as the *congiarium* at Rome. This is true not only of Antoninus, but of all the other reigns under survey here.

Moreover, how we are meant to interpret overrepresentations among hoards from the frontiers as evidence of a specific *donativum* (as opposed to some other kind of shipment) is unclear. As with the Italian hoards, timing is key: there, several of the χ^2 overrepresentations neatly align with the confirmed or postulated dates of known *congiaria*, whereas the overrepresentations we observe in frontier provinces do not. If *donativa* really were pegged to the *congiaria*, and if they were paid in substantial quantities of newly struck *denarii*, it might

---

[25] Kemmers 2006, pp. 209-210 found it similarly difficult to marry seeming peaks in the arrival of new *denarii* in the Flavian period to known *donativa.*
[26] Hellings 2022, pp. 288-292.
[27] Wigg-Wolf 2014, pp. 162-163.
[28] But note Suetonius (Domitian 7.3), who recorded that Domitian prohibited soldiers depositing more than 1,000 *sestertii* into savings accounts at headquarters in order to prevent them being appropriated by rebellious commanders.

well be that they took place after some considerable delay.[29] In brief: a lack of evidence for matching *donativa* need not bother the argument that a plausible, causative link can be drawn between Antoninus' known *congiaria* and overrepresentations of *denarii* that are still observable in the hoard profile of the Italian region.

Britain and Italy aside, the two remaining regions of interest are the Western and Eastern Danube, where a series of overrepresentations point to a strong supply of *denarii* through much of the 150s (**Table 3.5**) while, at the same time, the supply to other regions sat at a level that χ^2 deemed either normal (*i.e.*, between -1.9 and 1.9 standardised residuals) or below normal (*i.e.*, underrepresented: equal to or less than -2). The extraordinary strength of the overrepresented values from the Western Danube for the periods 153-154 and 154-155, in particular, are such that every other region under survey simultaneously returned results pointing to an appreciable degree of underrepresentation, as if to suggest that the supply to this part of the frontier resulted in lower levels of supply elsewhere.[30] This is a phenomenon we have observed before: both in the case of Britain and Italy, above, and in previous reigns (*e.g.*, the Trajan & Jupiter *denarii* of 114-115, which are so overrepresented in the Eastern Danube that all the other regions under survey returned underrepresentations for the same years: see **Chapter 1**). It is natural to wonder how far the extremely strong results for the Western Danube can be connected with the impressive frontier building project along the *agri Decumantes* in Upper Germany and Raetia *c.* 155, which was at least as substantial as the

---

[29] The occasion of *congiaria,* by contrast, regularly feature in the *fasti Ostienses*. On *donativa,* Pliny (*Panegyricus* 25.2) comments that Trajan honoured a pledge to fulfil his accessional *congiarium* but neglected to pay the military *donativum* in full. Duncan-Jones (1990, p. 88), too, acknowledges that his own dataset of hoarded coins does not point to *donativa* on obviously important occasions, *e.g.*, the 900th anniversary of Rome's founding in 148 (this is not to say that they did not happen).

[30] A standardised residual of 2 or more indicates overrepresentation; several of those from the Western Danube at this time register above 10. These very strong results follow a long period in which the standardised residuals for the Western Danube suggest a consistent degree of underrepresentation. This might be a reflection of ancient reality (*i.e.,* this region being starved of supply for over a decade between *c.* 138-152), or it could be a product of χ^2 reacting to the strength of the Western Danube's standardised residuals for the overrepresented years 153-154 and 154-155.

construction of the Antonine Wall in Britain. If so, we must ask why a corresponding spike does not appear among the hoards from any part of the Rhine around the same time.[31] The distribution of the hoards from the Western Danube is, in fact, far from even; most are bunched up along the course of the Danube in Hungary, Serbia, and Romania, with yet more concentrated in central Romania to the west of the Carpathian range.

Any number of tentative explanations might be fielded to explain why χ^2 found the number and proportion of *denarii* struck 153-154 and 154-155 in the Danubes to be so out of the ordinary, ranging from possible disturbances at the frontier itself, to ongoing frontier building projects such as the so-called *limes Transalutanus*, but none can be advanced with any certainty.[32] We would do well to remember that it is not always possible to reach into the historical narrative when seeking to explain phenomena arising from the χ^2 tests. There might by any number of reasons now unknown to us why the state would have wished to supply this heavily militarised region with newly struck *denarii*.

The Eastern Danube returns a set of overrepresentations that occur at different times to those in the Western Danube, with three main groups of overrepresented values in the issue periods 145-161, 149-152 and 156-158 (**Table 3.5**).[33] Only one other region returned standardised residuals signifying overrepresentation at the same time as the Eastern Danube, this being Italy and the Adriatic for issue periods spanning the years 149-152. The temptation to theorise a link between the two – *e.g.,* a known *congiarium* in Rome in 151 matched by a *donativum* at the frontier? – is strong, but the complete absence of simultaneous spikes in other

---

[31] Birley 2000a, p. 155. The frontier defences constructed along the long strip of newly occupied territory between the sources of the Rhine and Danube were greater in length than the Antonine Wall in Britain, with substantial portions of constructed in stone.

[32] Găzdac 2010, p. 54.

[33] The breadth of the period 145-161, to which *RIC* III assigned a large portion of Antoninus' coinage, poses a problem of interpretation when talking about the exact nature of coin supply. The problem here arises from the fact that Antoninus' fourth consulship, assumed in late 145 (Kienast 2017, p. 128), was also his last, leaving open to question the dating of *COS IIII* coins that were struck without tribunician years. Mattingly and Sydenham acknowledge in their introduction to Antoninus Pius (*RIC* III, p. 8.) that many of the types assigned to this broad period were most likely struck *c.* 145-146.

frontier regions urges caution. It is possible, too, that the repeated overrepresentations we see for the Eastern Danube might have some relation to the murkily-understood conflict in Dacia in the 150s, which was apparently so serious that it required the installation of a new commander and the committal of soldiers from other regions of the empire.[34] The dating of this conflict is still open to question, but a possible date of *c.* 157/158, concurrent with a number of the overrepresentations we see for the Eastern Danube, has been advanced by scholars who point to epigraphic evidence attesting to the reorganisation and division of the province into smaller administrative units.[35] As with the strong set of overrepresentations arising from the χ^2 tests on the Western Danube, these historicising explanations for overrepresentations on the Eastern Danube are tentative; they are just as likely to evidence 'routine' shipments driven by any number of fiscal concerns now unknown to us.

Finally, a word on the overrepresentations from Spain and the Western Mediterranean. The hoards from this region could not be analysed in the subsets of *denarii* from hoards closing by 180 and 192 owing to a lack of data. They did, however, return overrepresentations in both the 211 subset and the complete dataset of hoards closing up to *c.* 250 for the issue periods *c.* 149-151 and *c.* 158-161. Whether these are connected in any way to the financing of Roman military efforts in the so-called Moorish War that took place on the north African *limes* in Mauretania between *c.* 150-156, or whether they represent nothing more than the normal and periodic in-flow of new coinage, is open to question. The war of the 150s is poorly understood, although recent scholarship has raised the possibility that whatever took place on this section of the frontier constituted a far more significant investment in men, money, and resources than the few literary sources would imply.[36] It could be the case that

[34] Birley 2000a, p. 152.
[35] Grant 1996, p. 2; Găzdac 2010, p. 51.
[36] Kienast 2017, p. 129. Pausanias, in one passage of his near-contemporary *Description of Greece* (8.43.3), records that Antoninus responded to Moorish incursions by pushing them back to the Atlas Mountains, while the *SHA* (5.4) records merely that the emperor compelled the Moors to sue for peace. Several discharge diplomas, however, record that units from as far away as the Pannonias and Moesias,

the overrepresented values we see in the data from Spain reflect a significant inflow of cash correspondent with a military build-up, but without corroborating evidence from hoards closing earlier than 211, and in the absence of more hoards from North Africa itself, this theory cannot be scrutinised any further.

ii. Distribution at the level of the issue

Discussion has so far concerned itself with specific instances of over- and underrepresentation in the regional χ^2 results at the level of issue. We will now draw back to consider how the results of the phased χ^2 tests above inform our general understanding of the overall distribution and circulation of the *denarius.* The standardised residuals from the χ^2 tests presented in **Tables 3.1-3.4**, above, were averaged out and their standard deviations calculated. **Table 3.7** and **Figures 3.4-3.7**, below, presents the standard deviations per issue period for the each of the subsets tested here (180, 192, 211) and in the final, uncontrolled group of hoards closing up to *c.* 250. The first point of note is that, in each of the charts, the standard deviations for the 153-154 and 154-155 issues are very high, registering over 4 and 7 respectively in the earliest subset (hoards closing up to 180), and rising to as many as 5 and 9 in the group of hoards closing up to *c.* 250. These indicate a considerable degree of interregional difference in the coins they represent, and can be explained with reference to the fact that the χ^2 tests showed coins of these two issue periods to be vastly overrepresented in the Western Danube (see section *i*, above, and **Table 3.5**) while, at the same time, being significantly *under*represented across all the other regions under survey

Noricum, and Britain were seconded for service in Mauretania, pointing to serious unrest running up to the later 150s that could not be dealt with by the resident garrison: see Eck, Holder, and Pangerl 2016.

Table 3.7: key to standard deviations in Figures 3.4-3.7				
Period	Figure 3.4: *Denarii* in hoards up to 180	Figure 3.5: *Denarii* in hoards up to 192	Figure 3.6: *Denarii* in hoards up to 211	Figure 3.7: *Denarii* in hoards up to *c.* 250
138, 138-139	2.5341	2.5080	1.7647	1.4575
139	2.4814	1.8073	1.5234	1.5753
139-141 (Faustina I Aug)	1.8508	2.4028	2.1863	2.1497
140	1.6515	1.1239	0.8643	1.9948
140-143	3.2663	2.8813	2.1315	2.3483
140-144 (Aurelius Caes)	2.8662	2.4888	2.3953	2.4828
141-161 (F Div)	1.1158	0.5158	1.1355	1.0508
143-144, 144	1.5165	1.4130	1.2715	1.1057
145/146-147 (Aurelius Caes)	3.1679	2.9006	2.4027	2.0595
145-161	1.7668	1.9270	2.1155	1.9055
147-148	1.7758	1.3156	1.6622	1.0810
148-149	1.3939	1.7141	1.2155	0.9543
149-150, 150-151	2.5335	1.8775	1.8897	2.2133
151-152	2.8666	2.4649	2.6630	2.3468
152-153	0.9626	0.9457	1.3065	1.4561
153-154	4.7386	4.8904	5.4830	5.1882
154-155	7.6603	8.3472	9.6908	9.8447
155-156	0.6635	1.2466	0.8402	1.3409
156-157	1.7980	1.6454	1.9856	1.2270
157-158	2.8970	1.8340	1.7032	2.2956
158-159	0.8690	0.7205	1.2713	1.4160
159-160, 160-161	2.2059	1.9346	2.3110	2.1403
Range (excl. 153-154 and 154-155)	**2.0091**	**1.7834**	**1.7319**	**1.7301**
Average (excl. 153-154 and 154-155)	**2.6028**	**2.3848**	**1.8227**	**1.5284**

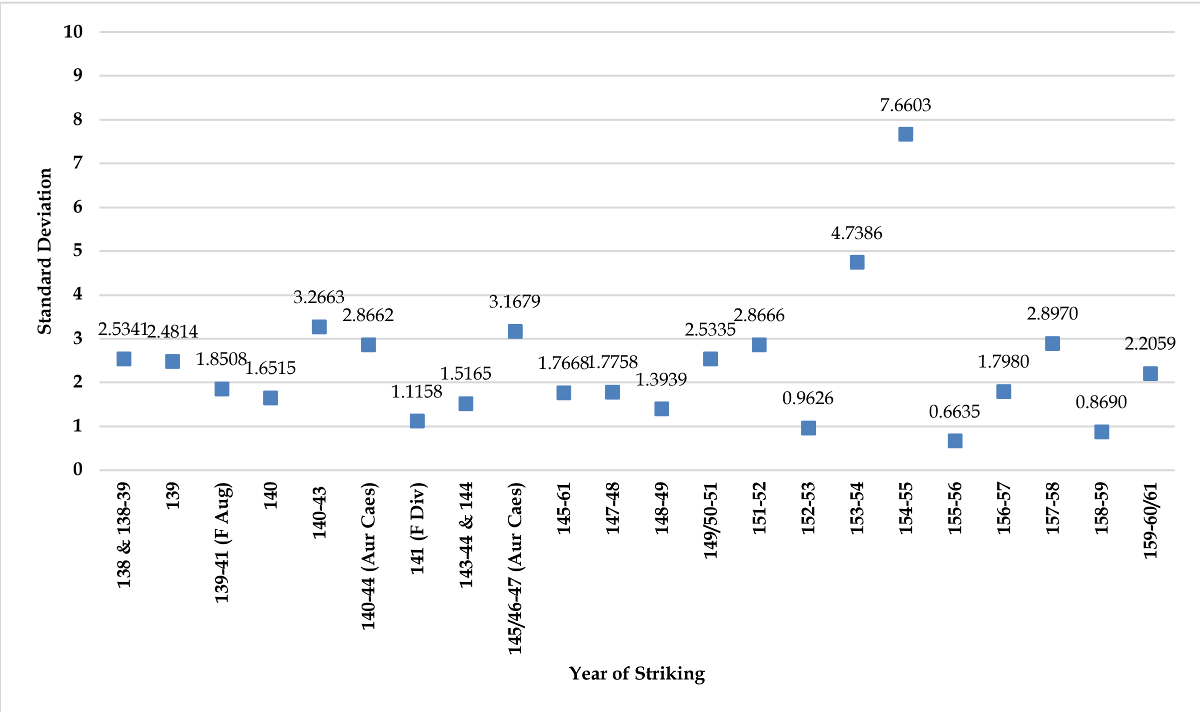

Figure 3.4: standard deviations at the level of the issue - *denarii* in hoards closing up to 180. Range (excl. 153-154 and 154-155): 2.0091. Average (ditto): 2.6028

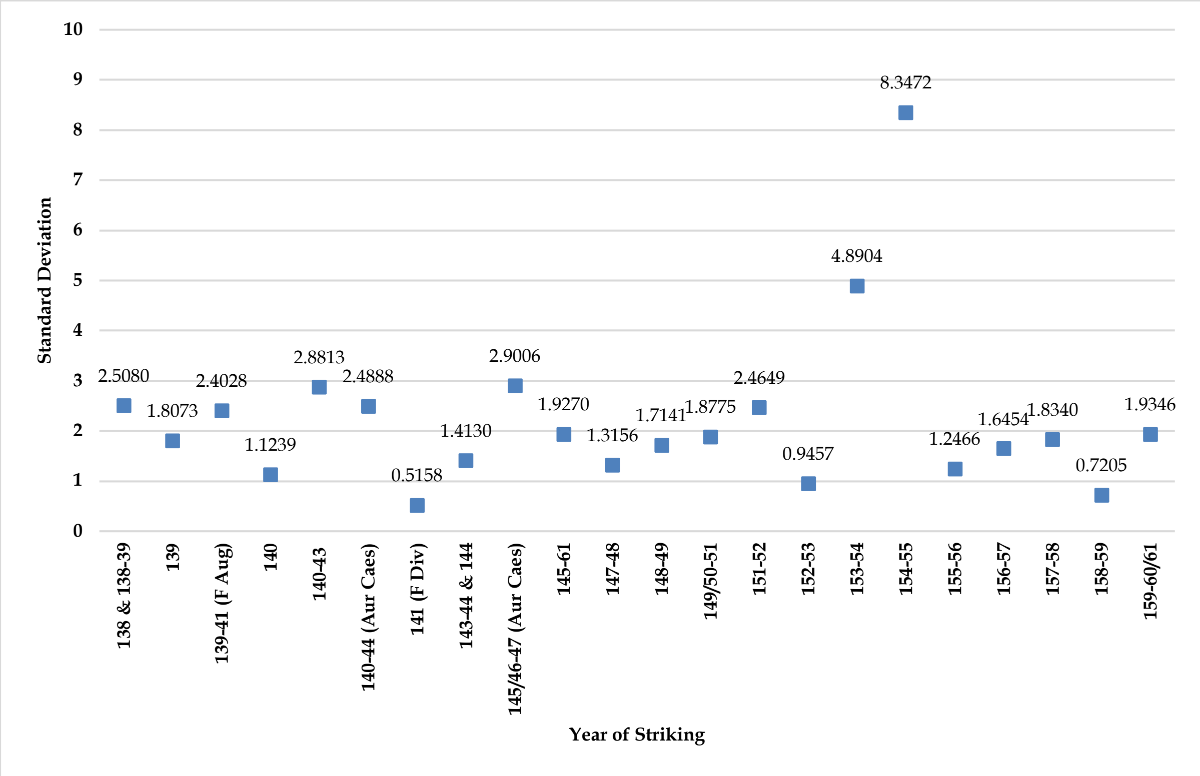

Figure 3.5: standard deviations at the level of the issue - *denarii* in hoards closing up to 192. Range (excl. 153-154 and 154-155): 1.7834. Average (ditto): 2.3848

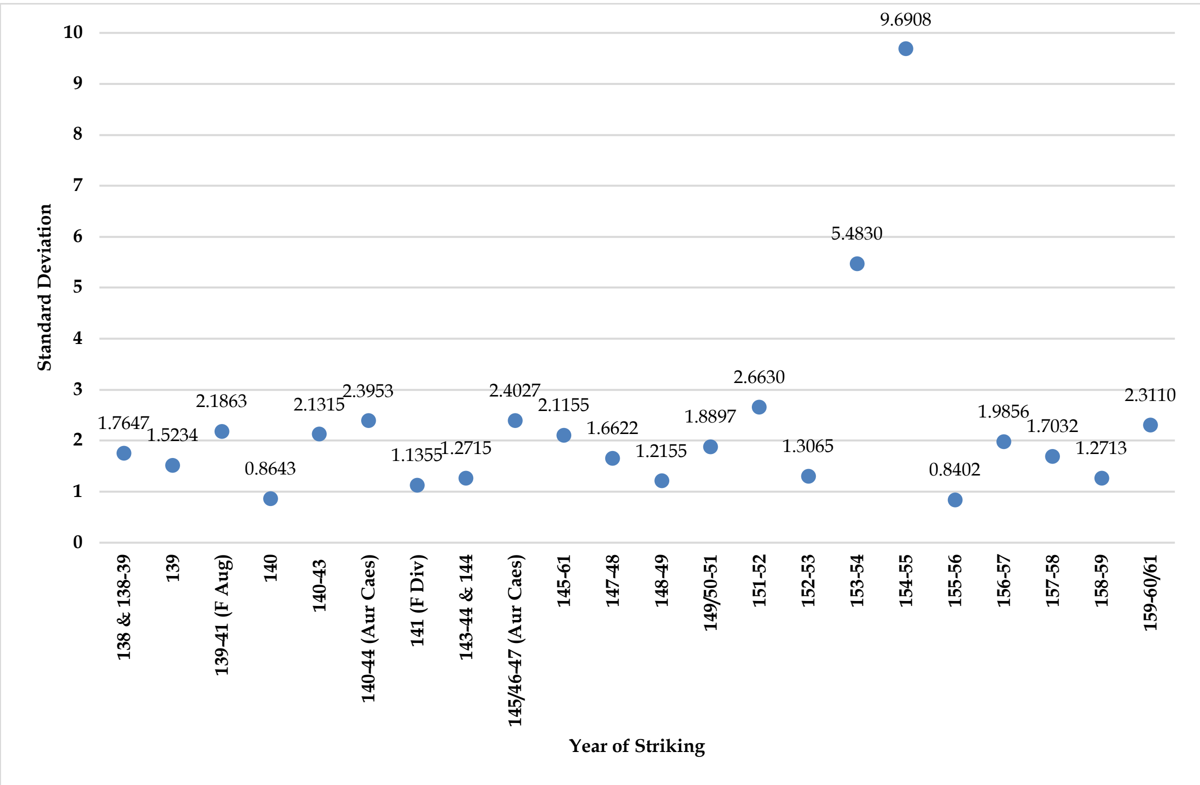

Figure 3.6: standard deviations at the level of the issue - *denarii* in hoards closing up to 211. Range (excl. 153-154 and 154-155): 1.7319. Average (ditto): 1.8227

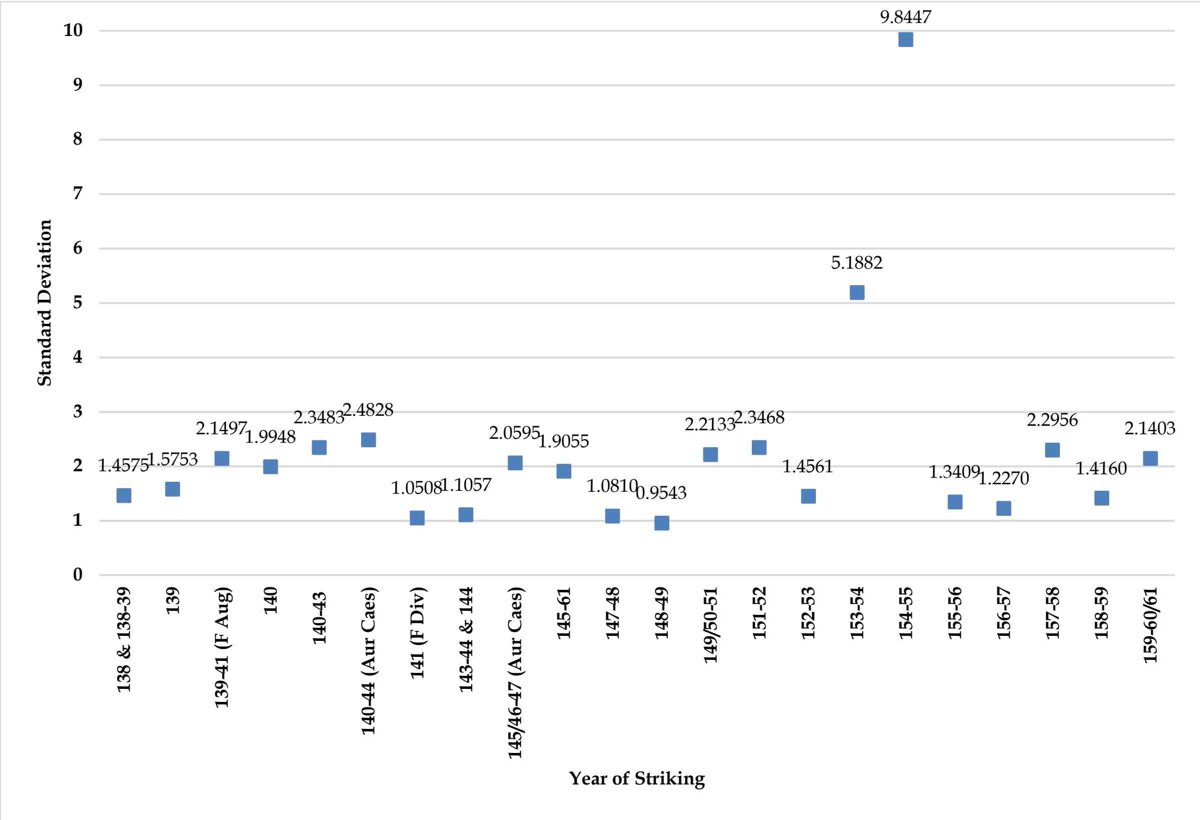

Figure 3.7: standard deviations at the level of the issue - *denarii* in hoards closing up to *c.* 250. Range (excl. 153-154 and 154-155): 1.7301. Average (ditto): 1.5284

The unusually high standard deviations for 153-154 and 154-155 have excluded from the calculations of the average and range of the standard deviations. Without them, the general spread of the remaining standard deviations indicates that, as in past reigns, interregional difference in the spread of issue periods tends to smooth out in hoards with progressively later closing dates. The range between the highest and the lowest of the standard deviations in the 180 subset (**Figure 3.4**), excluding the outliers for 153-155, is 2.6028. As we progress through the various subsets, the standard deviations become far more densely clustered within a much narrower range of values. By the 211 subset (**Figure 3.6**), the range shrinks to 2.3848, and in the group of hoards closing up to *c.* 250 it is narrower still, at 1.5284. All this indicates a gradual loss (if not a total eradication) of interregional difference as coins circulated over longer periods of time. Had it been possible to carry out analyses on coins from the subset comprising hoards closing up to 161 (*i.e.*, by the end of the reign), a more complete picture of distribution might have presented itself – one in which the standard deviations would show an even greater degree of interregional difference in the distribution of *denarii* than in the 180 subset.

The generally high degree of interregional similarity at the level of the issue we see in the complete dataset of hoards closing up to *c.* 250 can be comprehended in **Figure 3.8**, below, which shows the correlation between the relative frequences at which issues appear in the Reka Devnia hoard compared with the remaining 271 hoards containing *denarii* of Antoninus in this study's dataset. The only true point of difference is in the form of the issues for 153-154 and 154-155 issue, which are slightly less common to Reka Devnia (respectively, 3.31% and 2.60% of its contents) than in the amalgamated dataset (wherein they represent 3.93% and 4.30%). The large spikes for 141-161 (Diva Faustina I) and 145-161 (Antoninus and Faustina II) are deceptive; with better dating, their coins could be distributed between issue several periods. Regardless, the degree of correlation between both datasets remains high.

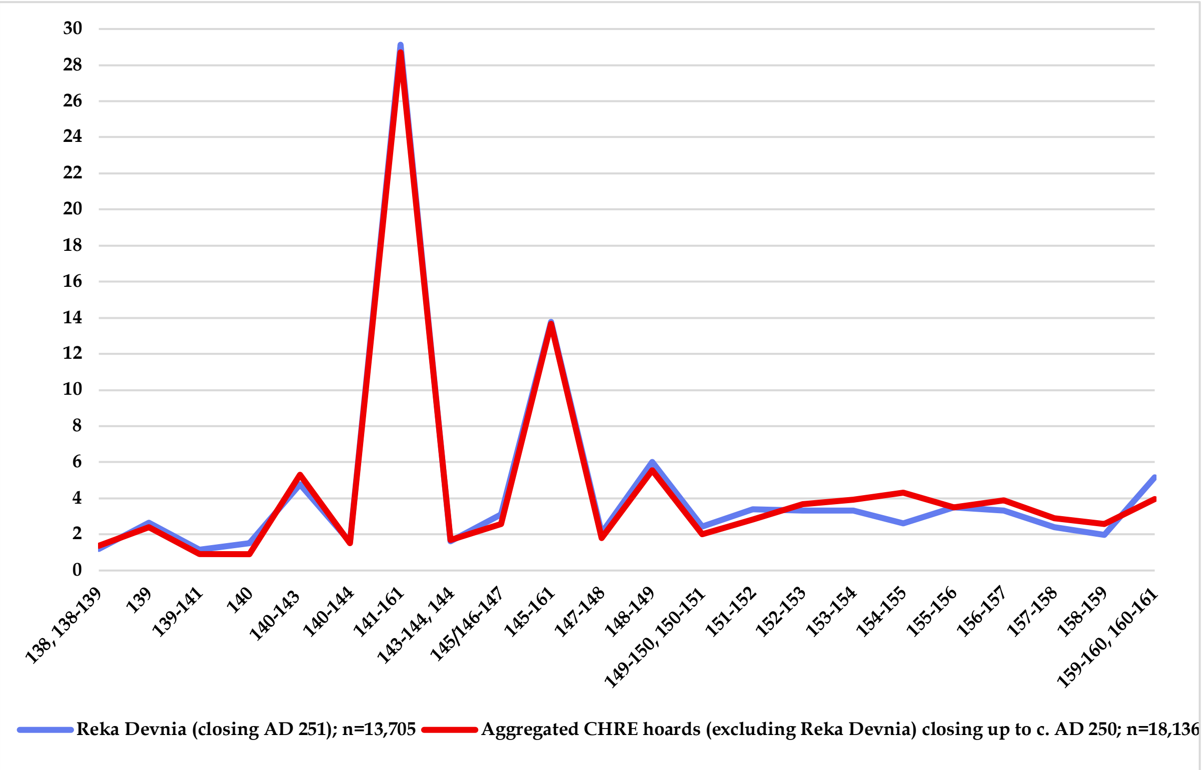

Figure 3.8: Relative frequencies of *denarius* issues of Antoninus, expressed as percentage of the total number of coins in each dataset

It would be helpful to put these results into perspective by comparing them with the results of the same tests carried out on the *denarii* of Trajan and Hadrian in the previous two chapters. Refer back to **Figure 3.7**, above, which displays the full set of standard deviations at the level of the issue for the complete dataset of hoards closing up to *c.* 250.[37] This should be compared with charts displaying the same information for the reigns of Trajan (**Chapter 1**, **Figure 1.2**) and Hadrian (**Chapter 2**, **Figure 2.5**). While the standard deviations for each reign share broadly similar ranges - 1.4274 (Trajan), 1.4150 (Hadrian), and 1.5284 (Antoninus) – it is important to note that the standard deviations for Trajan generally exist within a lower register of values (*i.e.*, closer to 0) than those of Hadrian, which, in turn, exist in a lower register than those of Antoninus. In other words: overall, the standard deviations for Trajan's reign indicate the least interregional variation of all three reigns, whereas those of Antoninus display the most. This is unsurprising, given that Trajanic *denarii* were struck and issued at a much earlier date than those of his two successors. They, therefore, had a generally greater chance to mix and iron out any imbalances in their interregional distribution than those of Hadrian, which, likewise, had more opportunity to circulate than *denarii* of Antoninus, which are the least integrated of all three reigns investigated so far.

All of this is relative: the actual differences between each set of standard deviations are slight, probably owing to the fact that we are looking at coins from hoards that close, in the main, from around the last decade-or-so of the second century and into the third. Such a long period of time would have allowed for substantial mixing, but not quite enough to eliminate all trace of the fact that, even by *c.* 230 (by which time the majority – 201 (or 73%) – of the 272 hoards in the database close), the *denarii* of Antoninus had not mixed as thoroughly

[37] The ranges for Trajan and Antoninus exclude unusually high standard deviation for the issue of 114-115, the causes of which are discussed in **Chapter 1**, and the equally unusual and outsized standard deviations for 153-154 and 154-155, which discussed in this chapter (above).

as those of his predecessors.[38] The 201 hoards in question contain over half (16,000) of the coins.[39] Nearly half of this 16,000 – 7,210 *denarii* – come from hoards closing up to *c.* 190. The indication, then, is that the patterns of distribution and mixing outlined here are, in large part, being expressed in coins from hoards that close around 30 years after the latest of Antoninus' *denarii* were issued, rather than well into the third century (although closing dates and dates of composition might well differ; we are not know how many of these hoards are, in fact, Severan in date. Even if they were, and their dates of deposition were well into the third century, then the fact that they still had not mixed by this point could be taken to support this point even further:).[40]

iii. Results of χ^2 tests at the level of the design

We now move on to reverse designs, and the way in which their geographical spread, as seen in each of the subsets, complements the picture of tightening distribution seen at the level of the issue. As well as this, we will examine each of the instances of overrepresentation to have emerged in the course of the χ^2 tests, asking whether these offer pointers to where *denarii* were released into circulation and, if at all, they might illuminate our understanding of what the state was trying to achieve when typologically homogenous batches of coins were released in one location or another. As will be seen, probable answers can be located in the dual desire to a) cultivate particular audiences by means of the targeted release of certain coin designs in certain locations, while also b) ensuring the more quotidian business of coin supply to the provinces was maintained. Point b) probably lies behind most of the regional concentrations of coin designs outlined below, as it did in the cases of Trajan and Hadrian (**Chapters 1** and

[38] The modal and average closing dates are even earlier, at 180 and 201 respectively.
[39] Most of the other half belong to the Reka Devnia hoard, closing 251.
[40] The debasement of the *denarius* in 194 (from an average fineness of around 67% to 45%) might be partially responsible for the fact that so many made their way into hoards by the final decade of the second century. On the debasement, see Butcher and Ponting 2012, pp. 76-77 and 2022, p. 277.

2); point a) – *i.e.,* the active targeting of predetermined audiences – was probably a far more sporadic practice that did not touch on all parts of the empire, and for which, as in all reigns, there exists a comparatively small body of supporting evidence.

Prior to testing, the 31,841 *denarii* of Antoninus were further sorted and divided according to reverse design. In many issue periods, a particular design – *e.g.* a generic image of Concordia – could be represented by several *RIC* numbers on account of unimportant obverse variations or minor differences in the reverse legend, in which case they were amalgamated and tested as a group. Only in instances where Concordia was struck for two people – *e.g.,* separately for both Antoninus and Faustina II, *c.* 145-161 – were the coins kept apart and their distribution analysed accordingly.

When further dividing the dataset at the much finer level of the design, it was naturally harder to obtain subsets large enough to permit testing. As at the level of the issue, it was not possible to analyse the earliest subset (*denarii* from hoards closing by 161) using χ^2. Moreover, several designs and/or regions returned too few *denarii* for them to be tested in the succeeding subsets of hoards closing 180-211. Designs from two issue periods – 139-141 (Faustina I) and 143-144 – had to be omitted from analysis entirely because none of their constituent designs were represented by a sufficient number of coins.

Thus divided by issue period and design, χ^2 tests were carried out on subsets composed of *denarii* from the usual subsets of hoards closing up to 180, 192, and 211, and on the complete dataset of hoards with uncontrolled closing dates going up to *c.* 250, in order to understand their distribution across the regions under survey, and to compare with the tests carried out in section *ii.*, where it was seen that the standard deviations for each issue evidence a gradual reduction in levels of interregional variation. Tables giving complete per-region totals at the level of the design, as well as results of the χ^2 tests, can be found in **Annexe 3**.

Figures 3.9-3.12, below, present the standard deviations for each of the designs tested in each of the subsets (hoards closing by 180, 192, and 211) and in the complete dataset of hoards running up to *c.* 250. Barring a small handful of designs with unusually high standard deviations (those equal to or greater than 2 – these will be discussed separately below), the overall picture mirrors what we have seen at the level of the issue: *i.e.*, the standard deviations for the 180 subset are generally more spread out than in the final chart for hoards closing up to *c.* 250.[41] The range of the standard deviations in the 180 subset is 1.5900, sitting within a register of between around 0.5 and 1.9 deviations. The range of the standard deviations for the 192 subset is broadly the same, at 1.4067, but their upper limit is, in the main, lower, at around 1.6 deviations. By the 211 subset, the range of the great majority of values is smaller again – between around 0.3 and 1.5 standard deviations. Within the final group of hoards closing up to *c.* 250, the range is narrower still, with almost all values clustering within a band between around 0.5 and 1.5 standard deviations. In simpler terms, the overall range between the highest and the lowest of the standard deviations, as well as the register of values within which they sit, decreases as hoard closing dates – and possibly time itself – get later. Each successive hoard group appears to see a contraction of the area over which the majority of the standard deviations are spread until, by the 211 subset (and very probably earlier, from 192), most are tightly clustered between 0.5 and 1.5 standard deviations.

Here, we see confirmation of what might have been thought to be the obvious: just as *denarii* appear to have circulated in a way that smoothed out much of the interregional difference in their distribution at the level of the issue, so, too, do we see the same pattern repeated at the more granular level of the design. This and similar results presented in the other chapters of this study nevertheless represents, the first time this process has been visualised for any second-century *denarii* beyond the reign of Trajan (*cf.* Spoerri Butcher and Hellings 2017).

[41] It should be noted that it was not possible to accurately compare the standard deviations for each and every design across all four periods 180-*c.* 250 because the number of designs under survey varies (fewer were testable in the 180 subset than in 192 subset, and so on).

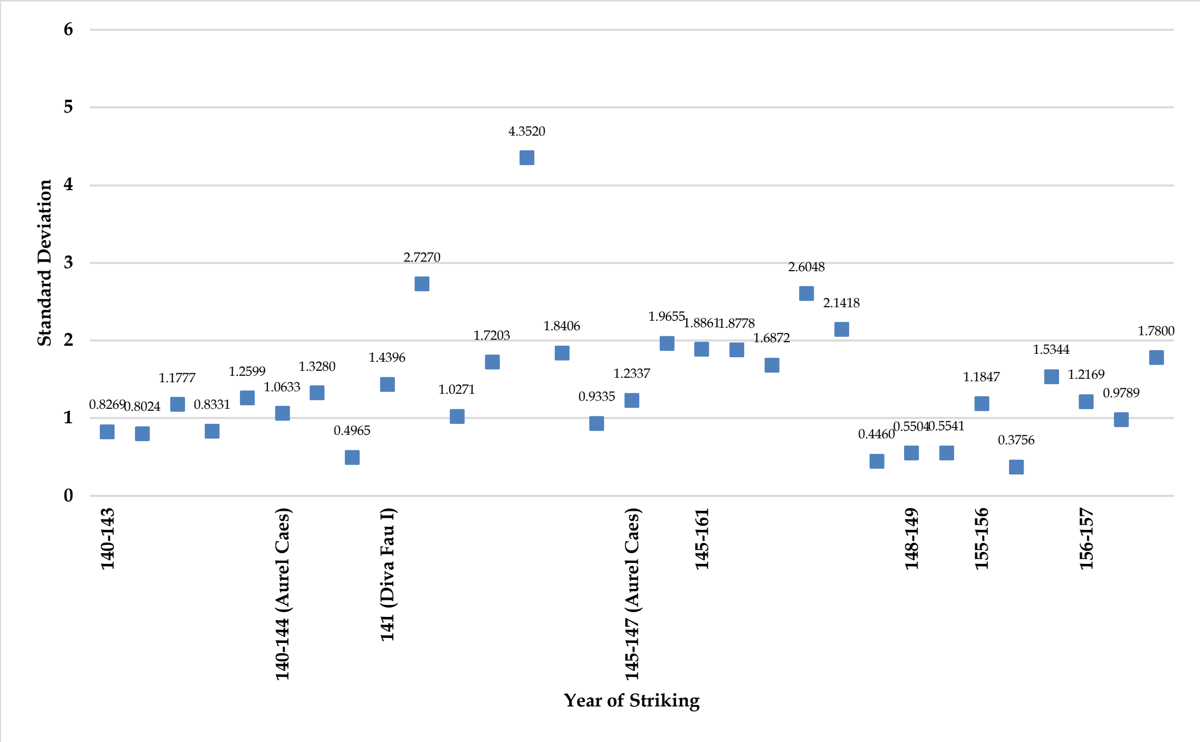

Figure 3.9: standard deviations at the level of the design - *denarii* in hoards closing up to 180. Range of values (excl. standard deviations ≥2): 1.5900. Average (ditto): 1.8590

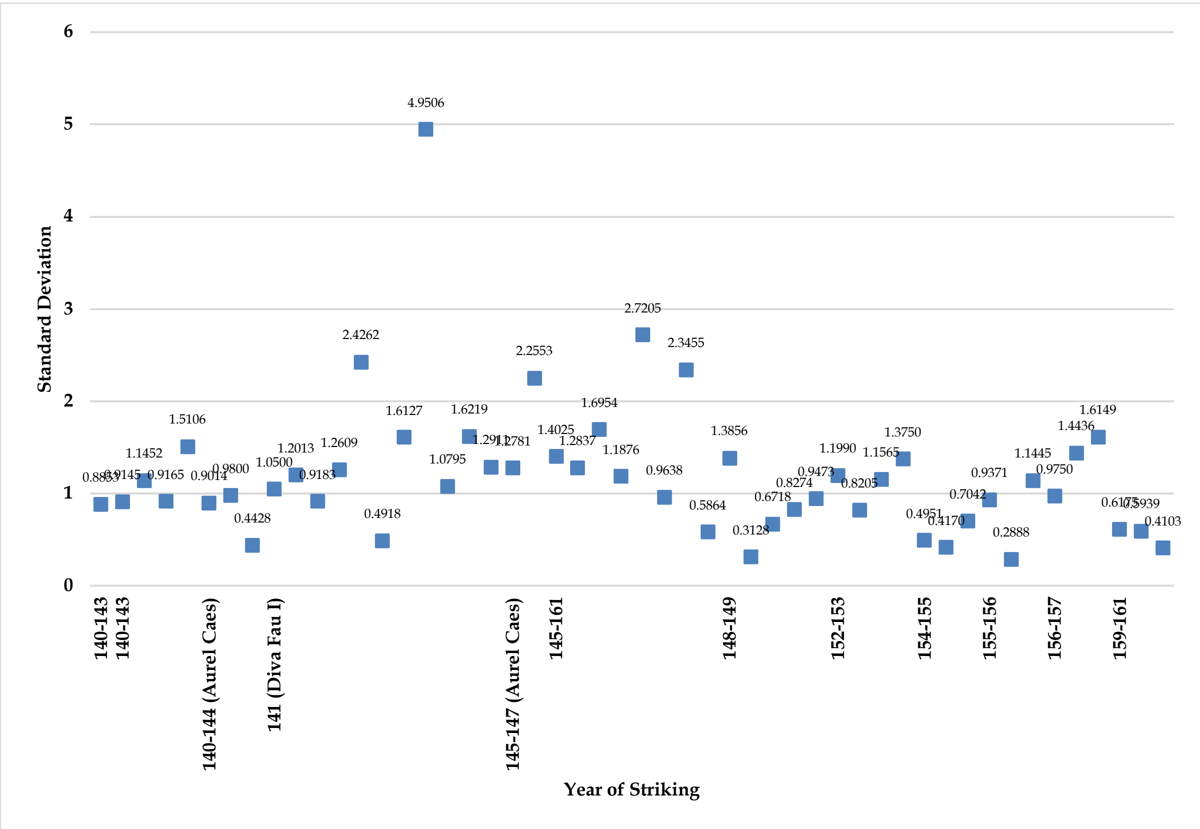

Figure 3.10: standard deviations at the level of the design - *denarii* in hoards closing up to 192. Range of values (excl. standard deviations ≥2): 1.4067. Average (ditto): 0.9991

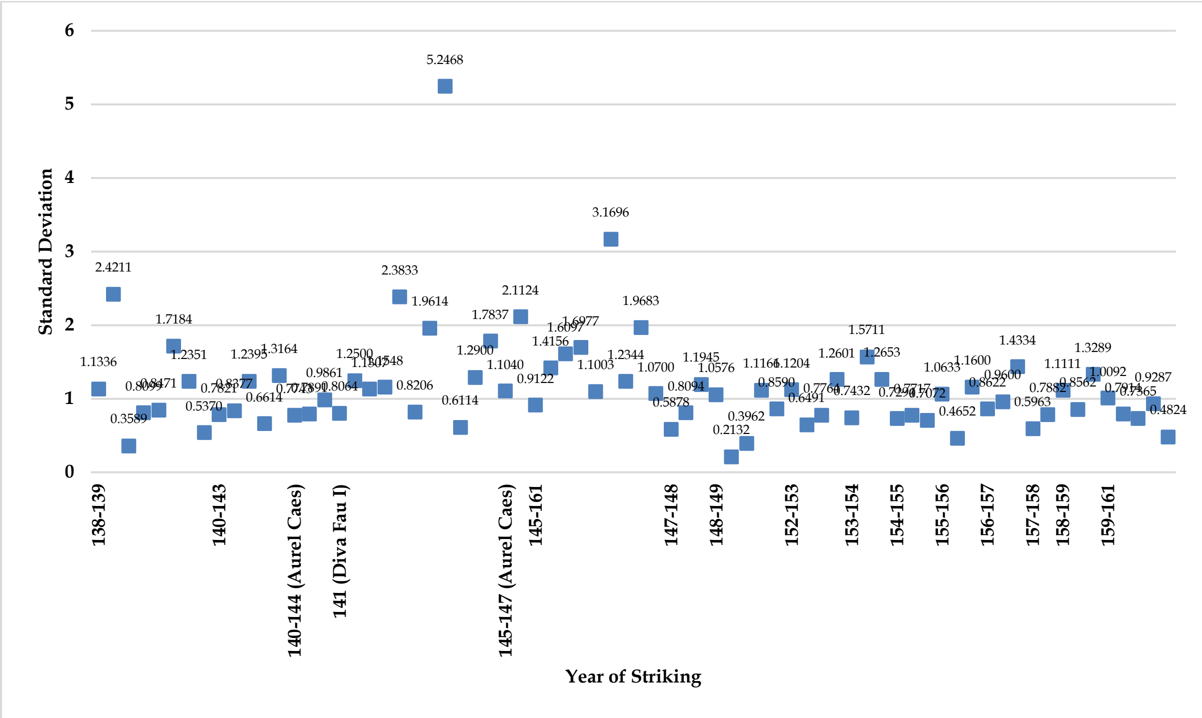

Figure 3.11: standard deviations at the level of the design - *denarii* in hoards closing up to 211. Range of values (excl. standard deviations ≥2): 1.7550. Average (ditto): 1.0052

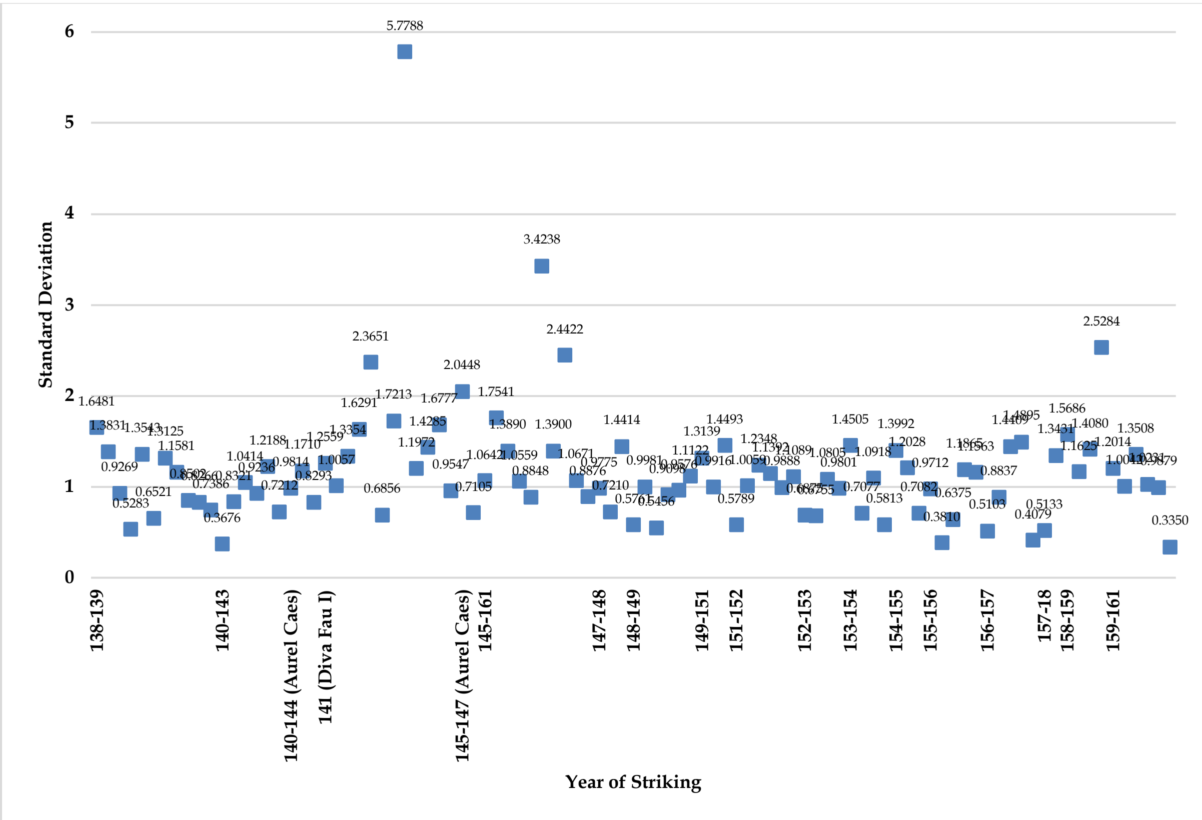

Figure 3.12: standard deviations at the level of the design - *denarii* in hoards closing up to *c*. 250. Range (excl. standard deviations ≥2): 1.4191. Average: 1.0353

It would be wrong to say circulation had the power to remove all difference in the interregional spread of designs: a range of around 0.5 to 1.5 standard deviations in the group of hoards closing up to *c.* 250 implies the preservation of some small amount of variation, even at a late stage. The starkest examples of this are to be found in seven designs that consistently returned standard deviations indicating a greater level of interregional imbalance than the rest: these are labelled in red text on **Figures 3.9-3.12**, and listed in **Table 3.8**, below. That the standard deviations are so much higher for these seven designs in particular is because one or more of the standardised residuals arising from the χ^2 tests are under- or overrepresented in one region or another (a full list of all overrepresentations at the level of the design can be found in **Table 3.9**, below); remove these instance of under-or overrepresentation, and the standard deviation for the design in question falls back to a 'normal' level comparable with the rest – *i.e.*, between ~0.5 and 1.5.

Table 3.8: Standard deviations linked to under-/overrepresentations from χ^2 tests

Design	Issue Period	Reason for high standard deviation
Clasped hands over caduceus	138, 138-139, 139	Overrepresented in the Rhine (2.6671 standardised residuals) in the 211 subset. Corresponding underrepresentation in the Western Danube (-2.9454). **No testing carried out on the 138-139 period before the 211 subset owing to low numbers in earlier subsets.*
Juno (Diva Faustina I)	141-161	Overrepresented in Britain from 180-211. Corresponding underrepresentation in Western Danube across all subsets.
Providentia (Diva Faustina I)	141-161	Highly overrepresented on the Western Danube from 180-*c.* 250 (standardised residuals ranging from 5 to 11). Corresponding high degree of underrepresentation across almost all other regions in all periods.
Spes (Aurelius Caesar)	145/146-147	Overrepresented in Italy & Adriatic from 180-211. Standardised residuals for all other regions indicate distribution within normal range.
Concordia (Faustina II)	145-161	Overrepresented in Western Danube from 180-211. Corresponding underrepresentations in Britain, Italy & Adriatic, and Eastern Danube.
Spes (Faustina II)	145-161	Overrepresentations in both the Eastern Danube (180-192) and Britain (c. 250); corresponding underrepresentations in Italy & Adriatic and Western Danube across same period.
Antoninus sacrificing (*VOTA SVSC DEC III*)	159-160, 160-161	Overrepresented in Eastern Danube (3.7854) in the hoards closing up to *c.* 250. Corresponding underrepresentations in Spain and the Western Mediterranean (-2.2737), Rhine (-2.1027), and Western Danube (-3.4594). **No testing carried out on the period 159/160-161 before the group of hoards closing up to c. 250 owing to low numbers in earlier subsets.*

In all, 55 instances of regional under- and overrepresentation were brought to light by χ^2 – see the full list in **Table 3.9**. It should be stressed, of course, that the majority of the designs tested by χ^2 returned standardised residuals indicating a comparatively even and unremarkable interregional spread from as early as the subset of hoards closing up to 180.[42] This much is already evident in the way the standard deviations for most of the designs in **Figures 3.9-3.12** cluster within a relatively narrow range of low values; these designs include some of the most plentiful of all those struck over the course of the reign – *e.g.*, Annona, which, by one reckoning, constituted something like 20% of all *denarii* struck over the course of the reign.[43] At no point were Annona *denarii* of any issue period found to be overrepresented in any region, even in the earliest hoard subsets. This could be taken to imply either: a) circulation was so rapid that interregional imbalances in their distribution were completely levelled out by *c.* 180, or b) that they were released over a much wider area to begin with, and that highly regionalised distribution according to reverse design (as implied by the overrepresented designs in **Table 3.9**, below), was not the total norm. This applies to many designs, not just Annona, which were not found to concentrate in one region or another. It is to the various over- or underrepresented designs presented in **Table 3.9** that we will now turn.

Table 3.9: under- and overrepresented designs, 180-*c.* 250
*Fields marked ' - ' indicate where a design was not present in sufficient numbers for testing to take place.

Period	Region	Design	χ^2 standardised residuals			
			Denarii in hoards up to 180	*Denarii* in hoards up to 192	*Denarii* in hoards up to 211	*Denarii* in hoards up to c. 250
138 138-139 139	**Rhine**	**Clasped hands & caduceus**	-	-	**2.6671**	1.6166
	Western Danube		-	-	**-2.9454**	-0.8565
140-143	**Eastern Danube**	**Modius *ANNONA***	-	**2.0661**	1.9366	1.5653
141 Div Fau I	**Western Danube**	**Antoninus & Faust I**	-	-	-	**-2.0523**
	Italy & Adriatic	**Ceres**	**2.1987**	1.6547	1.9599	1.8682
	Western Danube	**Fortuna**	-	-1.0406	**-2.0301**	**-2.4563**
	Rhine	**Temple**	-	0.8359	1.5032	**2.1085**

[42] See **Annexe 3** for the full set of χ^2 results for each of design in all issue periods.
[43] Rowan 2013, pp. 220-224 and figure 7. Annona is also the single most common reverse depiction on the 31,841 *denarii* of Antoninus in the dataset of the present study, although the figure is lower: 9.30% rather than Rowan's 20%.

Table 3.9: under- and overrepresented designs, 180-*c.* 250 *Fields marked ' - ' indicate where a design was not present in sufficient numbers for testing to take place.						
Period	**Region**	**Design**	**χ^2 standardised residuals**			
			***Denarii* in hoards up to 180**	***Denarii* in hoards up to 192**	***Denarii* in hoards up to 211**	***Denarii* in hoards up to c. 250**
	Britain	Juno	**4.1323**	**3.6112**	**3.4130**	1.6833
	Western Danube		**-3.3976**	**-3.0556**	**-3.7367**	**-4.2189**
	Eastern Danube		1.6894	1.6220	1.6215	**2.4811**
	Spain & W Med	Pietas	-	-	**2.5011**	**2.2450**
	Rhine		1.7507	**2.2974**	0.9400	-0.1802
	Western Danube		**-2.0290**	-1.7081	**-2.8339**	**-2.1252**
	Britain	Providentia	**-4.1940**	**-4.1581**	**-3.5169**	**-3.0117**
	Spain & W Med		-	-	**-2.9188**	-1.8388
	Italy & Adriatic		**-4.3161**	**-4.1748**	**-3.3463**	-1.9319
	Western Danube		**5.9157**	**6.9899**	**9.3937**	**11.2436**
	Eastern Danube		**-3.8394**	**-4.8693**	**-4.7464**	**-4.8885**
	Eastern Danube	Venus	**2.7750**	**2.3029**	1.8929	1.8794
	Western Danube	Vesta	-1.0970	-1.7204	**-2.8399**	**-2.6735**
145/146-147 Aurel Caes	Italy & Adriatic	Honos	-1.5512	-1.8010	-1.9742	**-2.1299**
		Spes	**2.4715**	**3.1780**	**3.7775**	**4.5622**
145-161	Western Danube	Clasped hands & cornucopia	-1.7274	-1.6530	**-2.0151**	-1.5009
	Spain & W Med	Concordia	-	-	**-2.4894**	**-2.5615**
	Italy & Adriatic		-	**2.0692**	**2.2548**	1.8607
	Spain & W Med	Liberalitas *LIB IIII*	-	-	**2.0007**	1.5305
	Italy & Adriatic		**3.2260**	**3.0796**	**2.3991**	1.6745
	Britain	Concordia (Faustina II)	**-2.0170**	-1.8829	-1.4218	-0.7572
	Italy & Adriatic		**-2.2881**	**-2.2740**	-1.8025	-0.8705
	Western Danube		**3.8122**	**4.1220**	**5.9203**	**6.7512**
	Eastern Danube		**-2.1058**	**-2.0379**	**-2.7113**	**-3.4650**
	Spain & W Med	Pudicitia (Faustina II)	-	-	**-2.4877**	**-2.7214**
	Britain	Spes (Faustina II)	-0.3910	0.9651	0.9964	**3.8448**
	Italy & Adriatic		-1.9722	**-2.3762**	**-2.5637**	**-2.1257**
	Western Danube		-1.2076	-1.8460	**-2.3867**	**-2.5343**
	Eastern Danube		**3.3244**	**3.3296**	1.8056	-0.3777
148-149	Britain	Aequitas	-	**2.0711**	1.9012	1.4969
	Italy & Adriatic		-	0.6916	0.5478	**2.6386**
149-150, 150-151	Italy & Adriatic	Pax	-	-	-	**2.2704**
151-152	Britain	Annona	-	-	-	**-2.4804**
152-153	Italy & Adriatic	Genius Exercitus (Aurelius Caesar)	-	1.8203	1.6728	**2.0710**
153-154	Spain & W Med	Fortuna	-	-	**-2.0125**	**-2.3113**
		Aurelius Caesar	-	-	-	**2.0971**
154-155	Eastern Danube	Vesta	-	0.5884	0.8631	**2.3058**
		Minerva (Aurel Caes)	-	-0.9757	-1.3217	**-2.0097**
155-156	Italy & Adriatic	Aurel Caes	1.9519	**2.0581**	1.8816	1.8378

Table 3.9: under- and overrepresented designs, 180-*c.* 250 *Fields marked ' - ' indicate where a design was not present in sufficient numbers for testing to take place.						
Period	Region	Design	χ^2 standardised residuals			
			Denarii in hoards up to 180	*Denarii* in hoards up to 192	*Denarii* in hoards up to 211	*Denarii* in hoards up to c. 250
156-157	**Eastern Danube**	**Salus**	1.1713	**2.0226**	1.4380	0.9964
	Spain & W Med	**Felicitas (Aurel Caes)**	-	-	-	**2.4362**
	Italy & Adriatic	**Virtus (Aurelius Caesar)**	**2.2404**	**2.4437**	**2.4091**	**2.5333**
	Eastern Danube		-1.2060	**-2.0399**	-1.7915	-1.7962
158-159	**Western Danube**	**Fortuna Obsequens**	-	-	-	**-2.3113**
	Italy & Adriatic	**Aurelius Caesar**	-	-	**2.5278**	**2.5082**
159-160 160-161	**Spain & W Med**	**Antoninus sacrificing *VOTA SVSC DEC III***	-	-	-	**-2.2736**
	Rhine		-	-	-	**-2.1027**
	W Dan		-	-	-	**-3.4594**
	E Dan		-	-	-	**3.7854**
	Western Danube	**Pax**	-	-	0.6857	**2.0379**
	Eastern Danube		-	-0.2621	-1.2363	**-2.0089**

As with Trajan and Hadrian, so too here: designs seen to be under- or overrepresented in an earlier subset commonly return standardised residuals that continue to indicate under-or overrepresentation into the later subset composed of hoards closing up to 211 or even in the complete dataset of hoards closing as late as *c.* 250. See, for instance, the overrepresentations of Providentia (Western Danube, 141-161), Spes (Italy and the Adriatic, 145/146-147), Concordia (Western Danube, 145-161), and Virtus (Italy and the Adriatic, 156-157) – each of which flare up in the subset of hoards closing by 180 and endure to all the way through to *c.* 250. Many of these overrepresentations might well have had their origins in the earliest subsets (*i.e.*, hoards closing by 161), but a lack of data meant it was not possible to carry out testing to confirm or deny this.

Several more overrepresentations appear in the 180 and 192 subsets which disappear, possibly flattened out in the course of circulation, by either 211 or *c.* 250 – *e.g.*, Modius (Eastern Danube, 140-143), Juno (Britain, 141-161), Venus (Eastern Danube, 141-161), Concordia and Liberalitas (Italy and the Adriatic and Spain and the Western Mediterranean, 145-161), Spes (Eastern Danube, 145-161), and Aequitas (Britain, 148-149). In most cases, the standardised residuals begin at a very high level and decline in strength over the succeeding hoard groups until they level out and pass below 2 (the threshold denoting overrepresentation). The same process, but in reverse, can be seen at work in many instances of underrepresentation; see, for instance, how the British and Italian standardised residuals for the Concordia design of 145-161 (Faustina II) gradually increase until, by the 192 and 211 subsets, their standardised residuals are no longer at a level signifying underrepresentation (equal to or less than -2). In other words, it is possible that many of the regional concentrations and underrepresentations apparent in the earliest testable subset of hoards (180) were gradually blunted, and in some cases corrected, by the turn of the third century, if not before.

The several particularly strong instances of under- and overrepresentation that continue to appear in hoards closing as late as *c.* 250 merit further investigation. A look at **Table 3.9** will show that the strength of the standardised residuals for several overrepresented designs appear to *increase* with the passing of time: see, *e.g.*, the overrepresentations of Providentia (Western Danube, 141-161) or Virtus (Italy and the Adriatic, 156-157). Their overall increase in strength is probably result of the fact that, by the later groups (211 and *c.* 250), many more designs deliver standardised residuals indicating a level of interregional distribution we might call 'normal' (owing to levelling out in the course of circulation) than was the case earlier on. This is χ^2's way of drawing our attention to the increased contrast between these designs and the continued overrepresentation of others.

All of the above begs the perennial question: why do these designs continue to concentrate in their particular regions, while so many others exhibit a far wider and unremarkable distribution? The same question was raised in respect of the continued overrepresentation of various Trajanic and Hadrianic designs in **Chapters 1** and **2**, and there is no reason to suppose that the answer advanced there cannot apply here, too: *i.e.*, it is not certain that all designs were released into circulation in the same way. Some might have been released in batches over a wider area or a longer space of time, while others could have been earmarked for release on a far more regionalised basis over a shorter period.[44] The concentrations we continue to see among the hoards could well be members of the latter camp: their failure to disappear is a comment on the limitations of arguments that say circulation will necessarily eliminate all difference that existed at the moment coins were released. Clearly, in the space of time afforded the *denarii* of Antoninus Pius, as well as those of Trajan and Hadrian, near-total homogenisation as a result of circulation at either the level of the design or of the issue was not a realistic prospect, even if that might have been the general direction of travel. This is entirely to our gain, since the preservation of regionalised concentrations at the level of the design allows us to speculate on the reason(s) for their existence.

It is natural to wonder whether any of these concentrations that crop up bear even the slightest relevance to the regions in which they concentrate in light of the fact that two possible examples of targeted distribution have already been identified in the reigns of Trajan and Hadrian, as well as the possible targeted release of *denarii* of Aurelius in Italy in years of *congiaria,* discussed above. The *denarii* of Aurelius Caesar are worth dwelling on, since they are also overrepresented here, at the level of the design, among the hoards of the Italian region. These overrepresentations occur over five separate periods from 145/146-147, followed after an interval by an almost complete run of overrepresentations for *denarii* struck over the seven years between 152 and 159, comprising the periods: 152-153, 155-156, 156-157, and 158-159 (**Figures 3.13-3.15**).[45]

---

[44] So much of how the state organised the release of new coins is still unknown to us. It is tempting to place a lot of emphasis on the army and the role of garrisoned areas in the monetisation of their surroundings, but these cannot have been the only routes open to the state when it chose to put coins – new or old – into circulation. This is not to deny the link between the presence of salaried soldiers and an abundance (or not) of coins: see Creighton 2014 on the difference between the composition of hoards from 'militarised *versus* non-militarised parts of Britain, and Wigg-Wolf 2014, pp. 166-174 on how the removal of military units impacted the coins arriving at sites in the Rhineland.

[45] Technically, Aurelian *denarii* of 152-153 are only overrepresented in the complete dataset (hoards closing up to *c.* 250), but the standardised residuals for the 192-211 subsets are all are on the threshold of overrepresentation; *denarii* of 155-156, likewise, are only overrepresented in the 192 subset, but the

Figures 3.13-3.15: *denarii* of Marcus Aurelius as Caesar
3.13: *TR POT COS II*; Spes left, struck 146-147 (*RIC* III 437)
3.14: *TR POT VII COS II*; Genius Exercitus left, struck 152-153 (Llíria hoard; *RIC* III 458)
3.15: *TR POT XI COS II*; Virtus left, struck 156-157 (*RIC* III 473)

Barring one instance of overrepresentation in the Spanish region, Italy and the Adriatic is the only region to have returned χ^2 results denoting an overrepresentation of *denarii* struck for Aurelius as Caesar. If these results are indeed reflective of where his coins were released into circulation, then we must ask what could have motivated the state to take the decision, or repeated decisions, to preferentially release them into Italian circulation over a period of several years through the 150s.[46] Other studies have raised the possibility that the release of newly-struck *denarii* could, on occasion, have been organised on the basis of the obverse (*i.e.*, the person for whom the coins were struck), *e.g.*, Duncan-Jones' claim that a Balkan concentration of *denarii* struck for Sabina points to their release having occurred somewhere in that part of the empire.[47] Why the state might have chosen to distribute coins in this way is an open question, with reasons ranging from the practical (it being easy to earmark the output

---

standardised residuals for the other periods are approaching overrepresentation; 156-157 and 158-159, overrepresented in the subset of hoards closing by 211 and the hoards closing up to *c.* 250 only, could not be tested in earlier subsets because of insufficient data.

[46] Of the Italian hoards analysed here, all but one (Gauldo Tadino, from central Italy: CHRE no. 13869) were found in the north. The quantity of design-level data for Rome and its environs is woefully poor, despite the existence of large collections like the still-unpublished Via Braccianese hoard (6,442 *denarii* from Nero to Severus Alexander found in 1955, of which 4,391 are Trajan-Commodus; CHRE 13851), and assemblages like the so-called *sottosuolo urbano*: the largest collection of Roman coins to have been found in the centre of Rome – which, despite being excavated in the late nineteenth century – remains largely inaccessible (see Elkins 2017a, pp. 94-101).

[47] Duncan-Jones 1990, p. 40; 1994 p. 175. A claim which, as it happens, was not corroborated in the data assembled for this study: see previous chapter.

of *officinae* striking coins in the name of an heir or a wife for dispatch to meet a local demand for coins) to the ideological, or both.[48]

The likelihood here is that the reason was, in large part, ideological. Given what we know of Aurelius' upbringing and education after his creation as Caesar in 139/140, the notion that *denarii* bearing his image should have been preferentially released into Italian (and, presumably, Roman) circulation is not so surprising. When not with the emperor and imperial family at one of their Italian villas, Aurelius occupied a prominent position at Rome; there, he was elevated to all the major priestly colleges, made Prince of Youth, tribune (three times), consul (twice), and received extensive tuition in public life, the law, and imperial administration, often deputising for the emperor at meetings of the Senate and imperial council.[49] Hitherto, no heir to the throne except, perhaps, Titus (Caesar for a shorter period, between 70-79), had been so extensively and publicly prepared for the succession. In this context, then, it is understandable that the state would seek to emphasise his image within Italy itself *via* the medium of the coinage. There already exists a certain amount of evidence to suggest that *aes* denominations struck in Aurelius' name were also preferentially released within Italy, lending credence both to the χ^2 results and to the notion that his *denarii* could have been released in a similar way.[50]

Repeated Italian overrepresentations of *denarii* struck for Aurelius Caesar were detected in the issue-level χ^2 tests in section *ii*, above. The results of the design-level analysis

---

[48] Beckmann 2012a; Woytek 2012.

[49] Kienast 2017, pp. 131-133; Birley 2012, pp. 56-58, 61-63, 69-88, 89-115.

[50] For which, see Hobley 1998 (tables 9.1, 9.7, and relevant sections of Table 9.4, pp. 74-*ff.*), who notes that – apart from a minority of designs, which either appear more equally in all regions, or concentrate in one region alone - his Italian dataset contains a higher proportion of *aes* struck for Aurelius than the other parts of the western empire included in his survey. Hobley's findings add an interesting dimension to the evidence presented here, but their accuracy is not entirely beyond question: his Italian data are based on visits to museum collections (see Hobley 1998, pp. 1-2), the contents of which cannot be relied upon to honestly reflect the profile of coin finds in their localities, and comparisons between regions are based on total numbers of coins (expressed in their raw form or as percentages). In defence of Hobley, many of his observations – *e.g.*, the prominence of Aurelius' *aes* in Italy – are corroborated by the more dataset of hoarded *denarii* under scrutiny here.

undertaken in this section revealed overrepresentations pertaining to certain designs belonging to multiple issue periods: Honos and Spes (145/146-147), the Genius of the Army (152-153), Minerva (154-155), Felicitas, and Virtus (both 156-157); see again the results presented in **Table 3.9**. The messages inherent in these designs – in order: honour, hope, martial prowess, wisdom, good fortune, and manly vigour – are nothing less than we might expect to see paired with any male member of the imperial family, not least the heir to the throne. More intriguing – as briefly discussed in section *ii* – is the fact the overrepresentation of these designs and the issues to which they belong coincide with *congiaria* known to have taken place in the capital: specifically, *congiarium* II (January 140), III (possibly 142), IIII (early 145), VII (152), and VIII (possibly July 158).

Congiaria were spectacular and highly ritualised public occasions over which Aurelius, in league with the emperor himself, would probably have been expected to preside – not least *congiarium* II in early 140, which came shortly after (and might therefore have been held in honour of) Aurelius' elevation to the rank of Caesar in late 139, and *congiarium* IV, in 145, which was held in celebration of his marriage to Faustina II. An obvious criticism that can be levelled at theories of audience targeting is that the messages in question would surely have been blunted or diluted by the mass of other coins in circulation. Releasing a large number of similar coins among a captive audience, such as the recipients of a *congiarium*, therefore, might have been a tactic employed to ensure that the 'message' was noticed. The possibility that these ceremonies were the vehicles for the purposeful release of large quantities of newly struck *denarii* bearing Aurelius' image – so great that they register in the hoard record for Italy – is fascinating, and stands as one of the very small number of occasions within the scope of this study to have presented plausible evidence for audience targeting via the medium of the *denarius*.

The coinage struck for Aurelius was probably the largest yet struck for any Caesar, with 424 types recorded in *RIC* III across all metals (66 on the *denarii* alone) struck over a twenty-year period from 140.[51] The prominence afforded not only to Aurelius himself but also to Faustina I, whose enormous posthumous coinage of 141-161 dwarfed anything yet struck for anyone other than Antoninus himself, makes it clear that this was a reign in which the issuing authority was willing to use the coinage to emphasise figures other than the emperor, and to a greater extent than ever before.[52] Indeed, there are indications that several of Faustina's *CONSECRATIO* types were targeted at the people of Rome and Italy, too.[53] In a well-known 1986 article, Andrew Wallace-Hadrill pointedly remarked that, after a period of experimentation and innovation in the first century, "the typology of the peaceful Antonine period, though profuse, sinks to a level of soporific blandness."[54] While the jury may be out on whether Wallace-Hadrill was right to describe the coinages of Antoninus and his successors in this way, it is quite clear that the state still exercised its ability to match the 'right' designs to the 'right' audiences when it wanted to do so.

On this point of potential audience targeting, it is curious – if, indeed, Aurelius' coins were preferentially distributed in Italy – that no evidence emerged from the χ^2 tests to suggest that the same happened in the provinces and at the frontiers.[55] One line of reasoning would say that it was all well and good to promote the heir amongst an Italian/Roman 'home' audience, but the army were the key to power, as has been clear from the very beginning of the principate, and emperors were careful to make their nominated heirs known to the soldiers.[56] It might simply be that no case for Aurelian messaging in the provinces or on the

---

[51] Again, with the possible exception of Titus: 380 types across all metals, struck 70-79. Compare with those struck for Antoninus under Hadrian (44 types, all struck 138: *RIC* II.3 2718-2776) or Commodus under Aurelius (179 types, 178-179; *RIC* III 597-666, 1513-1618).
[52] Larger, certainly, than Hadrian's issues for Sabina and Antoninus Caesar: Rowan 2011, p. 991. See above, **footnote 5**, for the dating of Faustina I's deification coinage. Contrast this with the relative lack of emphasis on Faustina I on provincial coinages: see Beckmann 2012a.
[53] Compelling evidence for which was presented by Beckmann: 2012a, pp. 19-39.
[54] Wallace-Hadrill 1986, p. 70.
[55] *Cf. RPC* IV.4 for complementary evidence from the east, which shows Aurelius to have been fairly well represented on the provincial coinage.
[56] *E.g.*, Aurelius reacted to the revolt of Avidius Cassius by parading Commodus around the eastern provinces: Cassius Dio 72.22.

frontiers was forthcoming because circulation impacted *denarii* differently outside of Italy, thereby removing evidence for targeted distribution from our view, or maybe the evidence for this is on different metals not examined here, *e.g.* on the *aes*. Evidence put forward by Hobley suggests that, while most *aes* struck for Aurelius appear to be commoner to Italy, certain designs do appear more generally across the western provinces.[57]

Simultaneous with the overrepresentation of Aurelian *denarii* dating 145/146-147 in Italy is a design-level overrepresentation (also among the Italian hoards) of *denarii* struck for Antoninus himself bearing the legend *TR POT COS III LIB IIII* paired with a depiction of Liberalitas. These *denarii* are conventionally dated *c.* 145-161 by *RIC* III (no. 156), but their reverse legend clearly references the fourth *congiarium* of the reign, which took place in 145 (see **Table 3.9** and **Figure 3.16**).[58] The same *congiarium* was linked, above, with overrepresentations of *denarii* struck in the name Aurelius over the same period. The occurrence in Italy of a concentration of *denarii* struck at the same time as the fourth *congiarium* is such a coincidence that a connection between the two can plausibly be assumed, even in default of hoard evidence from the region of the capital itself. How far coins depicting Liberalitas, or the *congiarium* itself, were intended to function as circulating monuments to the emperor's liberality *after* the event, rather than as a part of the actual cash gift distributed on the day, has been a matter of debate.[59] There is no reason that both cannot be true; the evidence presented above suggests that coins distributed contemporary with (or at) *congiaria* tended to linger in Italy for many years after the event.

---

[57] Hobley 1998, pp. 73-78 for per-period and per-design totals across all regions under survey. See *e.g.* *RIC* III 1263-1266 (Minerva), which appear to be commoner in Pannonia; *RIC* III 1280-1281 and 1352 (Pietas and Mars), which returned coins from all regions; or *RIC* III 1322 (Mars), in Britain alone.

[58] Further *congiaria* (V and VI) followed in *c.* 148 and 151; *aurei* and *denarii* (*RIC* III 138b, 169a-169d) proclaiming *LIB V* have been dated to 147-148, providing a fairly certain date after which *LIB IIII* is unlikely to have been struck.

[59] Noreña 2011b, pp. 82-92; Rowan 2013, pp. 229-232.

That we do not see an Italian bias in the distribution of *denarii* commemorating the emperor's other *congiaria* does not pose a serious challenge to the theory that *LIB IIII denarii* of *RIC* III 156, nor the *denarii* of Aurelius Caesar, were preferentially released into Italian circulation in 145/146 with Italian and Roman audiences in mind. No other *congiarium* is commemorated on the *denarii* to the extent of *LIB IIII*, so it may be that the fourth *congiarium* held in honour of the marriage of Aurelius and Faustina was deemed to be extraordinary in some way (given its relevance to the continuity of the dynasty?), leading, perhaps, to an increased focus on the use of new *denarii* and the production of relevant types.[60] Indeed, some *congiaria* were not represented on the *denarii* at all: for reasons that are still not entirely clear, *congiaria* I, II, and IX were only commemorated on *aurei* and/or *aes* denominations. If the state made a habit of releasing *congiarium*-themed designs related to the *congiarium* into Italian circulation, then, it is possible that *aes* were sometimes the preferred medium: Rowan has pointed out that the overall number of *congiarium* types on the *aes* is greater than on the silver, and that this number surges in years when such types are absent from the silver altogether.[61] This could well account for Hobley's finding that *sestertii* and *dupondii* bearing Liberalitas and

[60] *LIB IIII* is represented in 493 *denarii* within this study's dataset. *Congiaria* VII, VIII, and VIIII, by contrast, returned a combined total of only 193 *denarii*, while numbers III, V, and VI returned no specimens at all – testament, perhaps, to the comparatively small quantities in which they were struck. These proportions are mirrored in the dataset of hoarded *denarii* assembled by Rowan (2013, p. 231 and n. 56).

[61] Rowan, *ibid*. Barring a couple of exceptional instances in which depictions of the *congiarium* itself were applied to *denarii* (*RIC* III 75c, 141c) instead of the more usual Liberalitas, this distinction largely holds true. Speculation on the reason for the divide has occupied scholars for some time, giving rise to a notion that the more literal depiction of *congiaria* on lower-value *aes* denominations (as opposed to the abstracted form of Liberalitas on precious metals) denotes an effort on the part of the state to target coin users of a lower social status: see Metcalf 1993 and Noreña 2011b, p. 91. Depictions of the *congiarium* do, in fact, appear on precious metal, including those struck under Antoninus (especially on *aurei*, by sheer number of types), but they remain extremely uncommon on *denarii*. *Cf.* Beckmann 2009, citing Duncan-Jones' (1994, pp. 115-120) estimation of the number of dies employed in the production of *denarii* in the second century: he used this to argue that the number of dies required to strike *denarii* militated against engravers spending too much time on complex compositions such as those that appeared on *aurei* and *aes*.

congiarium designs struck throughout the reign tend – with some exceptions – to occur more frequently in Italy than anywhere else.[62]

Figure 3.16: *denarius* of Antoninus Pius struck 145-146 in honour of the emperor's fourth *congiarium* (early 145). *TR POT COS III LIB IIII*; Liberalitas left (*RIC* III 156)

Rowan was probably correct when she pointed out that the numismatic commemoration of *congiaria* was flexible and dynamic, changing as circumstances dictated – in some years, the silver showcased *congiarium* types, while in others the *aurei* and *aes* took the leading role.[63] The year of *congiarium* II (140), for instance, saw no themed designs on the *denarii*, but χ^2 testing of the *denarii* of 140 did expose an Italian overrepresentation of issues struck for Aurelius. In this instance, perhaps, the image of the heir to the throne, rather than any single reverse design, was intended to be the prime – if not the sole – iconographic focus of the *congiarium* held in the same year. It is not hard to imagine that particularly important *congiaria* – marking accessions or marriages, for instance – were the object of intense work at the mint to deliver substantial quantities of new *denarii* bearing portraits and/or designs fitting for the occasion.[64]

---

[62] Hobley 1998, pp. 73, 75-76, 78: see, *e.g.*, *RIC* III 608A, (*LIB III*, struck 140-44); 775 (*LIB V*, 145-161); *RIC* III 1043, 1047 (*LIB VIIII*, struck 160-161). See also evidence from the same author (pp. 73-74) that other *aes* types specific to Rome or Italy – the Genius of the Senate (*RIC* III 605 and 660, struck 140-144), Tiber (*RIC* III 642-643, struck 140-144), and Italia (*RIC* III 746-747, struck 143-144) are predominantly found in Italy itself.

[63] Rowan 2013, p. 231.

[64] See also p. 44 (**Chapter 1** on Trajan) for the similar problem of why only one of his three *congiaria* are mirrored by an overrepresentation among the Italian hoards. A possible answer in that case (and one which might apply to this reign, too) was that the third *congiarium* might have relied on greater quantities of new *denarii* than the previous two.

These need not have been types specifically depicting Liberalitas or the *congiarium* ceremony itself, rather than – as here – large portions of entire coinages struck in the name of one named individual.

If the state was motivated to target audiences in Italy, then it might well have done so in other places at different times over the course of the reign. Italy and Rome might, of course, be considered as something of a special case – a place, and a population, that most merited attention owing to its privileged position – but so, too, might the garrisoned frontier regions of Britain, the Rhine, and the Danube, which have each produced their own evidence for targeted distribution of various kinds at one time or another.[65]

We cannot, however, argue for that which we cannot see. There are ample overrepresentations for the *denarii* of Diva Faustina (struck *c.* 141-161) at the level of the design/reverse type (**Table 3.9**). These cropped up in almost every region under survey, with overrepresentations for most of the main designs of her posthumous coinage: Juno, Temple, Venus, Vesta, Providentia, Juno, and Pietas. The range of regions and designs implies less a campaign of audience targeting than the state making use of a prodigious coinage (it is doubtful that issues in Faustina's name ceased in 141, but continued up to the end of the reign) to fulfil any number of financial obligations. This is interesting given a) the clear importance of Faustina's deification coinage to the programme of images being put out by the regime (*per* Rowan 2013), and b) because the regime clearly had the capacity and the willingness to distribute some of its coins (*i.e.*, *denarii* of Aurelius) in a targeted manner. Perhaps there exists among the results for Diva Faustina's coinage, in **Table 3.9**, at least one distribution that was motivated by audience targeting, but it is impossible to tell. If anything, we might have expected the coinages of Aurelius and Diva Faustina to have been used differently, or

[65] See, for instance, Flavian targeting of the garrisons in Britain and along the Rhine *via* the *aes* (Kemmers 2005, 2014), or the two possible instances of targeted distribution identified by this study in the reigns of Trajan and Hadrian.

distributed the other way around: the succession was arguably more relevant in the provinces and to the army than the deification of a member of the emperor's family at Rome.

Of the other prominent regional overrepresentations at the level of the design in **Table 3.9**, there are Concordia on the Western Danube and Spes on the Eastern Danube (both in *denarii* of 145-161 struck for Faustina II); neither bears any particularly obvious relevance to the regions in which they concentrate. Regionalised distribution might well have been a relatively common practice, but it would be wrong to suggest that audience targeting in the manner of the Italian examples discussed above was anything but a sporadic departure from the norm, confined to particular periods and places. It might well be that the distribution of certain designs only begins to make sense when viewed as one part of a communicative programme that involved designs on other metals; Rowan explored how designs on different precious and base metal denominations formed a single visual programme that emphasised a particular, and often changing, image of the emperor and his family, often by pairing individuals with deities and personifications that complemented each other, *e.g.*, Annona (Antoninus) paired with Ceres (Diva Faustina I).[66] As was suggested in the summary of the χ^2 tests at the level of the issue (section *i*), it is almost certain that most regional concentrations at the level of the design, too, evince the state moving money around for any number of reasons connected to the civil or military finances of the regions involved. That many of these overrepresentations do not occur at the same time or in the same place as those at the level of the design is not necessarily a problem: there are some instances of coincidence (*e.g.,* the British concentration of the Juno design, struck 141-161, occurs at the same time as large parts of the issues struck 138-144 were being sent there), but there is no basis for saying that an essential prerequisite for a design's overrepresentation in one region is that all coins of the same issue period must be similarly overrepresented, nor that the overrepresentation in a

[66] Rowan 2013, p. 222.

given issue in any one region precludes the possibility that one or more of its constituent designs were earmarked for dispatch in another direction.

iv. Summary

A considerable degree of empire-wide uniformity at both the level of the issue and of the design was again observed; the correspondence between the frequency at which *denarius* issues appear in Reka Devnia compared with the amalgamated hoards dataset was even more striking than in the previous two chapters (**Figure 3.8**). A point worth noting is that the standard deviations for Antoninus' silver coinage at the level of the issue do indicate a gradual move toward uniformity, possibly as a result of circulation (**Figures 3.4-3.7**), but when compared to the standard deviations for the reigns of Trajan and Hadrian (see **p. 143**), it is clear that the degree of mixing visible in their *denarii* (viewed in a dataset composed of hoards closing up to the mid-third century) is slightly greater in the coinage of Antoninus.

Despite the move toward uniformity, interregional variation in both issues and designs persisted, even into the latest groups of hoards. It was seen that regional overrepresentations at the level of the issue rarely overlap; for example, British concentrations fade before those in the Western and Eastern Danube emerge. This pattern, also observed under Hadrian, may reflect cyclical, empire-wide distribution practices, first mooted by Kemmers and Wigg-Wolf.[67]

It is important here to stress that concentrations observed in the *denarii* are not exclusive to the regions in which they occur, as they can be in the case of the *aes* (see *e.g.* the *BRITANNIA* issues of Hadrian and Antoninus). *Denarii* did mix, and there are virtually no known cases of entire issues or batches of a single design appearing in one region alone.[68]

---

[67] Kemmers 2006, pp. 212-215 and Wigg-Wolf 2014, p. 163.

[68] True even in the case of *denarii* with the strongest χ^2 results, *e.g.* the Trajan and Jupiter *denarii* struck 114-115: see **Chapter 1**, on Trajan.

Rather, the concentrations brough to light here by χ^2 are simply pronounced bulges in the presence of *e.g.* a design that is generally found everywhere.

Regional concentrations of *denarius* issues and designs were found by χ^2 in the earliest testable subset (hoards closing by 180), and commonly persist into the latest group of hoards closing up to c. 250 (see **Table 3.5**), indicating that circulation did not eliminate all regional differences in all cases. Some concentrations plausibly reflect known events. In Britain, overrepresentations of *denarii* struck at the same time as the war of the late 130s–early 140s suggest heightened supply to finance the military in Scotland. In Italy, it was noted that there was a noticeable correspondence between overrepresentations and years of known *congiaria* (**Table 3.6**). *Denarii* struck in these years were consistently overrepresented, among which are included designs specific to the *congiarium* itself (*e.g.,* an overrepresentation of Liberalitas *denarii* struck *c.* 145-146, contemporary with the fourth *congiarium*) and of Aurelius, as heir to the throne. On the occasion of the fourth *congiarium*, in honour of Aurelius Caesar's marriage to Faustina II in 145, the overrepresented *denarii* are those struck in his name. Taken together, these represent two of the clearest examples so far of distribution being organised with coin designs in mind. The lack of accompanying overrepresentations within Italy for the *denarii* of Diva Faustina was flagged as a curiosity.

Comparable evidence for targeting is not evident in the provinces or frontier zones. Indeed, most regional concentrations cannot be tied to specific events and likely reflect routine state distribution of coin rather than deliberate audience targeting. Likewise, not all instances of under- or overrepresentation at the level of the issue coincide with under- or overrepresentations at the level of the design/reverse design. There are some instances where they match, but many do not. This was not flagged as a problem: it is possible for an overall issue to be overrepresented in one region at the same time as one of its designs is overrepresented in another, likely reflecting the dispatch of discrete batches to different regions.

Chapter 4: Marcus Aurelius (161-180) and Lucius Verus (161-169)

Introduction

23,372 *denarii* recorded to the level of the design from 231 hoards were taken from the CHRE database. See **Figure 4.1**, below.

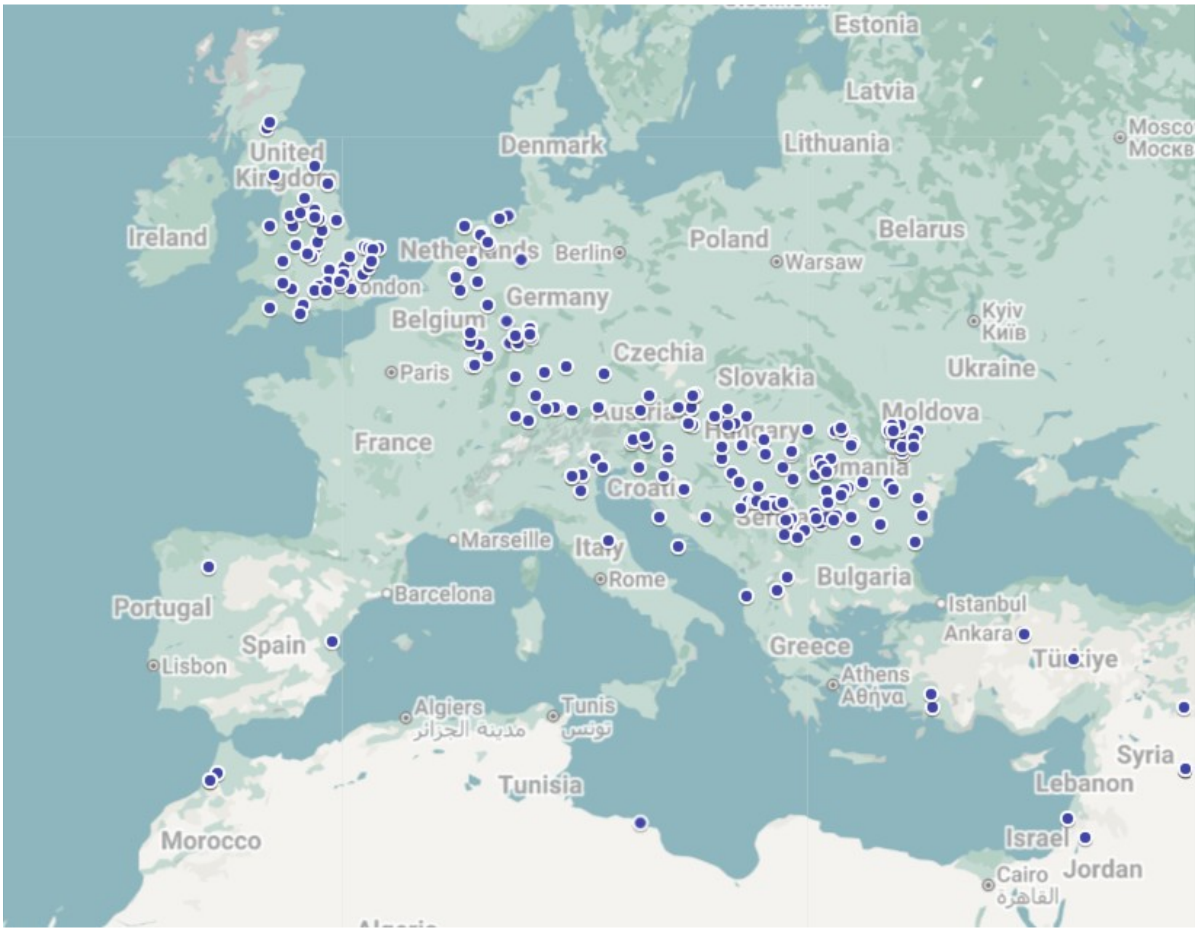

Figure 4.1: hoards containing *denarii* struck under Marcus Aurelius and Lucius Verus in this study's dataset that were recorded to the level of the design on the CHRE database at the time of data collection (n=231). Find an interactive version of this map with links to CHRE records at: https://www.google.com/maps/d/edit?mid=1qOLVlCrcEgYC9IjSPzosLsgOAoBAbsQ&usp=drive_link

A digression on chronology and geography is necessary before diving into the analyses. The successive issues of *denarii* struck for both Marcus Aurelius and Lucius Verus can be dated with a high degree of precision owing to the regularity with which tribunician years and imperatorial acclamations were recorded on their coinages, which is ideal for a study such as this.[1] Less perfect is the dating of the coinages of Faustina II (lifetime and posthumous) and Lucilla, which are dated by *RIC* III to 161-175, 176-180, and 164-180 respectively (**Figures 4.2-4.3**). Dating the coinage of empresses has been a persistent source of difficulty for Roman numismatists, not least because of the absence of titles that are common to the coinages of their male relatives.[2] These wide periods of time are unsatisfactory from this study's point of view, since they make it difficult to compare the spatial distribution of the female coinages with the better-dated issues in the name of Aurelius and Verus. The following paragraphs will outline some of the difficulties involved, as well as possible refinements in the chronology of these coinages that might be employed in the analyses to come.

The coinage struck for Faustina II during her lifetime is commonly dated to a broad period starting with the accession of Aurelius in 161 and ending with her untimely death while travelling the east in late 175.[3] Attempts to refine this period over the past century have centred on the creation of relative chronologies based on the stylistic development of Faustina's obverse portrait. Prominent among these are Strack (1937) and Wegner (1939), who each developed systems consisting of seven portraits, later modified and expanded to nine by Fittschen (1982).[4] Beckmann (2021) and Niederhuber (2022) are the most recent scholars to have tackled the issue; Niederhuber's examination of Faustina's bust types, which is fundamentally based on the approaches of Strack, Fittschen, and Beckmann, resulted in an

---

[1] Aurelius was made tribune on 34 occasions (31 during his reign) and imperator ten times; Verus could boast a no less impressive nine tribunates and five imperatorial proclamations between his accession and premature death in 169: Kienast 2017, pp. 132-133, 136.

[2] This is not to say that portions of the coinages struck for imperial women cannot be more securely dated on the basis of titles, especially where these were unusual or innovative – but even then, confusion can reign. The date of Faustina's acclamation as Mother of the Camps in 174 (securely datable on the basis of epigraphic evidence: Levick 2014, pp. 78-79) was not reflected on the coinage until the time of her death.

[3] Levick 2014, pp. 87-90, 135-138.

[4] The reasons and processes underlying the development of new portrait busts are ultimately lost to us. This fact has allowed for much scholarly speculation. The periodisation proposed by Fittschen, for instance, hinged on a change of hairstyle with the arrival of each new child. This theory did not gain widespread acceptance: see Niederhuber 2022, p. 9 for a summary of the criticisms.

improved sequence of ten portrait types tied to real dates. Of interest here are his types 7-10, which cover the period between the accession of Aurelius in 161 and Faustina's death in 175. The last of these – portrait type 10 – appeared at some point after 163/164 and remained in place until 175/176.[5] The breadth and relative imprecision of the period covered by portrait 10 is unfortunate, since it leaves the majority of Faustina's coins as empress without a finer chronology against which their distribution might be analysed. Unfortunately, it was not possible to divine which of the coins in this study's dataset belong to one or another of Niederhuber's types 7-10 because the data upon which this study is based have been drawn from hoard lists rather than physical consultation. In any case, most of them will probably belong to the period covered by type 10 (163/164-176). *RIC* III's broad dating scheme of 161-175/176 – unsatisfactory though it might be – will, therefore, be retained here.[6]

Neither Beckmann nor Niederhuber dealt with the chronology of Faustina's posthumous coinage, except – in Beckmann's case – to state that it was probably over within a year or so of her death.[7] This is certainly possible (see below, **pp. 169-170**, for evidence – far from conclusive – that Beckmann might be correct) but at present we lack a scheme that can give assurance that Faustina's posthumous coinage did not continue up to 180, or even into the reign of Commodus (who struck for his deified father).[8] In lieu of a satisfactory alternative, then, Faustina's posthumous coinage will be analysed here according to the dating laid out by *RIC* III: *i.e.,* a broad, four-year period from 176, shortly after her death, to the end of the reign in 180.

---

[5] Beckmann 2021, pp. 57-91; Niederhuber 2022, pp. 8-29.

[6] Any thought that reverse types might allow us to arrive at more refined dates for Faustina's lifetime coinage must also be dispelled. Some, it should be pointed out, can be reliably dated, *e.g.,* the *SAECVLI FELICIT* and *TEMPOR FELIC* types depicting the infants Commodus and Antoninus, which, as Niederhuber tells us, were almost certainly introduced in 161. A large number of Faustina's reverse types, however, appear to have been shared between obverse busts, *e.g.*, *FECVNDITAS*, which is paired with Niederhuber's bust types 7 (dated to 161) and 8 (162-163).

[7] Beckmann 2021, p. 66.

[8] Jarzęcki 2021, p. 154.

Figures 4.2-4.3: *denarii* of Faustina II as *augusta* and *diva*
4.2: *IVNO*; Juno left, struck 161-175 (*RIC* III 688)
4.3: *CONSECRATIO*; Peacock right, struck 176-180 (Cyprus hoard; *RIC* III 744)

Lucilla's coinage is commonly dated to 164-180 (*per RIC* III), although it is quite likely that striking began as early as 161 with *aurei* and *denarii* bearing a *VOTA PVBLICA* reverse (*RIC* III 790-792). Szaivert (1980) correctly pointed out that reverses such as this, which typically refer to vows made by the emperor, are uncommon on the coinages of imperial women, and that on this occasion the type alludes to vows offered up by Verus (to whom Lucilla was betrothed between the years 161-164), who fell seriously ill ahead of his departure for the east in 161-162. If correct, this would push the start of Lucilla's coinage to the beginning of her father's reign, in 161.[9] Most authors agree that refinement is possible by dividing the coinage into two broad phases distinguished by the two legend varieties *LVCILLAE AVG F PII FIL* and *LVCILLA AVG*, although the precise dating that should be applied to these phases is still the subject of disagreement. Szaivert sensibly supposed that the first phase (characterised by the longer legend) began in 161 and ended with Lucilla's marriage to Verus in 164.[10] His theory

[9] Not everyone agrees with Szaivert's assessment. Schultz (1982) sided with the authors of *RIC* III in thinking that Lucilla's marriage to Verus in 164 marked the beginning of her right to a coinage. Fittschen (1982), by contrast, advocated a date no earlier than the birth of their first daughter, Aurelia Lucilla, in 165/166. Howgego (*RPC* IV.4, p. 44), in his examination of the Egyptian evidence, pointed out that Alexandria, coins in Lucilla's name do not appear in Year 6 (165/66).
[10] Fittschen (1982, p. 73) assumed the switch from long to short legend took place at the birth of Lucilla's second daughter in 166, while Schultz (1982, p. 285) sided with *RIC* III in advocating the death of Verus (*AD* 169), although he fails to provide any specific reasoning. The most plausible explanation is the one fielded by Szaivert (1980), who saw Lucilla's marriage to Lucius Verus in 164 as the reason behind the disappearance of her filiation from the obverse legend, arguing that being the wife of a reigning Augustus removed the necessity to derive her right to a coinage from her parentage. That designs such

that the second phase ended with the death of Verus 169 (as opposed to 180) feels much less certain, so it is worth exercising caution.[11] The chronologies put forward by Szaivert and others permit further, tentative refinements of Lucilla's coinage on the basis of bust types and hairstyles, but – as in the case of Faustina II – the nature of the data drawn from the CHRE database does not allow for such an analysis.

Relative quantities of coins from the dataset of hoards assembled for this study might be of some assistance in gauging the overall size of Lucilla's coinage: smaller, as we might expect, than those struck for Aurelius, Verus (lifetime), Faustina II (lifetime), and Divus Antoninus (in that order), but larger than those struck for Commodus (as both Caesar and co-Augustus), and Divus Verus.[12] This could be said to fit with the notion that her coinage was issued over a longer period, from 161 until the later part of the reign, and perhaps even as late as 180. If striking had been confined to a narrower period, then the number of specimens might have been as low as the totals for Commodus, whose silver coinages as Caesar and then co-Augustus were struck for short periods of time between 172-177 and 177-180 respectively. Incidentally, the number of *denarii* bearing the longer obverse legend (see *e.g.* **Figure 4.4**), which might have been struck between 161-164, is 925. This not much larger than the 888 bearing the shorter *LVCILLA AVGVSTA* formulation (perhaps 164-169/180), and could attest to a fairly balanced output between both phases.

The reign of Aurelius, with two emperors and their wives, as well as an heir in the form of Commodus, makes for a diverse numismatic landscape that is ripe for a distributional

---

as Fecunditas are restricted to coins with the post-marriage *LVCILLA AVGVSTA* legend are an indication that the switch from the longer to shorter legend form occurred around 164.

[11] Szaivert theorised that Lucilla's subsequent marriage to Claudius Pompeianus, a man from outside the imperial family, made her continued appearance on the coinage inappropriate. Birley (2000b, pp. 161-162) outlines the close ties between Aurelius and Pompeianus, and that the marriage need not have necessitated the end of Lucilla's coinage. *RPC* IV.4, pp. 44-45 and n. 94 also casts doubt on an end date of 169, drawing, among other things, on posthumous issues from Asia Minor datable to as late as 180.

[12] Number of *denarii* per member of the imperial family in descending order: Aurelius: 10,937; Faustina II: 4,273; Verus: 2,663; Divus Antoninus Pius: 2,178; Lucilla: 1,813; Diva Faustina II: 769; Commodus as co-Augustus: 415; Commodus as Caesar: 212: Divus Verus: 116.

Figure 4.4: *denarius* of Lucilla from the Cyprus hoard struck *c.* 161-162. *VOTA PVBLICA*; legend within wreath (*RIC* III 791)

analysis such as this. In amongst these 'regular' imperial coinages there also exist more unusual issues, the most famous of which are the so-called 'restoration' *denarii* (*RIC* III 443) that partly reproduce the legends and imagery of the legionary series struck for Mark Antony in the first century BC. It is hard to pinpoint exactly what the state had in mind when it issued coins bearing the names and titles of past rulers, but a connection to the fact that the originals were being actively withdrawn at this time seems logical. The re-issue of selected rulers and designs appears, therefore, to have been the result of a decision to 'restore' these circulating monuments of Rome's past.[13] Very worn Antonian *denarii*, for instance, were, in the late second century, still conspicuous among the circulating coinage, serving as circulating reminders of one of the most famous periods of Roman history.[14] Beckmann (2017) has written engagingly on the purpose of Aurelius' restored *denarii*, arguing that, in the act of restoration, the state aimed to cast itself as a preserver of Roman heritage. In any case, the extremely small number of restoration *denarii* in this study's dataset (just 29, more than half of which come from the Reka Devnia hoard alone) regrettably precluded their inclusion in the analyses below. This is interesting in itself: such small numbers could speak in favour of the smaller

[13] The practice was not unique to Aurelius: the mint under Titus (*RIC* II.1 399-497), Domitian (*RIC* II.1, 825-30), Nerva (*RIC* II 126-138), and Trajan (*MIR* 14 801-877) also 'restored' selected types of the late Republic and early empire. See Woytek 2022, esp. pp. 255-72.

[14] Woytek reckoned Aurelius' restoration of Mark Antony's *denarii* was the largest of all the restored coinages of the first and second centuries given their commonality on the auction market: Woytek 2022, p. 259.

and more targeted kind of distribution, but with surviving examples belonging to hoards closing between the 190s and 250s as far apart as Britain, the Rhineland, Spain, Germany, Italy, and Bulgaria, we cannot at present speculate on where or when this might have been.

Turning, briefly, to geography: the paucity of data for the Eastern Mediterranean is a notable and recurrent feature of these analyses: none of the hoards that contain coins of Aurelius' reign from this region close before the 211 subset, making analysis of the spread of *denarii* impossible except in the case of the complete and uncontrolled dataset running up to *c.* 250 (and even then, the dataset comprises only 679 *denarii* recorded to the level of the design). This lack of data has an adverse bearing on our ability to detect peculiarities in the distribution of *denarii* dating to the years corresponding with Verus's presence in the east, between 162-166, which would have been of great interest. Similar issues were encountered in respect of the data from Spain and the Western Mediterranean, where the total number of hoards is low: just five, none of which close before the turn of the third century. As with the Eastern Mediterranean, this means that the data for the Spanish region only come into play in the final pair of datasets (hoards closing up to 211 and *c.* 250). The dominance of the Llíria hoard – which produced 1,569 of the 1,577 *denarii* from the Spanish region – should be borne in mind, although there is nothing wrong with the principle of using a single, large hoard as a point of comparison with hoards from other regions.[15]

i. Results of χ^2 tests at the level of the issue

The 23,372 *denarii* of Aurelius and his family were divided into groups according to hoard closing dates, as in the previous three chapters: hoards closing up to 180 (2,729), 192 (4,240), 211 (7,528), and, finally, *c.* 250 (23,372). They were then subjected to χ^2 testing to detect regional

[15] See **p. 29**.

variations in their spread at the level of the issue. Note: no testing took place on Italian hoards of the 211 subset because none close between 192 (the end of the previous group) and 211.

Tables 4.1-4.4, below, present the results of χ^2 tests on the coins of the groups outlined above. An interesting feature of these analyses is that, for the first time, the earliest of the subsets (hoards closing up to 180) coincides with the end of the reign being investigated. As already mentioned elsewhere in this study, the healthy number of hoards that close by 180 might reflect the instability that characterises the reign of Aurelius. This instability can largely be laid at the door of two major events: the Antonine Plague (from 165) on the one hand, and the Marcomannic Wars (from 166) on the other. The effects of the war will be discussed at further length below, particularly in respect of correspondences between overrepresentations and the known events, as well as the movements of the emperor and army. The generally higher number of hoards ending with coins up to *c.* 180 might, more convincingly, be a consequence of the Plague, given the increased number of hoards are not solely concentrated in the Balkans and the Danubian provinces (*i.e.*, the theatre of operations for the war), but all over the empire. This could well attest to a more wide-ranging event that led to an increased rate of non-recovery across the empire. The effect of the Plague upon Roman society and the economy in the 160s, 170s, and 180s has long been the subject of debate, but multiple streams of evidence suggest that the impact was severe and devastating. Wilson (2026) presents a number of specific examples that attest to the plague's catastrophic impact on communities across the empire, *e.g.*, imperial remittances granted to communities and other organisations unable to function as before, the winding up of a funerary collegium in Roşia Montana (Alburnus Maior) in 167 because of a membership shortfall and a lack of sufficient coffins to bury the dead, the near-collapse of mining operations in Dacia, and the cessation of mining in Spain (which, contrary to commonly-repeated opinion, were not abandoned because the seams of ore were exhausted).[16] Galen tells us that Aurelius himself is known to have been forced out of his own camp in the later 160s for fear of the disease that was present amongst the soldiers, and it is possible that he also died after contracting the Plague in 180.[17] It is also possible – given evidence that will be presented in this chapter and in **Chapter 5** – that a downturn in the volume of mint output in the later reign of Aurelius and that of his son, Commodus – mean that hoards formed in the 190s or even the early 200s take on an earlier appearance by terminating with *denarii* of the 170s or 180s.

Table 4.1: ***Denarii* in hoards closing up to 180**								
Period	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
161, 161-162	49	0	37	261	347	122	0	**816**
161-164 (Lucilla)	13	0	6	36	23	21	0	**99**
161-175 (Faustina II)	45	0	25	124	295	99	0	**588**
162-163	6	0	4	56	135	35	0	**236**
163, 163-164	11	0	15	88	147	39	0	**300**
164-165	3	0	4	27	23	34	0	**91**
164-180 (Lucilla)	1	0	4	0	6	12	0	**23**
165, 165-166	6	0	5	27	54	15	0	**107**
166, 166-167	12	0	14	83	69	46	0	**224**
167-168	2	0	1	4	13	3	0	**23**
168, 168-169	14	0	1	23	24	15	0	**77**
169 (Divus Verus), 169-170	8	0	0	1	11	6	0	**26**
170-171	3	0	0	0	7	5	0	**15**
171-172	3	0	0	0	5	5	0	**13**
172-173	3	0	0	0	6	4	0	**13**
173-174	0	0	0	0	2	5	0	**7**
174, 174-175	2	0	0	0	3	3	0	**8**
175, 175-176	6	0	0	0	6	13	0	**25**
176, 176-177	5	0	1	0	1	5	0	**12**
176-180 (mostly Div Faust II)	2	0	2	0	1	10	0	**15**
177, 177-178	3	0	0	0	0	3	0	**6**
178-179,179-180	1	0	0	0	0	4	0	**5**
Qty	**198**	**0**	**119**	**730**	**1178**	**504**	**0**	**2729**
Standardised residuals $\chi^2 = 148.15$, df = 32, **p-value < 2.2e-16**								
Period	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Avg**
161, 161-162	-0.2965	-	0.2196	1.8276	-0.6400	-1.2786	-	-0.0336
161-164 (Lucilla)	**2.7296**	-	0.8026	1.4516	**-3.1164**	1.0752	-	0.5886
161-175 (Faustina II)	1.3449	-	-0.1412	**-3.3924**	**2.2512**	0.0306	-	0.0186
162-163	**-2.2846**	-	-1.9676	-1.3902	**3.0549**	-0.7328	-	-0.6641
163, 163-164	-1.7978	-	0.5188	0.2487	1.3025	-1.6001	-	-0.2656
164-165	-1.1312	-	0.0100	0.1971	**-2.6941**	**4.7913**	-	0.2346
165, 165-166	-0.2716	-	0.1480	-0.6449	1.0066	-0.6984	-	-0.0920
166, 166-167	-0.5427	-	1.3429	**2.3768**	**-2.9796**	1.3702	-	0.3135
168, 168-169	**4.1779**	-	-1.2901	0.2141	-1.6986	0.5773	-	0.3961

[16] Wilson 2026, see esp. pp. 103-109, and pp. 115-123; on the cessation of mining in Spain registering as a drop in atmospheric lead trapped within Greenland ice cores, see McConnell *et al*. 2018

[17] Wilson, *op, cit.*, pp. 105-106.

Table 4.2: *Denarii* in hoards closing up to 192								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
161, 161-162	85	0	52	268	490	193	0	**1088**
161-164 (Lucilla)	27	0	8	38	50	36	0	**159**
161-175 (Faustina II)	91	0	36	135	471	173	0	**906**
162-163	17	0	5	57	156	49	0	**284**
163, 163-164	26	0	18	90	229	63	0	**426**
164-165	8	0	5	28	33	43	0	**117**
164-180 (Lucilla)	15	0	5	3	23	32	0	**78**
165, 165-166	12	0	7	29	92	24	0	**164**
166, 166-167	33	0	16	88	147	63	0	**347**
167-168	2	0	1	5	75	5	0	**88**
168, 168-169	37	0	3	27	83	35	0	**185**
169 (Divus Verus), 169-170	19	0	2	2	32	17	0	**72**
170-171	8	0	1	2	11	13	0	**35**
171-172	8	0	1	1	13	11	0	**34**
172-173	5	0	0	0	11	5	0	**21**
173-174	4	0	0	0	7	7	0	**18**
174, 174-175	8	0	1	1	9	6	0	**25**
175, 175-176	14	0	1	3	22	24	0	**64**
176, 176-177	8	0	2	2	18	9	0	**39**
176-180 (mostly Div Faust II)	9	0	4	1	9	32	0	**55**
177, 177-178	7	0	0	1	8	7	0	**23**
178-179,179-180	4	0	0	1	7	15	0	**27**
Qty	**447**	**0**	**168**	**782**	**1996**	**862**	**0**	**4255**
Standardised residuals χ^2 = 374.45, df = 52, **p-value < 2.2e-16**								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Avg
161, 161-162	-2.0886	-	1.2104	**4.0964**	-1.1363	-1.3607	-	0.1442
161-164 (Lucilla)	**2.8957**	-	0.6208	1.3550	-2.9232	0.8774	-	0.5652
161-175 (Faustina II)	0.2404	-	-0.1020	-2.9482	**2.0012**	-0.3189	-	-0.2255
162-163	-2.0507	-	-1.9121	0.3380	1.8407	-0.8801	-	-0.5329
163, 163-164	-2.4341	-	0.1885	0.9116	1.9025	-2.2281	-	-0.3319
164-165	-1.0218	-	0.1247	1.1703	-3.0168	**4.2034**	-	0.2920
164-180 (Lucilla)	**2.6630**	-	1.0405	-3.0936	-2.2987	**4.2854**	-	0.5193
165, 165-166	-1.0136	-	0.1443	-0.4410	1.6160	-1.4272	-	-0.2243
166, 166-167	-0.1691	-	0.5274	**2.6229**	-1.3650	-0.5929	-	0.2047
167-168	-2.2545	-	-1.3556	-2.8929	**5.1524**	-2.9441	-	-0.8590
168, 168-169	**4.4355**	-	-1.6372	-1.4272	-0.5025	-0.1982	-	0.1340
169 (Divus Verus), 169-170	**4.4993**	-	-0.5334	-3.1792	-0.3653	0.7764	-	0.2396
175, 175-176	**3.0881**	-	-0.9865	-2.6486	-1.5143	**3.2441**	-	0.2365
176-180 (mostly Div Faust II)	1.5567	-	1.1919	-2.9411	-3.3438	**6.4751**	-	0.5878

Table 4.3: *Denarii* in hoards closing up to 211								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
161, 161-162	133	231	88	268	533	346	0	**1599**
161-164 (Lucilla)	43	56	18	38	56	66	0	**277**
161-175 (Faustina II)	139	234	102	135	504	374	0	**1488**
162-163	28	42	11	57	167	78	0	**383**
163, 163-164	45	69	25	90	236	126	0	**591**
164-165	15	26	10	28	37	60	0	**176**
164-180 (Lucilla)	28	76	15	3	27	70	0	**219**
165, 165-166	18	37	13	29	101	55	0	**253**
166, 166-167	55	89	40	88	162	128	0	**562**
167-168	5	9	3	5	78	17	0	**117**
168, 168-169	57	118	21	27	92	92	0	**407**

Table 4.3: *Denarii* in hoards closing up to 211								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
169 (Divus Verus), 169-170	39	75	15	2	38	47	0	**216**
170-171	15	49	12	2	21	36	0	**135**
171-172	14	46	9	1	22	30	0	**122**
172-173	10	24	3	0	17	16	0	**70**
173-174	8	28	6	0	13	11	0	**66**
174, 174-175	14	27	10	1	14	30	0	**96**
175, 175-176	24	66	7	3	28	50	0	**178**
176, 176-177	9	36	5	2	21	17	0	**90**
176-180 (mostly Div Faust II)	29	82	20	1	20	60	0	**212**
177, 177-178	12	63	1	1	10	21	0	**108**
178-179, 179-80	14	92	5	1	18	33	0	**163**
Qty	**754**	**1575**	**439**	**782**	**2215**	**1763**	**0**	**7528**
Standardised residuals $\chi^2 = 804$, df = 84, **p-value < 2.2e-16**								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Avg
161, 161-162	-1.2925	**-4.5240**	0.1487	-	**4.5910**	-0.0988	-	-0.2351
161-164 (Lucilla)	**3.1512**	0.0268	0.6204	-	**-2.5369**	0.4478	-	0.3419
161-175 (Faustina II)	-0.9940	**-4.6073**	1.4869	-	**2.8349**	1.0852	-	-0.0389
162-163	-1.3977	**-3.9100**	**-2.2177**	-	**5.7955**	-0.7797	-	-0.5019
163, 163-164	-1.4695	**-4.4353**	-1.3315	-	**5.5747**	-0.4309	-	-0.4185
164-165	-0.3791	-1.4551	0.1188	-	-1.6632	**3.4283**	-	0.0099
164-180 (Lucilla)	0.7851	**3.6007**	0.2517	-	**-5.2154**	1.8035	-	0.2451
165, 165-166	-1.4062	**-2.1153**	-0.4130	-	**3.2009**	-0.4626	-	-0.2393
166, 166-167	0.2776	**-2.0595**	1.6482	-	0.5102	0.3706	-	0.1495
167-168	**-2.1249**	**-3.3535**	-1.5884	-	**6.7982**	**-2.2679**	-	-0.5073
168, 168-169	**2.2291**	**3.1086**	-0.7498	-	**-2.9335**	-0.7334	-	0.1841
169 (Divus Verus), 169-170	**3.0836**	**3.5420**	0.2877	-	**-3.8491**	-1.1936	-	0.3741
170-171	0.0349	**3.2209**	1.1369	-	**-3.4304**	0.2106	-	0.2346
171-172	0.1293	**3.3395**	0.4012	-	**-2.8128**	-0.2884	-	0.1538
172-173	0.7779	1.8940	-0.7287	-	-1.2481	-0.5362	-	0.0318
173-174	0.2294	**3.2074**	0.8227	-	-1.8625	-1.5045	-	0.1785
174, 174-175	1.0378	1.0234	1.5354	-	**-3.0783**	1.0381	-	0.3113
175, 175-176	1.0039	**3.9334**	-1.3003	-	**-3.8864**	0.6307	-	0.0763
176, 176-177	-0.2664	**3.4095**	-0.3036	-	-1.4685	-1.2507	-	0.0240
176-180 (mostly Div Faust II)	1.1153	**4.6643**	1.6918	-	**-5.9206**	0.6541	-	0.4410
177, 177-178	0.0117	**7.6065**	-2.2598	-	**-4.2401**	-1.3168	-	-0.0397
178-179, 179-80	-0.9651	**8.8093**	-1.7069	-	**-4.8252**	-1.4349	-	-0.0246

Table 4.4: *Denarii* in hoards closing up to *c.* 250								
Period	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
161, 161-162	206	231	161	303	732	2395	110	**4138**
161-164 (Lucilla)	58	56	35	45	96	610	25	925
161-175 (Faustina II)	236	234	193	174	769	2523	144	**4273**
162-163	46	42	22	60	206	573	23	**972**
163, 163-164	73	71	43	102	301	794	26	**1410**
164-165	28	26	24	31	65	303	8	**485**
164-180 (Lucilla)	110	132	70	55	173	1217	56	**1813**
165, 165-166	30	37	36	36	152	456	22	**769**
166, 166-167	82	89	75	99	249	792	40	**1426**
167-168	9	9	6	7	104	164	2	**301**
168, 168-169	81	118	48	41	208	919	46	**1461**
169 (Divus Verus), 169-170	56	75	41	5	111	625	28	**941**
170-171	25	49	32	5	71	435	23	**640**
171-172	18	46	20	7	73	407	12	**583**
172-173	19	24	10	6	50	240	20	**369**
173-174	15	28	17	1	44	199	9	**313**

Table 4.4: ***Denarii*** **in hoards closing up to** ***c.*** **250**								
Period	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
174, 174-175	17	27	18	3	39	237	10	**351**
175, 175-176	31	66	23	4	96	462	26	**708**
176, 176-177	19	36	17	7	48	228	10	**365**
176-180 (mostly Div Faust II)	54	82	47	9	72	691	24	**979**
177, 177-178	24	63	12	2	33	312	24	**470**
178-179, 179-80	28	92	23	5	64	377	16	**605**
Qty	**1207**	**1577**	**938**	**962**	**3660**	**14349**	**679**	**23372**
Standardised residuals χ^2 = 1032, df = 126, **p-value < 2.2e-16**								
Period	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Avg**
161, 161-162	-0.5266	**-2.8850**	-0.3936	**10.1663**	**3.2997**	**-2.8863**	-0.9318	0.8347
161-164 (Lucilla)	1.4801	-0.8117	-0.3485	1.1225	**-4.0590**	1.7668	-0.3613	-0.1730
161-175 (Faustina II)	1.0319	**-3.1988**	1.6425	-0.1416	**3.8603**	-1.9595	1.7826	0.4311
162-163	-0.5923	**-2.9122**	**-2.7234**	**3.1607**	**4.3596**	-0.9722	-0.9857	-0.0951
163, 163-164	0.0214	**-2.4747**	-1.8063	**5.7709**	**5.3970**	**-2.4354**	**-2.3378**	0.3050
164-165	0.5900	-1.1755	1.0279	**2.4702**	-1.2564	0.3036	-1.6224	0.0482
164-180 (Lucilla)	0.9068	**2.0777**	-0.1069	**-4.3916**	**-5.2626**	**2.6477**	1.0241	-0.4435
165, 165-166	-1.5413	**-2.0667**	0.9247	0.7727	**2.8774**	-0.7418	-0.0721	0.0218
166, 166-167	0.9738	-0.7358	**2.3489**	**5.2609**	1.7192	**-2.8213**	-0.2218	0.9320
167-168	-1.6599	**-2.5095**	-1.7493	-1.5311	**8.2825**	-1.5297	**-2.2807**	-0.4254
168, 168-169	0.6388	1.9560	-1.3888	**-2.4675**	-1.3744	0.7357	0.5457	-0.1935
169 (Divus Verus), 169-170	1.0620	1.4441	0.5263	**-5.4200**	**-2.9951**	1.9671	0.1266	-0.4698
170-171	-1.4004	0.8851	1.2459	**-4.1583**	**-2.9190**	**2.1227**	1.0219	-0.4574
171-172	**-2.2066**	1.0623	-0.7024	**-3.4696**	-1.9148	**2.5938**	-1.1996	-0.8339
172-173	-0.0128	-0.1799	-1.2497	**-2.3576**	-1.0240	0.8940	**2.8342**	-0.1566
173-174	-0.2895	1.4972	1.2522	**-3.3107**	-0.7163	0.4931	-0.0309	-0.1578
174, 174-175	-0.2646	0.6815	1.0426	**-3.0116**	**-2.1534**	1.4650	-0.0617	-0.3289
175, 175-176	-0.9200	**2.6373**	-1.0157	**-4.6573**	-1.4123	1.3109	1.1975	-0.4085
176, 176-177	0.0346	**2.2915**	0.6143	**-2.0700**	-1.2113	0.2613	-0.1854	-0.0379
176-180 (mostly Div Faust II)	0.4840	1.9616	1.2299	**-4.9301**	**-6.5668**	**3.6691**	-0.8328	-0.7122
177, 177-178	-0.0552	**5.5558**	-1.5801	**-3.9436**	**-4.7325**	1.3803	**2.7997**	-0.0822
178-179, 179-80	-0.5803	**8.0101**	-0.2599	**-3.9882**	**-3.1583**	0.2888	-0.3760	-0.0091

Table 4.5, below, gathers in one place all the instances of overrepresentation presented in the four tables above. It can clearly be seen that most of the regional overrepresentations originating in an early subset (*e.g.*, hoards closing up to 180) endure through to the 211 subset and, in many cases, all the way up to the complete dataset of hoards closing up to *c.* 250. It can also be seen that the start of the reign is dominated by overrepresentations for Italy and the Adriatic and the Western Danube. In the Western Danube's case, virtually all the overrepresented issues first appear in the 180 subset and continue to appear until the complete *c.* 250 group. On several occasions, standardised residuals indicating a quantity of coins that χ^2 deems 'normal' for the region in question are in fact approaching the point of overrepresentation (*i.e.*, a result equal to or greater than 2): see, *e.g.*, the Italian result from the

180 subset for coins of 161-162, and the two standardised residuals for the Western Danube in the 192 subset for the coins of 162-163 and 163-164.

Table 4.5: Regional overrepresentations over time
*Fields marked ' - ' indicate where an issue was not present in sufficient numbers for testing to take place.

Period	Region	*Denarii* in hoards up to 180	*Denarii* in hoards up to 192	*Denarii* in hoards up to 211	*Denarii* in hoards up to *c.* 250
161, 161-162	W Danube	-0.6400	-1.1363	**4.5910**	**3.2997**
	Italy & Adr	1.9736	**4.0964**	-	**10.1663**
161-64 (Lucilla)	Britain	**2.7296**	**2.8957**	**3.1512**	1.4801
161-175 (Faustina II)	W Danube	**2.2512**	**2.0012**	**2.8349**	**3.8603**
162-163	Italy & Adr	-1.3902	0.3380	-	**3.1607**
	W Danube	**3.0549**	1.8407	**5.7955**	**4.3596**
163, 163-164	Italy & Adr	0.2487	0.9116	-	**5.7709**
	W Danube	1.3470	1.9025	**5.5747**	**5.3970**
164-165	Italy & Adr	0.1971	1.1703	-	**2.4702**
	E Danube	**4.7913**	**4.2034**	**3.4283**	0.3036
164-180 (Lucilla)	Britain	-	**2.6630**	0.7851	0.9068
	Spain & WM	-	-	**3.6007**	-0.8117
	E Danube	-	**4.2854**	1.8035	**2.6477**
165, 165-166	W Danube	1.0336	1.6160	**3.2009**	**2.8774**
166, 166-167	Rhine	1.3429	0.5274	1.6482	**2.3489**
	Italy & Adr	**2.3768**	**2.6229**	-	**5.2609**
167-168	W Danube	-	**5.1524**	**6.7982**	**8.2825**
168, 168-169	Britain	**4.1779**	**4.4355**	**2.2291**	0.6388
	Spain & WM	-	-	**3.1086**	1.9560
169 (Divus Verus), 169-170	Britain	-	**4.4993**	**3.0836**	1.0620
	Spain & WM	-	-	**3.5420**	1.4441
170-171	Spain & WM	-	-	**3.2209**	0.8851
	E Danube	-	-	0.2106	**2.1227**
171-172	Spain & WM	-	-	**3.3395**	1.0623
	E Danube	-	-	-0.2884	**2.5938**
172-173	E Med	-	-	-	**2.8342**
173-174	Spain & WM	-	-	**3.2074**	1.4972
175, 175-176	Britain	-	**3.0881**	1.0039	-0.9200
	Spain & WM	-	-	**3.9334**	**2.6373**
	E Danube	-	**3.2441**	0.6307	1.3109
176, 176-177	Spain & WM	-	-	**3.4095**	**2.2915**
176-180 (mostly Diva Faustina II)	Spain & WM	-	-	**4.6643**	1.9616
	E Danube	-	**6.4751**	0.6541	**3.6691**
177, 177-178	Spain & WM	-	-	**7.6065**	**5.5558**
	E Med	-	-	-	**2.7997**
178-79, 179-180	Spain & WM	-	-	**8.8093**	**8.0101**

Along the Eastern Danube, two of the six overrepresented periods (164-165 and 164-180, for Lucilla) are similarly long-lasting, enduring to the 211 and *c.* 250 groups respectively.[18] A third

[18] Western Danube: while not technically high enough to indicate overrepresentation, the standardised residuals for the years 161-175, 162-163, and 163-164 from the subset of hoards closing up to 192 are at the higher end of the 'normal' range. Eastern Danube: the same can be said of the standardised residual for 164-180 in the 211 subset.

might be added, in the form of the coins of 176-180, which are overrepresented in the 192 subset (it was not possible to test the 180 subset in this case) and in the *c.* 250 group.

As with Italy and the Western Danube, the set of overrepresentations for the Eastern Danube tend to cluster within a relatively tight time-frame – here, the six years beginning with 170-171 and ending *c.* 175/175-176.[19] This fact could be of use in resolving the dating of *denarii* struck for Diva Faustina (the problematic dating of which was discussed at the beginning of this chapter), currently dated to a broader period spanning the years 176-180, which are also overrepresented along the Eastern Danube. It is possible that the ending of the Eastern Danube's period of overrepresentation around 175/175-176 is indicative that a significant proportion, if not the majority, of Faustina II's posthumous *denarii* were struck and distributed in the year following her death, *c.* 175-176, as Beckmann alleged. The likelihood of this must be reckoned against precedents such as the issue of coins for Diva Faustina I, which probably continued up to the end of Antoninus' reign in 161.[20] Further refinement is clearly necessary.

A general observation on the pattern of regional overrepresentations in **Table 4.5** is that the times at which each region appears to have been in receipt of significant quantities of new *denarii* from the centre are much less distinct than in the preceding reigns. Up to the start of Aurelius' reign, there had been a mounting case for the argument that the state habitually distributed large numbers of new *denarii* between the various regions of the empire on a semi-cyclical basis.[21] In Hadrian's reign, for example, the overrepresentations for Britain occur only in the form of *denarii* struck 119-120. These overrepresentations cease and are succeeded by Italy and the Adriatic for the years *c.* 120-121 to 127. Italy, in turn, gives way to the Western Danube, which produces all overrepresentations for the years 128-130, after which time the

[19] This excludes the two overrepresentations for the 164-165 issue and for *denarii* of Lucilla's belonging to the broad period *c.* 164-180.

[20] See previous chapter, **footnote 5**.

[21] One that was, albeit, commonly shaped by the demands of military necessity, *e.g.*, Britain being the chief recipient of new coins in the run-up to, and during, Antoninus' Scottish campaign, *c.* 138-143. See section *i.* of the previous chapter.

Eastern Danube produces the lion's share of overrepresentations, between *c.* 130-136 (see **Chapter 2**, **Table 2.6**). At virtually no point do these broad regional concentrations overlap with each another. The same cannot be said in the case of Aurelius and Verus: we have seen above that two regions – namely, the Western Danube and Italy – compete for dominance in the share of new *denarii c.* 161-167/168, as do Britain and the Eastern Danube between *c.* 168-169 and 177. The Rhine, meanwhile, returned only one overrepresentation over the entire course of the reign (for *denarii* of 166/166-167) – a sign, perhaps, that a comparatively limited number of new coins were sent to what was (by contrast with the Danubian theatre) a quieter part of the frontier. It is also possible that our results for the Rhine are a function of the fact that this region, unlike in previous reigns, returned some of the lowest overall per-period totals out of any of the regions under survey.[22] This could in itself be a telling (if imprecise) indication of the state of the coin supply to this region in the reign of Aurelius.

If the system of *denarius* distribution sketched out above is indeed reflective of ancient practice, the reign of Aurelius appears to mark a point from which it is difficult to identify a rolling pattern of region-by-region distribution in the hoard record. Even in the reigns of Hadrian and Antoninus, where wars and disturbances in one province or another seem to have occasionally dictated the flow of new coinage (*e.g.*, Britain in the late 130s and early 140s), there still seemed to be a pattern within the results that suggested something of a more regular, region-by-region cycle of coin distribution. In the reign of Aurelius, however, overrepresentations appear to have an initial focus on Britian, Italy and the Adriatic, and the Danubes (see again **Table 4.5**), but the remainder of the reign from *c.* 168/169 is dominated by overrepresentations from Spain and the Western Mediterranean, with a minority from the Eastern Danube and Britain.

[22] Only in the case of the complete and uncontrolled dataset of hoards closing up to *c.* 250 were the coins from this region truly of a quantity to support proper testing.

The seeming dominance of the Spanish region in respect of the coin supply from the late 160s is likely to be something of a red herring, given a) it is unlikely the state directed so many shipments toward Spain to the detriment of the rest of the empire, and b) a relative lack of *denarii* from other regions from the mid-late 160s onwards means that the regions with the two largest blocks of Aurelian *denarii* – Spain (803 *denarii* from the Llíria hoard) and the Eastern Danube (Reka Devnia, 5,209 *denarii*) – managed to skew the results in their favour.[23] It is possible that a certain amount of blame for a seeming disruption to the cycle of coin supply might be laid at the door of the various wars and insurrections over the course of the reign, as well as calamities like the Antonine Plague, which might have degraded the empire's ability to bring in sufficient silver in the form of both taxes and fresh bullion from state-owned mines (more on which below). Quantities of coins produced in the first half of the reign (*c.* 161-168/169) relative to its second half (*c.* 170-180) are extremely out of balance, with the majority of the dataset (17,701 out of a total 23,372 *denarii*) being struck in the years up to *c.* 169.[24] This apparent steep decline in output is best visualised in **Figure 4.5**, below, which shows the relative frequencies of coins from each issue in both the Reka Devnia hoard and in a combined dataset comprising the 230 other hoards that contain *denarii* struck during the reign of Aurelius.[25] It is entirely reasonable to argue, of course, that events like the wars and the plague will have served to create or exacerbate existing strains in the system of bullion supply and coin striking, thereby contributing to a lowering of mint output.

---

[23] Which is not to say that some of the overrepresentations for the Spain and the Western Mediterranean and the Eastern Mediterranean are not genuine, or do not reflect ancient activity – see discussion over the following pages.

[24] *RPC* IV.4, pp. 26-31 gives a good summary of the varying opinions on the longevity of the socio-economic impact of the plague with specific reference to Egypt, where the documentation is at its best. Key voices in this instance are Duncan-Jones 1996, Scheidel 2002, Greenberg 2003, Bruun 2003, Rathbone 2007, Wilson 2009a, and Temin 2012, pp. 84-88.

[25] Coins from periods with unsatisfactorily wide date ranges (161-164, 161-175, 164-180, and 176-180) have been omitted because they create the misleading impression of spikes in output for periods of time that might not reflect actual episodes of striking at the time.

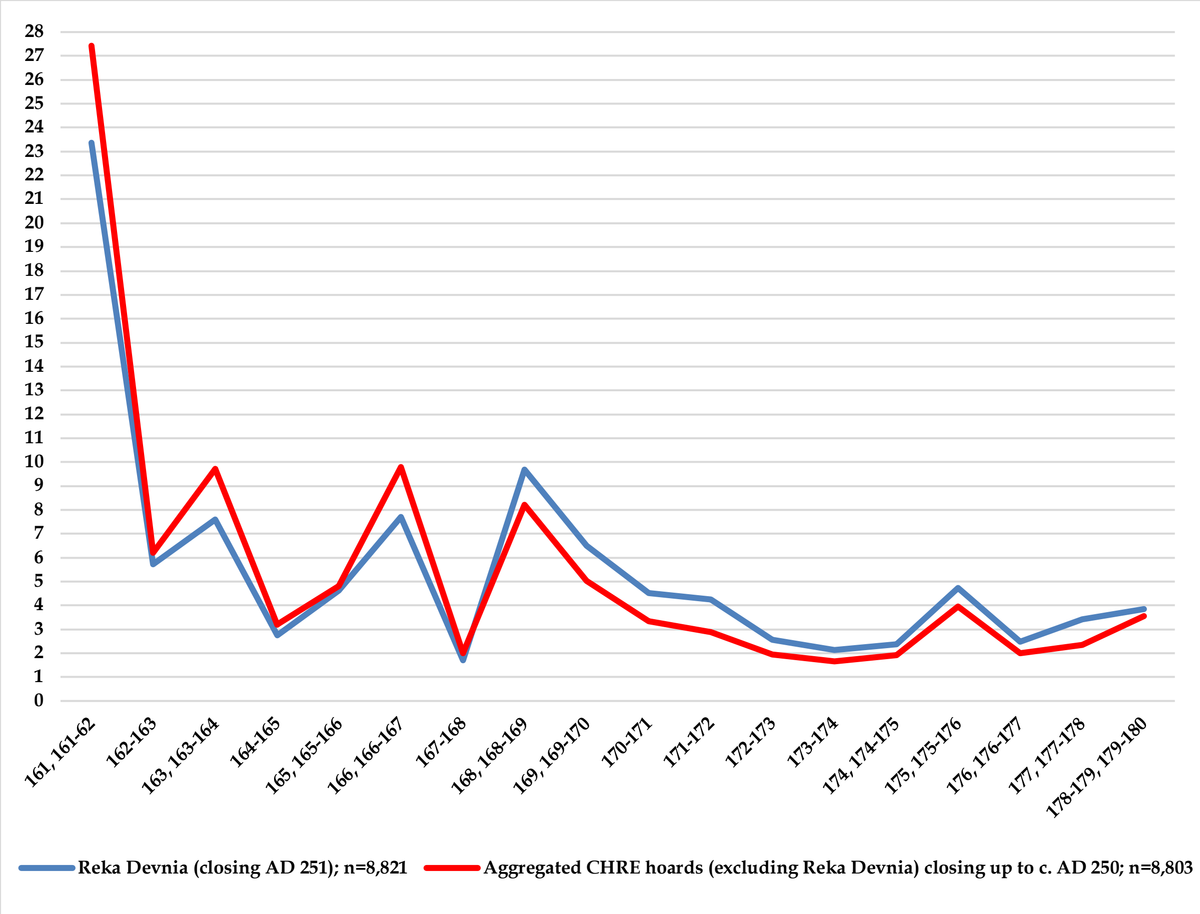

Figure 4.5: Relative frequencies of denarius issues of Aurelius, expressed as percentage of the total number of coins in each dataset

The exactness of their correlation is striking, complementing similar results produced by Spoerri Butcher and Hellings (2017) for the issues of Nerva and Trajan (**Chapter 1**, **Figure 1.3** and **Figure 1.7**), and for the reigns of Antoninus and Hadrian (this study, **Chapter 2**, **Figure 2.6**; **Chapter 3**, **Figure 3.8**). Taken together, they suggest that the production of *denarii* was heavily weighted toward the first half of the reign with a particularly intense period of output in the year-or-so following the joint accession of Aurelius and Verus in March 161. A burst of production at the beginning of a reign is to be expected given the customary accessional *congiarium* and *donativum*, which the new emperors might have paid in substantial quantities of new coins, as well as issues in the name of their deified predecessor.[26] Though typical in

[26] Strong overrepresentations among Italian hoards for *denarii* struck 161-162 suggest substantial quantities of new *denarii* were indeed used to pay the accessional *congiarium* in March 161: see **Table 5,**

this respect, the size of the apparent spike in mint output *c.* 161 is considerably larger than anything seen at the beginning of the other reigns under study here (see again **Figures 1.7**, **2.6**, and **3.8**, and **Figure 5.2** (Commodus).

Looking back to **Figure 4.5**, the data suggest that output in periods following 161-162, while nowhere near as substantial, was still considerable – with particular spikes *c.* 163/163-164, 166/166-167, and 168/168-169, concurrent with the Parthian war of 161-166 and the catastrophic opening years of the Marcomannic Wars from *c.* 166. The directness of the relationship between mint output and the financing of the army at times of war (as opposed to the regular financing of army pay), when the call on the treasury must have been greater, has never been agreed upon, but the case in favour would appear to be supported by this pattern of mint output.[27]

The noticeable dip in output from the beginning of the 170s, however, culminating in a low point around the middle of the decade, is interesting.[28] The empire was still at war with a host of enemies along the Danube and in Britain (a province that would continue to be a source of trouble well into Commodus' reign), which raises the possibility that the connection between high levels of mintage and periods of warfare was not always as clear as might be supposed. Alternatively, it might be that the hoards dataset being analysed here has an unrepresentative bias toward material from the beginning of the reign in a way that does not reflect annual levels of output in antiquity, but this is unlikely given that even the Reka Devnia hoard, which closes well into the mid-third century, itself contains more *denarii* of the first half of the reign than of the 170s onward. Other possibilities, presented in no particular order, are:

---

and discussion on *congiaria,* pp. 177-*ff.* At 2,178 coins, *DIVVS ANTONINVS* commemorative *denarii* are the third most numerous in the dataset for the reign of Aurelius, outnumbered only by those struck for the Aurelius himself (10,937), lifetime issues of Faustina II (4,273), and Verus (2,663).

[27] Lockyear 2012, pp. 203-207 advances that patterns of hoarding in late Republican Italy reflect peaks and troughs in the volume of coin production, and that periods of high production can, by and large, be tied to known periods of intense military activity, *e.g.*, the Social Wars; *cf.* Buttrey 1993.

[28] *Cf. RPC* IV.4, p. 22 (Graph 15) and pp. 29-39 for Egyptian tetradrachms, which underwent a hiatus in the 170s. Hellings 2025, p. 88 and figures 311-3.12 notes a dip in silver supply to the north-western provinces from this point onward, extending well into the reign of Commodus.

a) the state felt that production at a lower level in the 170s was adequate, given the quantities of coins struck in the 160s; b) the apparently lower level of production we see for the 170s was more like the norm, and the higher levels of the 160s, being driven by the war in Parthia and the eruption of war on the Danube, were, in fact, the oddities; c) there is substance to the idea that there was trouble with the metal supply, or otherwise that the mint was struggling to finance the production of silver, and that this, in turn, had some bearing on the rate of production (or, of course, a mixture of all three). Quite how far we should read a contemporary fiscal crisis into the story (given by the *SHA*) that Aurelius resorted to auctioning off properties and other moveable goods for the benefit of the military chest is hard to say, but the pressures of financing a war, co-mingling with the upheaval caused by the Plague (which probably included disruption to the supply of precious metal from state mining operations in both Spain and the Danubian provinces) cannot be underestimated.[29]

Evidence presented in the next chapter will show that option c) is likely to be the prime culprit, and that the apparent reduction in mint output from the early-mid 170s continued well into the time of Commodus, whose reign is characterised by a consistently low output of *denarii*. A peculiarity of this dip in the productivity of the mint of Rome from the time of Aurelius onward is that the silver fineness of the *denarius* did not decline: claimed debasements have been convincingly ruled out by Butcher and Ponting (*contra* Walker 1977, 1978), who have shown that the silver standard of the *denarius* remained fairly stable, at *c.* 68-70%, through to the end of the reign of Commodus.[30] It is now understood that traditional

---

[29] *SHA* (Aurelius 17.4-17.5, 21.9) details a two-month auction held in the Forum of Trajan at which all manner of imperial possessions, ranging from properties and items of furniture to clothing and jewellery belonging to Faustina, were sold off. On the impact of the Plague on mining, see this chapter, **pp. 173-174** and **footnotes 16-17**.

[30] In 156-157 the mint under Antoninus Pius reduced the *denarius* from an average fineness of around 78% to a new low of 70%: Butcher & Ponting 2012, pp. 72-75. This disproves Walker 1977, p. 58 and 1978, p. 125, who claimed to have identified a major debasement in *c.* 148, and several more through the reign of Aurelius. One of the (possibly intentional) effects of Antoninus' debasement in 156/157 was to bring the standard of the *denarius* closer to that of contemporary Egyptian tetradrachms: see *RPC* IV.4, p. 26. Butcher and Ponting's data show that the new standard established under Antoninus was

Spanish sources of silver were largely exhausted by the middle of the second century, and that from the time of Aurelius the state had probably shifted to new sources elsewhere in the empire, although their location remains uncertain.[31] It is possible that the new sources were insufficient to replace the old supply, and that the state struggled to strike a silver coinage of the size it would have liked: this could explain the fact that we appear to see an appreciable decline in silver output dating to the later part of the reign of Aurelius and the entirety of the reign of Commodus. That this decline came without a major debasement, or a series of incremental debasements, could well be an indicator that the mint took the decision to produce a smaller coinage instead of further reducing the silver standard. The latter part of Aurelius' reign, from *c.* 170-175 until 180, therefore marks a point in the history of the *denarius*, before its debasement under Severus in 194, when the state attempted to prevent any further debasements (the most recent of which, under Antoninus, had seen the *denarius* reduced to a fineness of 70%: the largest drop it had sustained within living memory). This will be further discussed in the next chapter with reference to the silver coinage of Commodus.

Whatever the state of the silver supply and the rate of production at the mint, it is entirely likely that the disrupted pattern of coin supply suggested in **Table 4.5** is also a

maintained, excepting some attempts at restoration under Aurelius and through the reign of Commodus (although there is evidence for one further debasement to around 67% in 178-179: Butcher and Ponting 2012, pp. 72-75 and 2014, pp. 452-460, figures 9.4, 12.1, 13.2, 14.4, 14.8). It was only with the coming of the Severans, in 194, that fineness nosedived to an all-time low of around 46%: Butcher & Ponting 2012, pp. 74-*ff.*

[31] Howgego 1992, pp. 7-8 notes the decline in productivity of Spanish sources of silver in the later part of the second century; Wilson 2007, p. 115 points to the fact that the Rio Tinto mines, which had been a primary source of silver bullion since the early imperial period, had essentially collapsed and that settlements associated with the mine workings had been abandoned by *c.* 170-180. These data are confirmed by analysis of Greenland ice cores (McConnell *et al.* 2018), which point to a marked decline in emissions associated with the mining and smelting of Spanish sources silver from the latter part of the second century. Butcher and Ponting 2012, pp. 77-81, argued that a change in the bismuth content of *denarii* struck from the reign of Aurelius onwards pointed to a new, probably Balkan source of silver to replace the exhausted Spanish workings. More recent work by the same authors, however, has cast doubt on the reliability of using lead and bismuth trace elements to pin down the true origin of a given source of silver. The true location of the state's new silver workings is – once again – thrown into doubt: see Woods, Butcher, and Ponting 2023.

consequence of the wider disruption wrought by the various conflicts that dogged the empire over the course of the reign. Any one of the conflicts faced by Aurelius and Verus would be reckoned a considerable challenge to the maintenance of that supply: Britain was a source of trouble from the earliest days of the reign (more on which below), with disturbances flaring up as late as 180 and into the reign of Commodus. At the other end of the Roman world, and running alongside unrest in Britain, was the war in Parthia, which occupied Verus in the first half of the 160s. Of highest importance was the protracted conflict with a host of enemies along the whole length of the Danubian frontier from 166/167, when the Marcomanni first broke into Roman Pannonia, triggering a war that would last until the end of the reign. The nadir of this struggle arguably came *c.* 170/171 with the virtual collapse of the Danubian frontier and subsequent invasions of Dacia, Moesia, and the Balkans. The governor of the combined provinces of Dacia and Upper Moesia was killed by invading Iazyges; the Costoboci penetrated as far as Thrace, Macedonia, and Achaea, and we hear of Roman mine workings being disrupted (presumably impacting the supply of bullion, further exacerbating the mint's problems) by warfare in both Spain and Dacia. One of the biggest shocks was dealt to the population of Aquileia, who were subjected to the experience of barbarian invaders laying siege to a major city on Italian soil.[32] All of this ran alongside the damage wrought by the Antonine Plague, which might have carried off as much as 20% of the population between the 160s and 180s.[33]

It is inescapable that these events will have made it harder to ensure the consistency and regularity of supply. Military pay is a good example: soldiers on active duty were more likely to be drawn away from their peacetime stations for longer periods of time than was customary; Roman counteroffensives against the Marcomanni and Iazyges, for instance, led substantial portions of the army out of their bases and across the Danube in the years 172-173

---

[32] Birley 2000b, pp. 164-165; Greenberg 2003, p. 424; Wilson 2007, p. 117.
[33] Wilson 2016 pp. 123-124.

(against the Marcomanni), and 174-175 (against the Iazyges).[34] The impact, too, of repeated incursions into Roman territory through the 170s, should not be underestimated or discounted: we know precious little of the logistical arrangements the state put in place when shipping new *denarii* from Rome to frontier regions, but it would be unsurprising if these were adversely affected by the presence of hostile forces on Roman territory. It is potentially instructive that the regular set of overrepresentations (signifying something like a regular supply?) seen in Italy and the Western Danube seem to end at about the same time as the beginning of the Danubian wars in 166/167, and the true onset of the Antonine Plague from *c.* 166.[35] Indeed, the data in **Table 4.5** suggest a more irregular pattern of region-by-region distribution than in previous reigns, with the troublesome regions of the Western and Eastern Danube both seemingly in receipt of the lion's share of new *denarii* (on the basis that they are overrepresented in more periods than any other region), followed by Britain.

None of the overrepresentations we see for the Western Danube fit neatly onto events insofar as we are aware of them. The incursions of the Langobardi, Marcomanni, and others beginning *c.* 166-168, as well as the presence of Aurelius himself on the Pannonian frontier from *c.* 168 (**Figure 4.6**), postdate the time when the results presented here suggest the Western Danube was in receipt of the greater amount of new *denarii*.[36] One of the overrepresented values for the Western Danube does – it should be pointed out – occur *c.* 167-168, indicating a possible overlap with the emperor's arrival at Sirmium, but this cannot be said with any certainty. It is known that Aurelius remained at the frontier for some time, in which case it is notable that no overrepresentations crop up along the Danube for the issues covering the years

[34] The conclusion of these campaigns, Cassius Dio tells us, led to the posting of several thousand barbarian soldiers to Britain under the terms of a treaty imposed by Aurelius. See below, **p. 196** and **footnote 54**.

[35] See Wilson 2026, p. 104 and Figure 5.1 for a location map of evidence for outbreaks of the Plague as it moved westward from the eastern empire.

[36] Birley 2000b, pp. 155-157 on the movements of Aurelius and Verus at the outset of the Danubian wars.

c. 167-168 and *c.* 170 (see **Table 4.5**).[37] To tie ourselves in knots over a gap of about two years would be an overreaction: any number of reasons might account for a lack of evidence for fresh batches dateable to the period *c.* 167/168-170; it is entirely possible, for instance, that supply lagged behind production in such a way that coins struck in *e.g.* 166 were used to supply the army and emperor at the frontier from 168 onward. Supply of new *denarii* does appear to more directly line up with events from *c.* 170 – evidenced, this time, in the form of two overrepresentations from the Eastern Danube for the issues of 170-171 and 171-172. These could reflect the financing of Roman countermeasures against contemporary invasions of Marcomanni, Costoboci, Iazyges, just as the two later overrepresentations for the issues of 175/175-176 and 176-180 issues could reflect expenditure in support of further offensives headed by Aurelius against the Iazyges, Quadi (both of whom had broken the terms of an earlier treaty with Rome), and Sarmatians.[38] All this is speculative; any one (or none) of these events, in conjunction with the galvanising presence of the emperor at Carnuntum and Sirmium, could be fielded as explanation for the overrepresentations we see in the regions of the Western and Eastern Danube.

Figure 4.6: *sestertius* of Marcus Aurelius struck in 169 to commemorate his departure for the Danubian frontier in the same year. *COS III // PROFECTIO AVG / S C*; Aurelius, on horseback, accompanied by three soldiers, advancing right (*RIC* III 978)

[37] Birley, *ibid*.

[38] Birley 2000b, pp. 165-168; 176-177, 183.

The repeated incidences of overrepresentation among the Italian hoards between the years 161 and 167, like those from the Western Danube, are tightly clustered within the first decade of the reign. In the Western Danube's case, all but a few of the χ^2 standardised residuals indicating overrepresentation relate to *denarii* struck before the eruption of war along the Danubian frontier in the later 160s. This made explaining them with reference to the historical record difficult, but, again, it is possible that supply in the later 160s was either facilitated in coins struck in the first half of the decade, or variously from stocks of older *denarii.*

The Italian overrepresentations for *c.* 161-167 display two striking features. The first is that they occur in the form of *denarii* struck when Aurelius and the imperial court were resident in Italy, only for them die away after he had left for the Danubian frontier to coordinate the Roman response to the Marcomannic invasions, *c.* 168. The second concerns the issues of 161-162 and 166-167, both of which are almost continuously overrepresented from the earliest subsets (hoards closing by 180 and 192) through to the uncontrolled group of hoards closing as late as *c.* 250. Both are represented by strong standardised residuals in the final group (hoards closing up to *c.* 250), especially the coins of 161-162, which returned a strongly overrepresented standardised residual of 10.1663. The coincidence of the Italian hoards producing overrepresentations of *denarii* struck in the same years as known *congiaria* has been noted in discussions of each of the preceding reigns. Here, too, it might be that the very strong set of overrepresentations for the issues of 161 and 161-162 are linked to the undoubtedly substantial accessional *congiarium* of March 161, and that the similarly strong results for the issues of 166 and 166-167 are linked to *congiaria* III and IV, held in October 166 (concurrent with joint triumph celebrated by Aurelius and Verus for the Parthian victory) and early 167 respectively.

The *congiarium* of 166 is arguably the most engaging feature of these results. The fact that the *denarii* of Aurelius and Verus were tested separately means it is possible to see when an overrepresentation is caused by one or the other of their coinages. Interestingly, Italy was among the few regions in which the *denarii* of Verus returned an overrepresentation at any time or place. Here, the overrepresentations take the form of *denarii* struck for Verus over the years 166-167, concurrent with the Parthian triumph and associated *congiarium* in 166.[39] This is interesting if for no other reason than *denarii* of Verus are far less common than those of Aurelius. Therefore, a result showing coins struck in his name *c.* 166-167 are overrepresented in Italy at the exactly the same time as the triumph and *congiarium* in honour of the Parthian victory is of real interest.[40]

Figures 4.7-4.8: *denarii* of Lucius Verus struck 166-167
4.7: *TR P VI IMP IIII COS II*; Victoria right with shield inscribed *VIC PAR* (*RIC* III 566)
4.8: *TR P VII IMP IV COS III*; Victoria left (*RIC* III 574)

---

[39] That the complementary χ^2 tests on the comparative spread of the coinages of Aurelius and Verus picked up no further examples of regional concentrations in the name of the latter is not necessarily proof that they never existed. It might be the case, for example, that Verus' *denarii* formed a proportionally greater share of hoards in the eastern part of the empire, but the limitations placed on our data by the comparatively poor recording and reporting of coins and hoards in the east means such patterns, if they exist at all, are presently invisible to us.

[40] Of the 947 *denarii* from this study's dataset from hoards closing by the death of Verus in 169, a majority of 393 (41.49%) are of Marcus Aurelius, compared with only 196 (20.69%) of Lucius Verus (the remaining 37% being other members of the imperial family). These proportions from the general coin population are mirrored in the much larger sample of coins from the Reka Devnia hoard, where, out of 8,841 coins dating up to 169, 3,356 (37.95%) are of Aurelius as opposed to 1,325 (14.98%) of Verus. The composition of a large hoard like Reka Devnia, as seen above in **Figure 4.5** of this chapter, can be taken as a good benchmark for the relative proportions at which coins occur across the empire – and, therefore, of the quantities in which they were produced. Hobley 1998, p. 84 observes the same imbalance in the quantities of coins struck for Aurelius and Verus in the case of the *aes.* This contrasts with the more balanced production for the two emperors observed in the provincial coinage of Egypt, the other great centre of imperial coin production: see *RPC* IV.4, p. 56.

The connection between the person of Verus and the victories in the east is made clear on the *denarii* struck in his name *c.* 166-167, which are dominated by reverses depicting Victoria, either standing alone or accompanied by shields inscribed *VIC PAR*, such as in **Figures 4.7** and **4.8**. The Italian bias of these *denarii* concurs with Hobley's data, which show that *aes* of Verus struck 165-167 – likewise dominated by Victory motifs – also display a general bias toward Italian circulation (**Figure 4.9**).[41] Hobley's data include museum collections and areas of the country that this study's dataset could not reach, including central Italy and Rome, thereby raising the likelihood that coins of Verus struck in celebration of his Parthian victories may also have been preferentially released into Italian circulation at the same time as the *denarii*, although whether this took place through the same channels (*e.g.*, public distributions like the *congiarium*) or different ones is hard to say for certain.

That *denarii* struck for Verus should have formed a proportionally greater part of the triumphal *congiarium* and other handouts of 166 feels fitting given that it was he who commanded the Roman forces in the east.[42] It is true that both emperors were hailed as co-victors at their joint triumph in Rome, but on the coinage, at least, Verus was given more credit for the victories in the east than Aurelius: types depicting Armenia appeared on the coinages of both men, but the mint conspicuously reserved all depictions of Parthia and Parthian captives for the coinage of Verus alone.[43] Similarly, although the honorifics *Armeniacus* and *Parthicus Maximus* were granted to both emperors on coins and inscriptions from 163 and 165-166 respectively, it instructive that these titles were dropped from the coinage of Aurelius when Verus died in 169, thereby suggesting that their use in the first place was contingent

[41] Hobley 1998, pp. 84-85, 90-91. Duncan-Jones 1994, pp. 88-89 notes a spike in hoards of the same years.
[42] See Beckmann 2015, pp. 195-196: *denarii,* rather than *aes*, were likely to have been the primary denomination in which the *congiarium* was paid.
[43] On the triumph: *SHA* Aurelius 12.7-12.11; Verus 7.9, 8.5. Reverse types depicting Armenia: *RIC* III 78-86, 121-122, 499-509, 526, 1360-1361, 1364-1369, 1408-1411. Reverse types depicting Parthia (all Verus): *RIC* III 539-542, 547-548, 1432-1435, 1440-1447)

upon Verus.[44] Rome's success was, therefore, more closely linked with the image and person of Verus rather than Aurelius; that our results appear to suggest Italy, and probably the *congiarium* of 166, as the primary place of release for his *denarii* at the same time as the Parthian triumph is therefore unsurprising. It is natural to wonder how that distribution might have been coordinated; were they batched up and distributed separately, or among select groups of recipients, to increase their visual impact? Or were they mixed in with – and therefore obscured by – the vast number of older coins that would have been needed to meet the sums required of a second-century *congiarium*?[45] We simply do not know.

Figure 4.9: *as* of Lucius Verus struck 165-166. *TR P VI IMP III COS II S C*; Victory left, setting hand on trophy (*RIC* III 1448)

The lack of similar overrepresentations for the other known *congiaria* of the reign is worth bearing in mind, but as in the case of the *congiaria* discussed in the preceding chapters, the degree to which newly struck *denarii* – never mind *denarii* bearing designs relevant to the *congiarium* – appears to have varied according to the occasion.[46] It is an interesting feature of the χ^2 tests that the most 'important' *congiaria* are prominent among those that returned overrepresentations of related *denarii* in Italy. Here, it is the *congiarium* of 166, held in honour

[44] This neatly accords with a reference in the *SHA* (12.9): "Marcus was so free from love of display that though he triumphed with Lucius, nevertheless after Lucius' death he called himself only Germanicus."
[45] Duncan-Jones 1990, pp. 248-250 speculates on the sums involved. See also Beckmann 2015, p. 195.
[46] Overrepresentations concurrent with the remaining *congiaria* of Aurelius' reign were not reflected in the χ^2 results for Italy– these being *congiaria* II (mid-165), V (early 169), VI (July 175) and VII (early 177).

of the Roman victories in the east; in the previous reign, we saw two separate Italian overrepresentations of Aurelius' *denarii* for the *congiaria* of 140 (which possibly marked his elevation to Caesar) and 145 (marking his marriage to Faustina II).

Britain's overrepresentations span the length of the reign (see again **Table 4.5**). The province was the only region to have produced a set of overrepresentations for Lucilla's *denarii* of the period *c.* 161-164 (overrepresented in the subsets of *denarii* from hoards closing up to 180, 192, and 211), and one of only three regions to have done so for her *denarii* of the broader period *c.* 164-180 (in the 192 subset alone). If these results evidence the mint sending *denarii* of Lucilla (*e.g.* those in **Figures 4.10-4.11**) to Britain, then we must ask ourselves whether these overrepresentations reflect two shipments (at least one in 161-164, and again at some point *c.* 164-180?), or just one. On a superficial level, the idea that the mint might send two shipments of *denarii*, perhaps years apart, feels less believable than the notion of one shipment, or shipments, occurring at more or less the same time. Given unresolved questions pertaining to the dating of Lucilla's coinage it is likely that the latter is correct, and that the overrepresentation of the better-dated *denarii* of 161-164 helps give a more precise date to the overrepresented *denarii* attributed to *c.* 164-180, the dating of which has long been understood as imprecise and in need of refinement.[47] Some years ago, Sam Moorhead drew attention to the fact that the number of coins of Lucilla reported to the PAS points to an unusual degree of commonality in Britain.[48] There might be any number of reasons why coins of Lucilla could have been selected for shipment to Britain in the 160s, but it feels unlikely that we are looking at evidence for targeted distribution of any kind. More work is clearly needed.

---

[47] See introductory section to this chapter for an outline of the issues surrounding the dating of Lucilla's coinage.

[48] Moorhead 2013, p. 101, noted the 221 coins of Lucilla reported to the PAS up to 2012/2013. These were compared with 1,317 for Aurelius and Verus, and 601 for Faustina II. These numbers have risen in the intervening years, but the numerical balance of coins struck for Lucilla versus other members of the imperial family still appears to be more pronounced in Britain than elsewhere. *Cf.* Hobley 1998, p. 111.

Figures 4.10-4.11: British single finds of *denarii* of Lucilla struck *c.* 161-180
4.10: *denarius* of Lucilla conventionally dated *c.* 164-180 but likely *c.* 161-164 (see **pp. 174-175**), *CONCORDIA*; Concordia seated left (*RIC* III 757)
4.11: *denarius* of Lucilla struck *c.* 164-180. *VENVS VICTRIX*; Venus standing left (*RIC* III 786)

Britain's remaining instances of overrepresentation occur in the form of *denarii* struck 168/168-169, 169/169-170, and 175/175-176. In each case, these issues show up as overrepresented in the early subsets of hoards closing up to 180 or 192, and continue to return standardised residuals signifying overrepresentation until the 211 subset, after which time the standardised residuals retreat to a normal level, suggesting these concentrations had dulled in strength.[49] Previous chapters have commented on specific shipments of coins that did not widely circulate outside of Britain; that these concentrations, which might date to the 160s and 170s, disappear from view when tested against the final group of hoards closing up to *c.* 250 suggests that the Channel was not a wholly insurmountable barrier to the movement of coin between Britain and the mainland provinces of the empire, and b) leads us to ask whether British concentrations that continue to show up in hoards dating to the later second and early third centuries were the result of the very largest shipments: movements of coin so substantial that they cannot but have left an indelible mark in the hoard record. The strong British χ^2 results for the early *denarii* of Antoninus' reign, for instance, continue to register in hoards closing as late as 211 and *c.* 250, implying that the year-on-year quantities of new *denarii* being

[49] It is a point of interest that none of these overrepresentations appears to be accompanied by peaks in the *aes* supply, as was occasionally the case in previous reigns: *e.g.*, **Chapter 3** (Antoninus Pius), where it was seen that large shipments of silver to Britain *c.* 138-145 were complemented by certain *aes* reverses. See Hobley 1998, p. 87.

moved into the province to support his campaign of expansion north of Hadrian's Wall in the early 140s were of an exceptional size. That the shipments of new Aurelian *denarii* of the 160s and 170s fail to do likewise might be a comment on their relative size: substantial, no doubt, in comparison to the quantities of coins being sent to other parts of the empire at the same time (hence their returning results signifying overrepresentation χ^2 tests), but, perhaps, less substantial when reckoned against the benchmark laid down by the shipments under Antoninus in the 140s? We must also reckon with the fact that mint output appears to have dipped from the late 160s and early 170s, which could have affected the size of shipments being sent from Rome (see this chapter, **pp. 181-185**, and **Chapter 5**, section *iv.*).

In a way that now feels typical of Britain, almost all the overrepresentations seen at the level of the issue can be plausibly related to periods of upheaval within the province. Britain had been the scene of episodic unrest since Hadrian's time.[50] Antoninus opened his reign with the prosecution of a war against the tribespeople of lowland Scotland; by the mid-late 150s, Roman forces were combating serious unrest across the north, that continued into the reign of Aurelius. Aurelius' appointment of new governors in the form of seasoned veterans Marcus Statius Priscus (in 161) and Sextus Calpurnius Agricola (161/162) would appear to underline the province's need of experienced military leadership at this time.[51] There is a suggestion that trouble continued to rumble on through the remainder of the 160s.[52] Interestingly, the results of the χ^2 tests do not indicate a great influx of new *denarii* struck for Aurelius or Verus at this time, which, again, could reflect a lowering of mint output at Rome. We should also note the overrepresentations of Lucilla's *denarii* for 161-164 and 164-180 (already mentioned above). Whether shipments of Lucilla's *denarii* were thought sufficient to meet the need for silver coins

---

[50] See **Chapter 2** (Hadrian), **pp. 107-114** for British unrest in the 120s reflected in in the numismatic evidence.

[51] Priscus had proven himself in campaigns in Dacia, while both men had had held governorships of provinces in frontier regions – qualities that likely spoke in favour of their appointment to the still-troublesome province of Britannia: Birley 2000b p. 121; Frere 1973, pp. 152-162.

[52] *SHA* Aurelius 8.7-8.8.

in Britain at this time is open to question; as **Table 4.5** shows, Britain is the only region to have produced an overrepresentation for Lucilla's 161-164 group, indicating that a substantial part of this batch of production for these years ended up in the province. The size of the silver coinage issued for Lucilla has not yet been ascertained, but relative numbers from the hoards assembled for this study suggest it was not insubstantial.[53] Perhaps the authorities did not feel the situation required any more than this (the several waves of coinage in between 138-*c.* 144 may also have factored into their considerations; see previous chapter, **Table 3.5** and **pp. 126-129**), or, alternatively, perhaps the coins of Lucilla were sent later, from stocks kept at Rome or elsewhere, when the heightened military activity of the later 160s and 170s might have created an increased need for cash.

The situation faced by Britain's governors in the second half of the 160s and into the 170s was evidently serious enough to warrant, in 175, the arrival of a large number of Sarmatian cavalrymen. This unit, perhaps equivalent in size to a full-strength legion, had recently been drafted into Roman service following a treaty concluded with the Iazyges.[54] As well as soldiers, there probably came money: the standardised residuals arising from the χ^2 tests suggest Britain was in receipt of a correspondingly high quantity of new *denarii* for the years 168/168-169 and 175/175-176 (**Figure 5.12**).[55] The parlous position in which Britain found itself is further evidenced by Cassius Dio who tells us that a Roman general – possibly the newly-appointed governor himself – fell in combat in the far north of the province *c.* 180.[56]

---

[53] See above, **pp. 169-170** and **footnote 12**.
[54] Birley 2000b, pp. 189-190; Cassius Dio 72.16.
[55] The standardised residuals for Spain and the Western Mediterranean and the Eastern Danube also signify overrepresentation for the period running 168-170, but, unlike in Britain, data for the earlier subsets (hoards closing by 180 and 192) could not be tested for those regions.
[56] Cassius Dio (73.8) employs the term *strategon* (*στρατηγόν*) instead of actually naming the governor, who at that time would likely have been Caerellius Priscus. Birley (1981, p. 135) convincingly argues that 'governor' is meant in instances where Dio uses *στρατηγόν*.

4.12: British single find of a *denarius* of Marcus Aurelius struck *c.* 168. *TR P XXII IMP V COS III*; Aequitas left (*RIC* III 192)

The hoards from Spain and the Western Mediterranean could not be tested except in the subset of hoards closing by 211 (because none of them closed before this date) and the final, uncontrolled group of hoards closing up to *c.* 250. They nonetheless loom large in **Table 4.5**, with eleven near-consecutive periods of overrepresentation taking in almost every issue period from *c.* 168 until the end of the reign. Their apparent significance, however, is tempered by the fact that they are almost entirely based on the coin profile of one large hoard (Llíria, near the colony of Valentia/Valencia), the Aurelian component of which numbers over 1,500 *denarii* alone. This does not mean we should write them off entirely: it could be revealing that four of the Spanish overrepresentations from the 211 subset survive into the complete, uncontrolled dataset of hoards closing up to *c.* 250; these four occupy a much narrower window of time, between 175-175/176 (*e.g.*, **Figure 4.13**) and 178-179/179-180, and coincide almost exactly with accounts of a poorly-documented Moorish incursion into the Spanish mainland, the seriousness of which required Aurelius to task Aufidius Victorinus – a veteran of the Danubian theatre – with the job of chasing the invaders out.[57] Whether there exists a link between the Roman response to the invasion and the overrepresentation of *denarii* corresponding with these years is an open question, and one that should not be pushed too

[57] Birley 2000b, pp. 203-204. Jones 1980, pp. 159-163, suggests that this event led to the abandonment of the Spanish silver mines at Rio Tinto. This was rebuffed by Wilson, who points to the Antonine Plague as the likely culprit: Wilson 2026, p. 119; Wilson 2009a, p. 78.

hard given the present state of the evidence.[58] We cannot discount the possibility, but the fact that virtually all our data for this region is drawn from the Llíria hoard means more work is needed before a link can be established with any confidence.

Figure 4.13: *denarius* of Marcus Aurelius from the Llíria hoard struck *c.* 175. *TR P XXIX IMP VIII COS III*; Mars right (*RIC* III 326)

ii. Distribution at the level of the issue

Figures 4.14-4.17, below, present the standard deviations for all the standardised residuals from each region in each issue period. We do not see a decrease in either the average or the range of the standard deviations as time goes on, as was observed in the same data for the three previous reigns. In their case, this decrease was credited to a pool of coinage that, over time, grew more integrated, probably as a result of circulation. Here, the inverse is true: **Tables 4.6-4.7** show that in the case of the *denarii* of Aurelius and Verus, both the average and the range of the standard deviations is lowest in the earliest subsets (hoards closing by 180 and 192), which, by the standards of the previous reigns, we would expect to exhibit the greatest degree of interregional difference. This is probably a function of the fact that only a fraction (nine and 14 respectively) of the 22 issue periods were suitable for survey, possibly resulting in a less accurate picture of coin distribution than in the later subsets. The subset of

[58] There exists one further period of possible overrepresentation for the coins of 176-180, where the standardised residual for the complete dataset of hoards closing all the way up to *c.* 250 is very nearly over the line denoting overrepresentation.

hoards closing by 211, by contrast, is backed by sufficient coins for all 22 issue periods to have been tested. Here, the trend observed in previous reigns manifests itself once again: **Figures 4.14-4.17** and **Table 4.7** together show that the range and the average of the standard deviations for the 211 group is higher than in the complete dataset of hoards closing up to *c.* 250. This conforms to the pattern we have seen in previous chapters, suggesting that, as time went on, regional variations in the distribution of *denarii* were probably flattened out (if not entirely removed) in the course of circulation.

Table 4.7: key to standard deviations in Figures 4.14-4.17				
Period	**Figure 4.14: *Denarii* in hoards up to 180**	**Figure 4.15: *Denarii* in hoards up to 192**	**Figure 4.16: *Denarii* in hoards up to 211**	**Figure 4.17: *Denarii* in hoards up to *c.* 250**
161, 161-162	1.1742	2.5322	3.2776	4.6065
161-164 (Lucilla)	2.1988	2.1404	2.0229	1.9896
161-175 (Faustina II)	2.1450	1.7757	2.8997	2.4026
162-163	2.1615	1.6370	3.7113	2.8018
163, 163-164	1.3664	1.9252	3.6740	3.7096
164-165	2.7955	2.6820	2.0491	1.4819
164-180 (Lucilla)	-	3.1641	3.3090	3.1309
165, 165-166	0.7019	1.1874	2.0492	1.6799
166, 166-167	2.1220	1.5160	1.3529	2.5680
167-168	-	3.4211	4.1339	3.8586
168, 168-169	2.3238	2.4796	2.4582	1.5662
169, 169-170	-	2.7877	3.0692	2.7135
170-171	-	-	2.4086	2.3873
171-172	-	-	2.1913	2.0614
172-173	-	-	1.2810	1.6764
173-174	-	-	2.0366	1.6040
174, 174-175	-	-	1.9073	1.6694
175, 175-176	-	2.7415	2.9002	2.3980
176, 176-177	-	-	1.9689	1.3829
176-180	-	3.9961	3.8850	3.7334
177, 177-178	-	-	4.5462	3.6745
178-179, 179-180	-	-	5.1669	3.8874
Average	**1.8877**	**2.4276**	**2.8318**	**2.5902**
Range	**2.0936**	**2.8087**	**3.8859**	**3.2236**

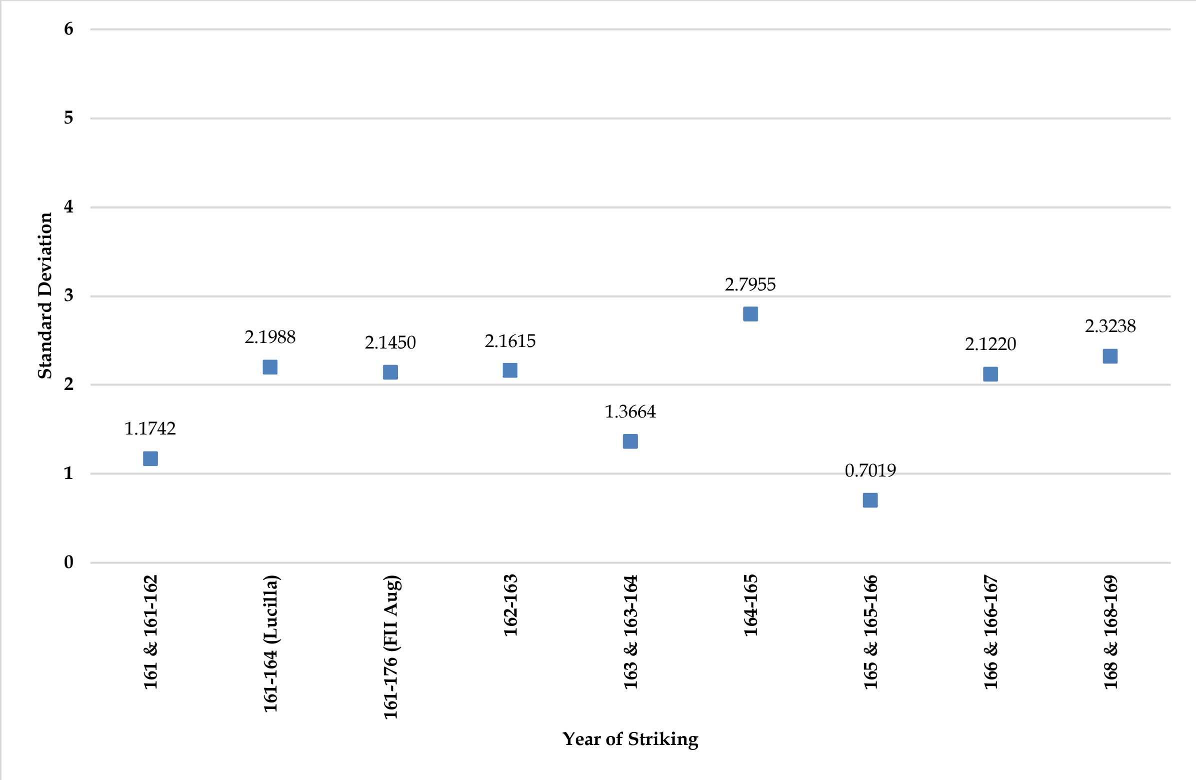

Figure 4.14: Standard deviations at the level of the issue - *denarii* in hoards closing up to 180. Range: 2.0936. Average: 1.8877

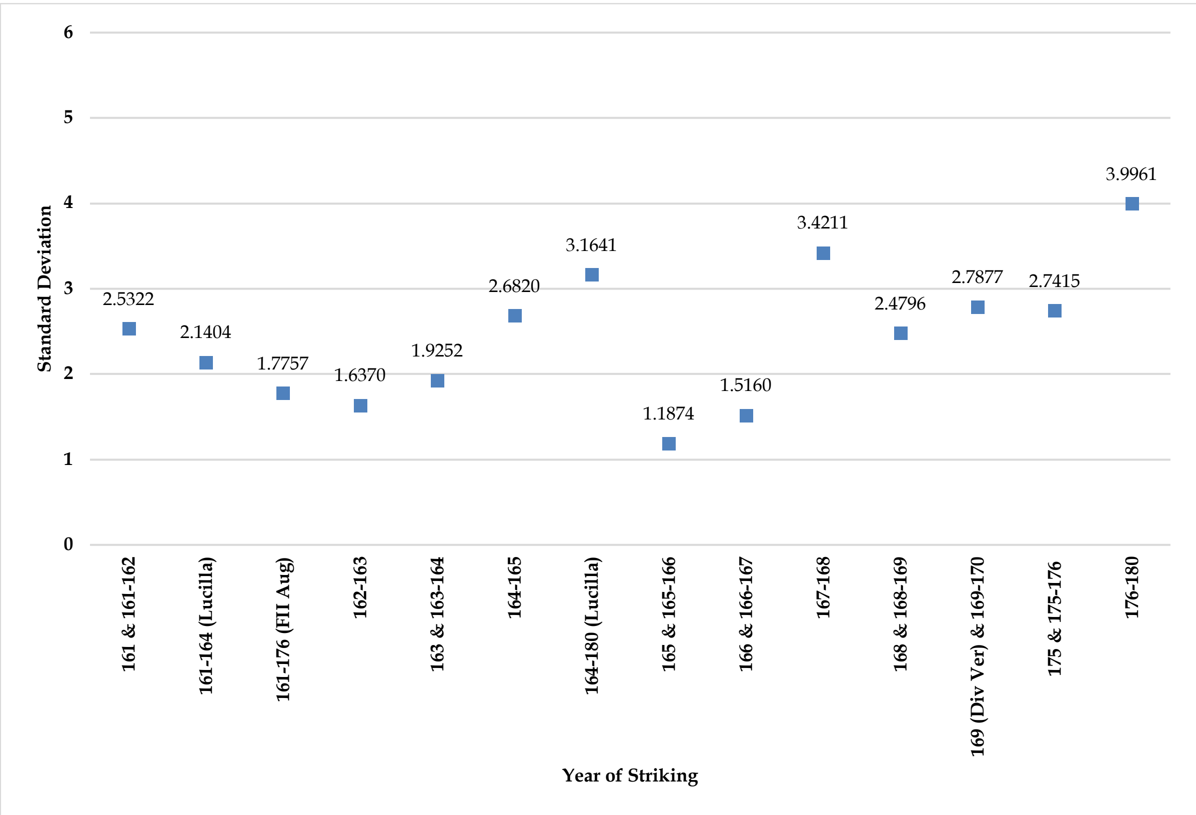

Figure 4.15: Standard deviations at the level of the issue - *denarii* in hoards closing up to 192. Range: 2.8087. Average: 2.4276

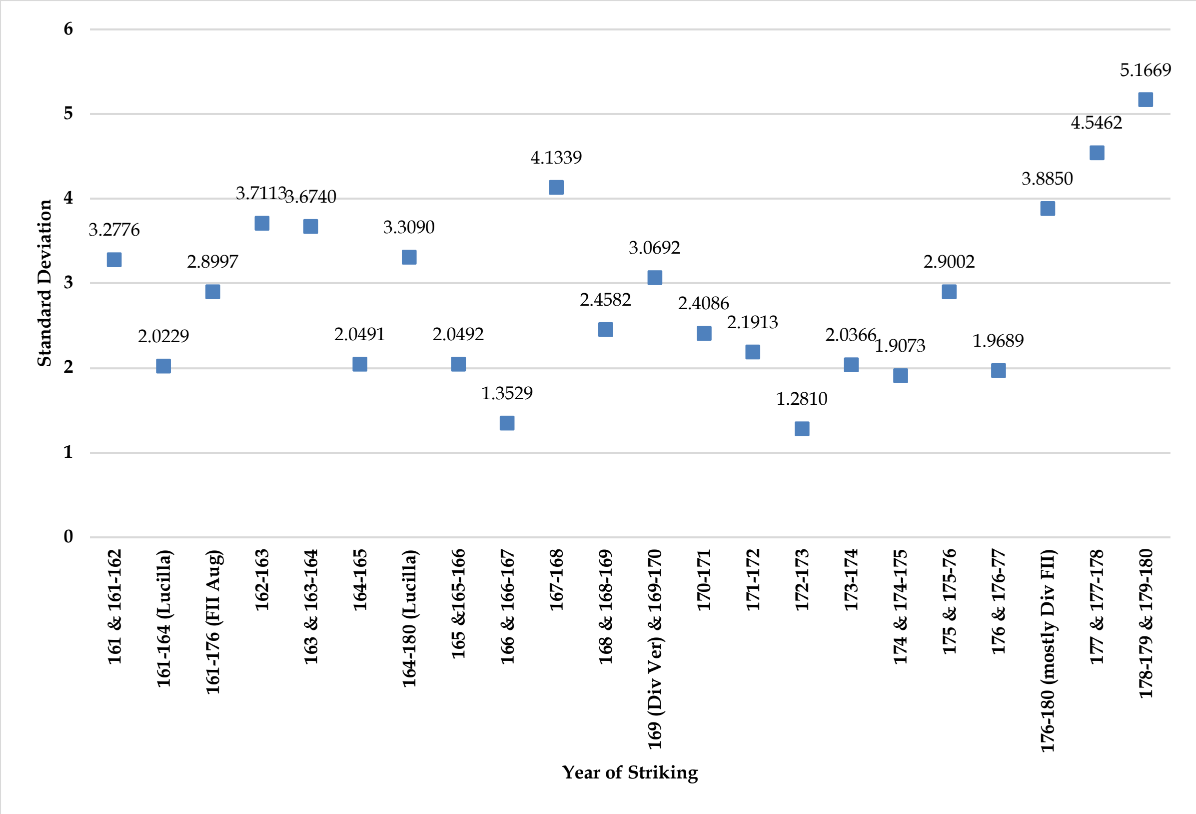

Figure 4.16: Standard deviations at the level of the issue - *denarii* in hoards closing up to 211. Range: 3.8859. Average: 2.8318

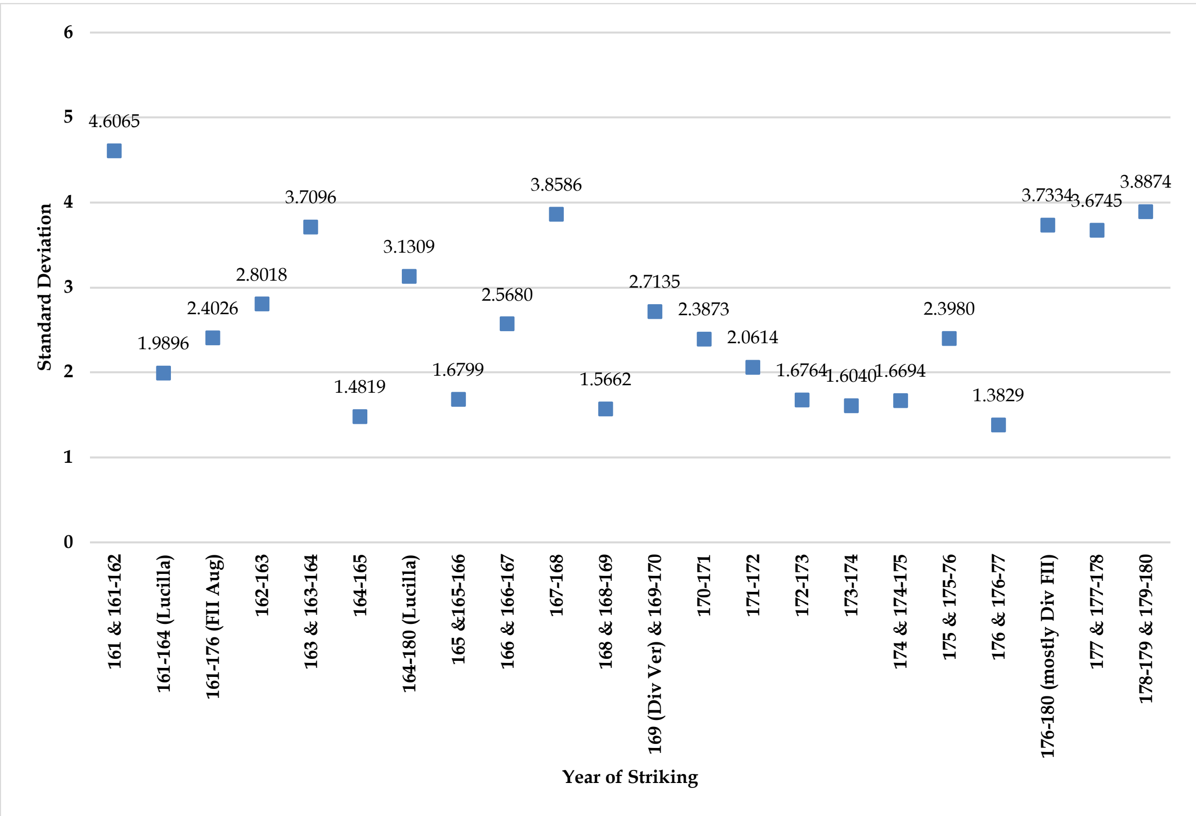

Figure 4.17: Standard deviations at the level of the issue - *denarii* in hoards closing up to *c.* 250.Range: 3.2236. Average: 2.5902

This is not to say that *denarii* of the reign of Aurelius circulated in identical fashion to those of his predecessors. One key point of difference emerges. This can be explained with reference to **Figures 1.2**, **2.5**, and **3.7**, each of which present the issue-level standard deviations in the final and complete dataset of hoards closing up to *c.* 250 for the reigns of Trajan, Hadrian, and Antoninus. These should be compared with **Figure 4.17**, which presents the same data for the reign of Aurelius. It can be seen that the standard deviations for the *denarii* of Trajan returned the lowest average and joint-lowest (with Hadrian) range of all the reigns under survey, indicating a degree of interregional variation at the level of the issue that is very low. The same is true of the reigns of Hadrian and Antoninus, although to a marginally lesser degree in each case. The trend is clear: as one moves forward in time, the averages and ranges of the standard deviations increase, but only slightly, indicating that, by the time most of the *denarii* were hoarded, those of Antoninus had mixed to a lesser degree than those of Hadrian, which were, in turn, less mixed than those of Trajan. The differences between them, however, are comparatively minor – so much so, that that the degree of interregional difference exhibited in their distribution is broadly the same.

The reign of Aurelius appears to mark a point of departure from this pattern. Both the range and the average of the Aurelian standard deviations are twice as large as those we see for Antoninus. The size of this jump is quite out-of-step with the far slighter increases we see in the transitions between Trajan-Hadrian and Hadrian-Antoninus, and is strongly indicative of a silver coinage that did not mix to the same degree as its predecessors before being hoarded. Compare also the individual values of the standard deviations for Aurelius in **Figure 4.17**, which sit in a higher register, generally above 2, than those of Trajan, Hadrian, and Antoninus in **Figures 1.2**, **2.5**, and **3.7**, which generally gather around 2 standard deviations or lower.

It is unlikely that the greater fragmentation we see in the distribution of Aurelius' *denarii* at the level of the issue is the result of a single factor. The disruption brought about by drawn-out wars in Britain, the east (if only we could see it in the data), and – particularly – along the Danubian frontier could be reached for as the main reasons, but they are unlikely to be the reason that this comparative lack of integration is still visible to us in the hoard record. Severe though these events might have been, it would be misguided to assert that they, or any other landmark events of the reign (*e.g.,* the Antonine Plague), were the system-changing moment that contributed to the undeniable regional variation we see in Severan *denarii*, for instance.[59] For that, we should probably look to two factors: first, the fact that there exists evidence for a plummet in silver output from the second half of Aurelius' reign onward (discussed below). This sudden drop in output might have prompted people to remove existing *denarii* from circulation at a faster rate than before. The second is the Severan debasement, which occurred barely a decade (*c.* 194) after Aurelius' death in 180, and which probably resulted in the final disappearance from circulation of many older and finer second-century *denarii*.[60] It is worth bearing in mind that something like 65% of all the *denarii* of Aurelius in this study's dataset come from hoards with a closing date of 211.[61] Had they been given the same chance, they might well have circulated to the same extent as those struck for his predecessors which, as the charts in **Figures 1.2**, **2.5**, **3.7** and **4.17** show, had mixed to a far greater extent by the time they were removed from circulation.

These two phenomena, then, arguably captured the state of Aurelius' silver coinage as it stood no more than twenty years after the end of his reign. Further refinement is possible: of the 23,372 *denarii* of Aurelius in the dataset, 5,130 (or 21%) belong to hoards closing by 200 – a figure that increases to 44% if we subtract the 11,945 coins from the Reka Devnia hoard (closing 251). This means that nearly half of the 11,427 non-Reka Devnia *denarii* could already have been in the ground at any point up to twenty years after the death of Aurelius. Indeed,

[59] See Duncan-Jones 2001, Howgego 1995a, 2002, and Hellings 2016.
[60] The silver content of the *denarius* nosedived to around 40%: Gitler and Ponting 2003, pp. 55-57. See **Chapter 5**, **footnote 21**, for a fuller outline of the metallurgy of the *denarius* in the second century.
[61] This figure excludes the enormous number of coins from Reka Devnia alone.

the majority of these 5,130 *denarii* – some 2,730 coins – come from hoards with a terminal date within Aurelius' lifetime, while only 847 belong to deposits spanning the six-or-so years between the Severan debasement of 194 and the turn of the third century.[62]

It is just as easy to imagine that, as well as increased withdrawals brought about by changes to the coinage, the lack of integration we see for the reigns of Aurelius (and, in the next chapter, Commodus) is one indicator that the empire was entering a period of economic fragmentation that culminated in the so-called 'crisis' of the third century.[63] It is has been said that the definite fragmentation of third-century radiate coinage act could as a mirror to the lack of connectivity in the economy as a whole.[64] This could well be true, but it must be borne in mind that the debased radiates struck from the middle of the third century onward were in circulation only until the introduction, under Diocletian, of the new system based upon the *nummus* (*c.* 294/295). They were not able, therefore, to mix to the same degree as *denarii* struck in the preceding century. On top of this, we would do well to remember that radiates were struck at a multiplicity of mints, and that from *c.* 260 onward the denomination was essentially a copper-alloy one, so it is to be expected that regional zones of circulation should have cropped up. The existence of opposing issuing authorities (*e.g.*, the Gallic and Central empires) could also mean that there were political, rather than economic, reasons for more localised patterns of circulation in the third century.[65]

---

[62] None of this seeks to discount the possibility that plenty of the hoards closing with coins of Aurelius' reign could belong to a later, Severan, date following the debasement.

[63] On the comparative degree of fragmentation of the third-century economy in terms of good imported and consumed: Morley 2009, esp. pp. 576, 590 and Reynolds 2017, pp. 382. Wilson 2009b also presents evidence for possible third-century downturns in production and long-distance trade but is cautious (see *e.g.* pp. 219-226 *passim*) that we do not read a perceived decline in *e.g.* shipwrecks or cargoes of various goods as proof of a more fragmented economy

[64] Howgego 1994, pp. 11-12 and 1995a; Mairat 2022, pp. 97-*ff*.

[65] RIC V.4, pp. 29-31 and Figure 3.8: radiates of the Gallic Empire are uncommon outside of areas under central authority in hoards terminating up to 268, for instance.

iii. Results of χ^2 tests at the level of the design

Even in the complete and largest group of hoards, composed of coins closing up to *c.* 250, it was not possible to subject the designs of every issue period to χ^2 testing. Some issues had to be excluded in their entirety because the per-design totals were too low. This mirrors what was seen in testing at the level of the issue (section *i.*), but in a more pronounced fashion: there, only nine of the total 22 issue periods that make up the subset of hoards closing by 180 were backed by enough coins from each region; when divided between their constituent designs, only two issue periods in the 180 subset (161/161-162 and 161-175) produced designs that could be tested – and even then, only seven designs met the testing threshold. The situation is hardly better in respect of the subset of hoards closing up to 192, which produced 17 testable designs from five issue periods. Only in the subset of hoards closing by 211 and in the complete dataset (hoards closing by *c.* 250) were there enough coins per design and per region for testing across multiple issue periods to take place.[66] These difficulties meant that no testing occurred on designs of particular interest – *e.g.*, Verus' Parthian designs of the mid-160s (*RIC* III 540-542, 548, 566), because this category of design, as well as others struck over those years, were not represented in sufficient quantity to satisfy χ^2. Their exclusion from testing is, on the one hand, a pity, since analysis of these designs might have told us more about the apparent concentration of Verus' coinage in Italy around the time of the Parthian triumph and *congiarium*; on the other, it is better to exclude designs represented by samples that would render inaccurate results.

One of the factors behind this difficulty is the fact that, as has already been established, the entire Aurelian dataset tends towards the first half of the reign, probably because of

[66] 31 designs from seven issue periods were testable in the subset of hoards closing up to 211, and 44 from 12 issue periods in the complete dataset of hoards closing by *c.* 250. Full breakdowns of totals by design, issue period, and region can be found in **Annexe 4**, along with the results of the χ^2 tests performed on them. Note: as in the tests at the level of the issue, no testing took place on Italian hoards in the 211 subset because our dataset has no hoards containing *denarii* of the reign of Aurelius closing between 192 (the end of the previous group) and 211.

declining mint output from the later 160s. The net effect of this is that many of the later issues did not meet the numerical standard required for testing. The latest issue period for which there were sufficient coins to permit testing across multiple hoard groups was 168/168-169; thereafter, only the latest group of hoards (closing up to *c.* 250) produced anywhere near enough coins to enable testing of the issue periods between the years 170 and 176. The very latest periods, *c.* 176-180, failed to return sufficient coins even in the complete dataset of hoards closing up to *c.* 250, thereby preventing their analysis altogether. Once again: this a problem that is more peculiar to the testing of coins at the level of the design, where the number of categories under survey is far greater than it is at the level of the issue, and the number of coins per category are necessarily lower.

These problems having been taken into account, we will begin by looking at how far the general distribution of each design compares with the results of the χ^2 carried out at the level of the issue (presented in section *i.*, above). In previous reigns, testing at the level of the issue and the coin showed that, over time, the distribution of *denarii* from all periods grew tighter as interregional variations were dulled through successive hoard groups, probably as a result of circulation. The same is true here, although the degree of mixing appears to have been stunted by factors such as the Severan reform of the silver coinage in the 190s. **Table 4.8** and **Figures 4.18-4.21**, below, present the standard deviations for the designs tested in each group of hoards from the 180 subset through to those closing up to *c.* 250.

The results for the subset of hoards closing up to 180 in **Figure 4.18** hardly warrant attention, given the number of testable designs and issue periods is so low. Starting, then, from the 192 subset (**Figure 4.19**), it is possible to see in the charts as well as in **Table 4.8** (below) that both the maximum and the overall range of the standard deviations counterintuitively <u>increases</u> as time goes on – a function, as we saw in the tests at the level of the issue, of the fact that the number of testable issue periods and designs increases with time. As expected, however, the average tends to fall: from 1.1141 in coins from hoards closing up

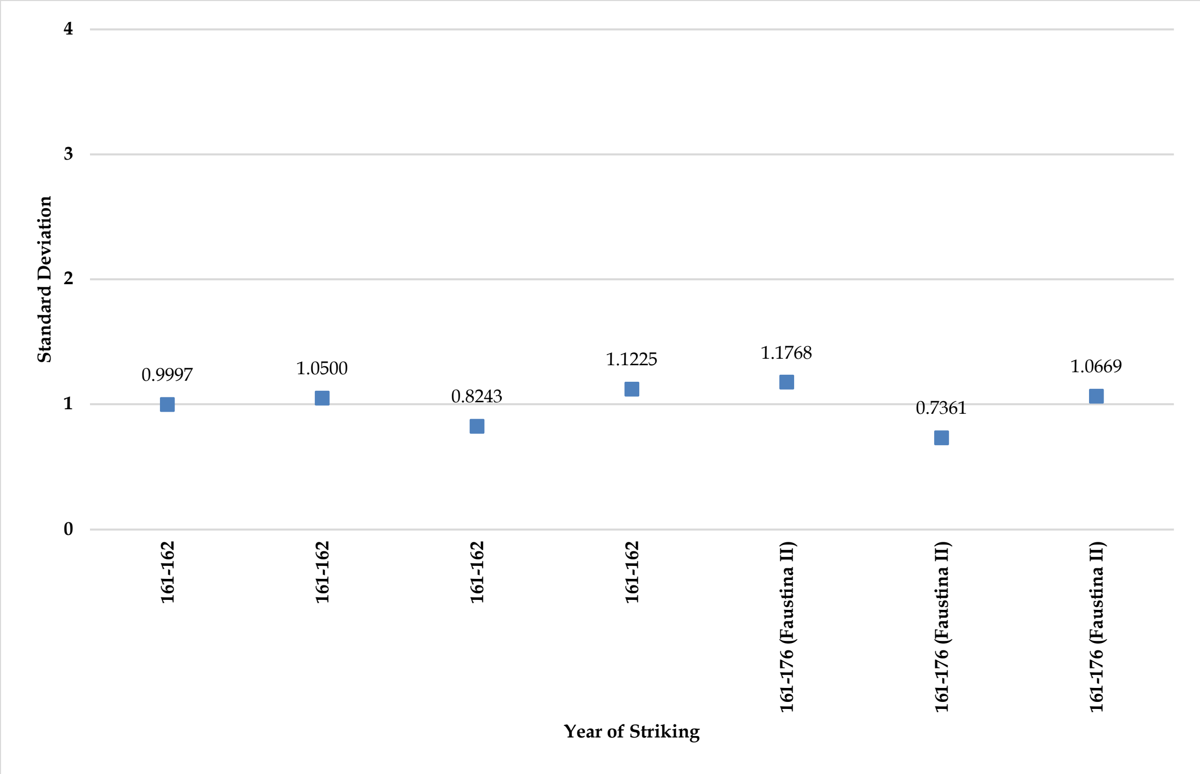

Figure 4.18: standard deviations at the level of the design - *denarii* in hoards closing up to 180. Range: 0.4407. Average: 0.9966

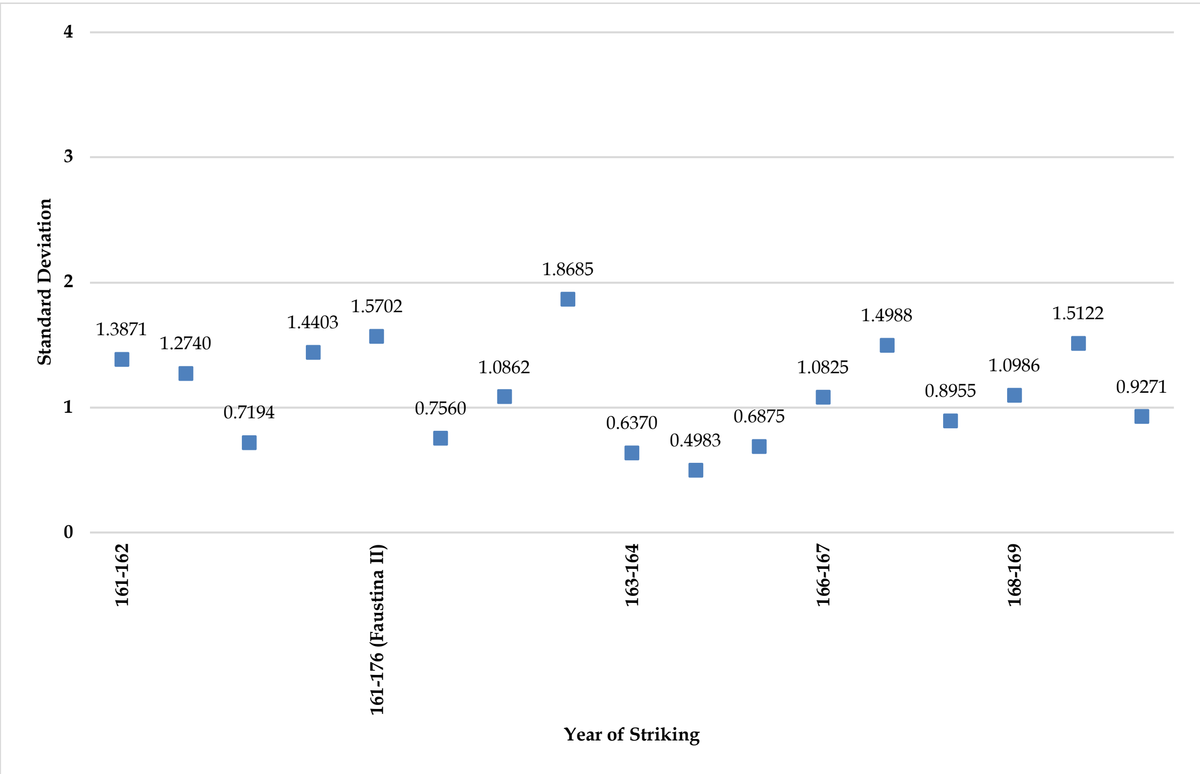

Figure 4.19: standard deviations at the level of the design - *denarii* in hoards closing up to 192. Range: 1.3702. Average: 1.1141

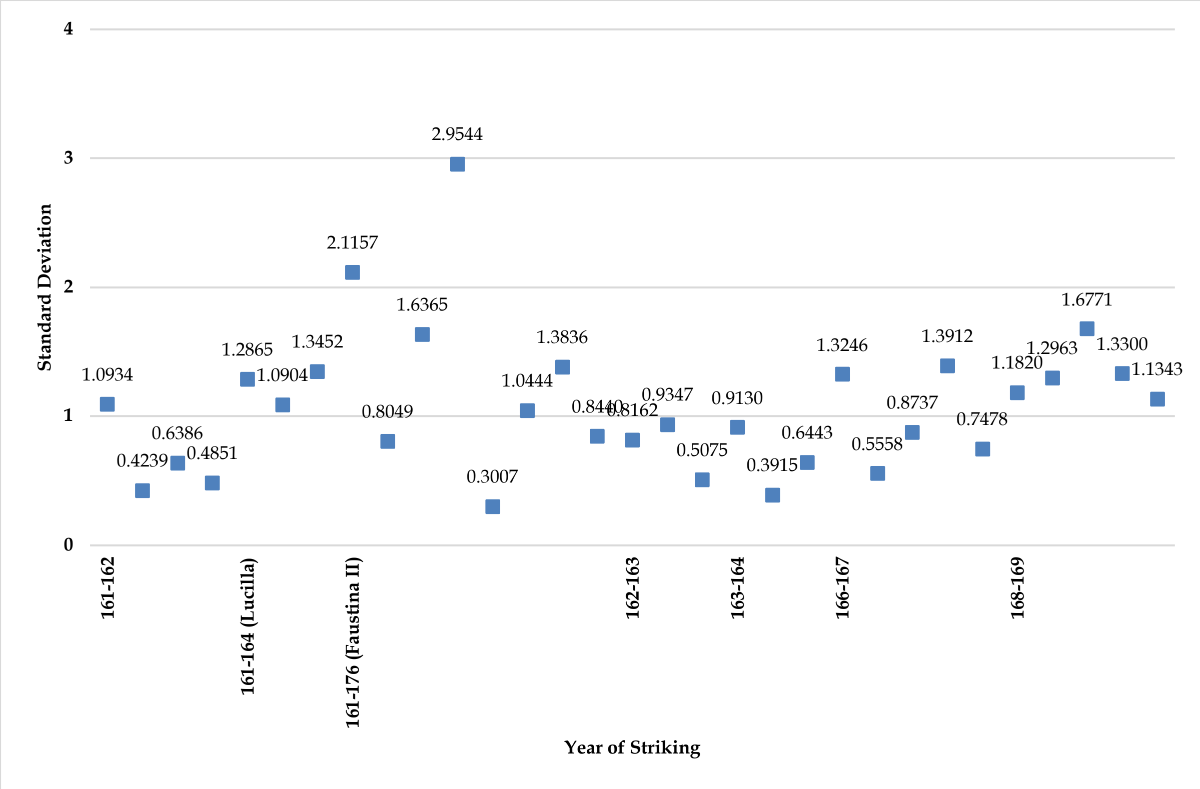

Figure 4.20: standard deviations at the level of the design - *denarii* in hoards closing up to 211. Range: 2.6538. Average: 1.0699

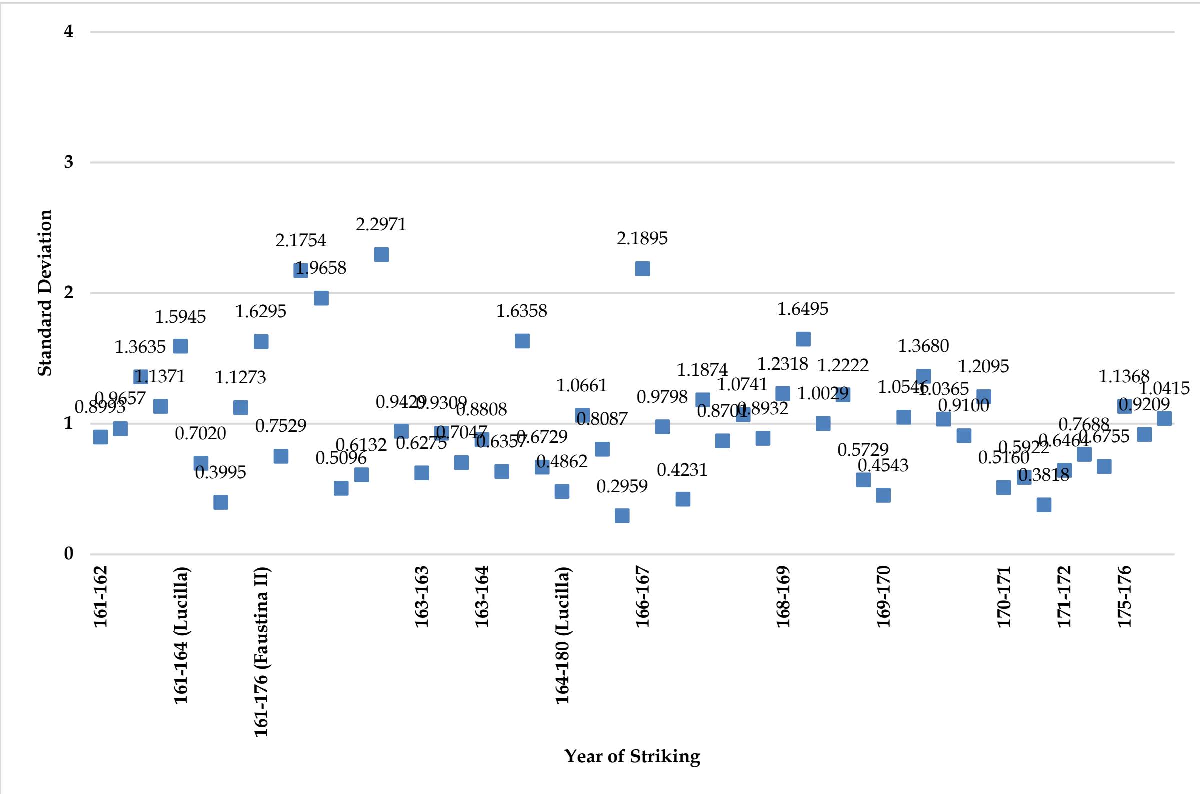

Figure 4.21: standard deviations at the level of the design - *denarii* in hoards closing up to *c*. 250. Range: 2.0012. Average: 0.9968

to 192, to 0.9968 in the complete and uncontrolled dataset of hoards closing up to *c.* 250. The most reliable sets of results are, of course, for the 211 and the *c.* 250 groups, given they are large enough to permit testing across many issue periods and designs. In their case, at least, the expected pattern manifests itself: *i.e.*, an observable decline in both the overall range and the value of the individual standard deviations, which, it is argued here, points to a reduction in the degree of interregional variance in the spread of the *denarius* at both the level of the design and the issue.

Table 4.8: key to standard deviations in Figures 4.18-4.21					
Period	**Design**	**Figure 4.18: *Denarii* in hoards up to 180**	**Figure 4.19: *Denarii* in hoards up to 192**	**Figure 4.20: *Denarii* in hoards up to 211**	**Figure 4.21: *Denarii* in hoards up to *c.* 250**
161, 161-162	**Concordia (Aurelius)**	0.9997	1.3871	1.0934	0.8993
	Providentia (Aurelius)	1.0500	1.2740	0.4239	0.9657
	Providentia (Verus)	0.8243	0.7194	0.6386	1.3635
	Divus Pius	1.1225	1.4403	0.4851	1.1371
161-164 (Lucilla)	**Concordia**	-	-	1.2865	1.5945
	Diana				0.7020
	Venus	-	-	1.0904	0.3995
	Vesta	-	-	1.3452	1.1273
161-175 (Faustina II)	**Ceres**	-	-	**2.1157**	1.6295
	Diana	-	-	0.8049	0.7529
	Fecunditas	1.1768	1.5702	1.6365	**2.1754**
	Hilaritas	-	-	**2.9544**	1.9658
	Juno	0.7361	0.7560	0.3007	0.5096
	Infants Comm & Anton	1.0669	1.0862	1.0444	0.6132
	Salus	-	1.8685	1.3836	**2.2971**
	Venus	-	-	0.8440	0.9429
162-163	**Concordia (Aurelius)**	-	-	0.8162	0.6275
	Providentia (Aurelius)	-	-	0.9347	0.9309
	Providentia (Verus)	-	-	0.5075	0.7047
163, 163-164	**Armenia (Aurelius)**	-	0.6370	0.9130	0.8808
	Mars (Aurelius)	-	0.4983	0.3915	0.6357
	Armenia (Verus)	-	-	-	1.6358
	Mars (Verus)	-	0.6875	0.6443	0.6729
164-165	-	-	-	-	-
164-180 (Lucilla)	**Concordia**	-	-	-	0.4862
	Juno	-	-	-	1.0661
	Pudicitia	-	-	-	0.8087
	Venus	-	-	-	0.2959
165, 165-166	-	-	-	-	-
166, 166-167	**Aequitas (Aurelius)**	-	1.0825	1.3246	**2.1895**
	Pax (Aurelius)	-	-	0.5558	0.9798
	Providentia (Aurelius)	-	-	0.8737	0.4231
	Victoria (Aurelius)	-	1.4988	1.3912	1.1874
	Aequitas (Verus)	-	-	-	0.8701
	Pax (Verus)	-	0.8955	0.7478	1.0741
	Victoria (Verus)	-	-	-	0.8932
167-168	-	-	-	-	-

Table 4.8: key to standard deviations in Figures 4.18-4.21					
Period	**Design**	**Figure 4.18: *Denarii* in hoards up to 180**	**Figure 4.19: *Denarii* in hoards up to 192**	**Figure 4.20: *Denarii* in hoards up to 211**	**Figure 4.21: *Denarii* in hoards up to *c.* 250**
168, 168-169	**Aequitas (Aurelius)**	-	1.0986	1.1820	1.2318
	Fortuna (Aurelius)	-	1.5122	1.2963	1.6495
	Liberalitas LIB AVG V (Aurelius)	-	-	1.6771	1.0029
	Salus (Aurelius)	-	-	1.3300	1.2222
	Aequitas (Verus)	-	0.9271	1.1343	0.5729
169, 169-170	**Diana**	-	-	-	0.4543
	Fortuna	-	-	-	1.0546
	Minerva	-	-	-	1.3680
	Salus	-	-	-	1.0365
	Victoria	-	-	-	0.9100
	Divus Verus	-	-	-	1.2095
170-171	**Jupiter**	-	-	-	0.5160
	Aurelius sacrificing	-	-	-	0.5922
	Mars	-	-	-	0.3818
171-172	**Aequitas**	-	-	-	0.6464
	Mars	-	-	-	0.7688
	Roma	-	-	-	0.6755
172-173	-	-	-	-	-
173-174	-	-	-	-	-
174, 174-175	-	-	-	-	-
175, 175-176	**Felicitas (Aurelius)**	**-**	**-**	**-**	1.1368
	Roma (Aurelius)	**-**	**-**	**-**	0.9209
	Commodus Caesar	**-**	**-**	**-**	1.0415
176, 176-177	-	-	-	-	-
176-180	-	-	-	-	-
177, 177-178	-	-	-	-	-
178-179, 179-180	-	-	-	-	-
Average		**0.9966**	**1.1141**	**1.0699**	**0.9968**
Range		**0.4407**	**1.3702**	**2.6538**	**2.0012**

The reduction in regional variance at the level of the design that we see in the hoards closing up to *c.* 250 can be compared to the same results for the previous three reigns. As might be anticipated, this reduction appears to have occurred to a lesser degree in Aurelius' coinage than in those of his predecessors.

See **Table 4.9**, below: the ranges seen in the standard deviations at the level of the design for Trajan, Hadrian, and Antoninus are very similar. The direction of travel between Trajan and Antoninus is what we have, by now, come to expect, insofar as the standard deviations of earlier reigns inhabit a narrower range than those of later ones, which are wider. As for the averages, the general trend is to see an increase as one moves forward in time (*i.e.,* the average standard deviation gets larger), except for the fact that the average for Aurelius' coinage is a little lower than that of Antoninus – a probable function of the fact that the number of Aurelian designs that were eligible for testing was so much lower (by nearly 50%), thereby depressing the average.[67] Even so, it is still possible to say that, in general, the averages and the ranges of the standard deviations tend in the direction we might have expected – *i.e.,* the averages are generally larger and the ranges generally wider in the later reigns than in the earlier ones, and are therefore indicative of coinages that either had progressively less time to mix, or that their ability to mix was inhibited by increasing fragmentation of the coinage. This mirrors what was seen in the same results at the higher level of the issue.

Table 4.9: ***Denarii*** **from hoards closing up to *c.* 250. Comparing standard deviations at the level of the design – Trajan-Marcus Aurelius**

Reign	Standard Deviation (Min)	Standard Deviation (Max)	Range	Average
Trajan (Figure 2.8)	0.2577	1.7070	1.4493	0.9000
Hadrian (Figure 3.11)	0.3444	1.6097	1.2653	0.9735
Antoninus (Figure 4.12)	0.3350	1.7541	1.4191	1.0353
Aurelius (Figure 5.21)	0.2959	2.2971	2.0012	0.9968

We will now lay aside the matter of overall distribution over time in order to consider the actual results of the χ^2 tests at the level of the design. **Table 4.10**, below, presents all examples of under- and overrepresentation seen in each region at the level of the design. As explained in the preamble to this section, it was, in most cases, impossible to see how far into the earlier subsets an overrepresentation appearing in the 211 subset and/or the complete dataset might extend, owing to the fact that the 180 and 192 subsets were largely untestable.

In the main, there is little correspondence between overrepresented designs and overrepresented issue periods (outlined in section *i.*, above). For example: χ^2 found the Armenia design (*RIC* III 501, 505-506, 509, 526), which was struck for Verus in 163/163-164, to be overrepresented in Britain; this contrasts with the results of testing at the level of the issue

[67] The number of testable designs from Aurelius' reign was the lowest of any of the reigns surveyed so far: lower than Trajan (66), Hadrian (80), and Antoninus (95).

(see **Tables 4.1-4.5**), where Italy and the Western Danube – and not Britain – were found to be overrepresented.

Table 4.10: under- and overrepresented designs, 180-*c.* 250
*Fields marked ' - ' indicate where a design was not present in sufficient numbers for testing to take place.

Period	Region	Design	*Denarii* in hoards up to 180	*Denarii* in hoards up to 192	*Denarii* in hoards up to 211	*Denarii* in hoards up to *c.* 250
161, 161-162	Italy & Adriatic	Providentia (Aurelius)	1.5656	**2.0036**	-	1.6932
		Divus Pius	-1.8361	**-2.3557**	-	**-2.2803**
	Western Danube	Providentia (Verus)	0.8646	-0.2469	0.6301	**2.1279**
161-164 (Lucilla)	Italy & Adriatic	Concordia	-	-	-	**2.9669**
		Vesta	-	-	-	**-2.0829**
161-175 (Faustina II)	Britain	Ceres	-	-	**2.1184**	1.2219
	Spain & W Med		-	-	**2.1912**	1.2427
	Italy & Adriatic		-	-	-	**-2.1889**
	Western Danube		-	-	**-3.0259**	**-2.1071**
	Italy & Adriatic	Fecunditas	1.2305	**2.5137**	-	**4.3582**
	Britain	Hilaritas	-	-	**3.9354**	0.8497
	Spain & W Med		-	-	**2.4298**	0.6498
	Italy & Adriatic		-	-	-	**-2.4989**
	Western Danube		-	-	**-3.8991**	**-2.9946**
	Italy & Adriatic	Salus	-	**-3.2272**	-	**-3.3120**
	Western Danube		-	1.6691	**2.1153**	**3.6616**
163, 163-164	Britain	Armenia (Verus)	-	-	-	**3.2306**
164-180 (Lucilla)	Spain & W Med	Juno	-	-	-	**-2.0052**
166, 166-167	Britain	Aequitas (Aurelius)	-	1.1249	-0.2749	**2.9976**
	Western Danube		-	-0.8343	-1.0492	**2.3184**
	Eastern Danube		-	0.9767	**2.0330**	**-3.1830**
168, 168-169	Rhine	Fortuna (Aurelius)	-	-	**2.0307**	1.8736
	Italy & Adriatic		-	**2.2303**	-	**2.7805**
	Western Danube	Aequitas (Aurelius)	-	0.7465	1.9512	**2.3226**
		Liberalitas *LIB V* (Aurel)	-	-	**-2.2569**	-1.3525
175, 175-176	Britain	Commodus Caesar	-	-	-	**2.0445**

There are, however, some cases where there is a correspondence between overrepresentations at the level of the issue and of the coin, although in virtually all cases the particular relevance of the design to the region is not clear. The building picture, based on the data here and from previous chapters, is one in which there is little observable targeting of audiences outside of very specific situations, mostly to do with Rome. The possible distribution of *denarii* struck for Verus at the triumphal *congiarium* in 166, which were overrepresented in Italy (see section *i.* of this chapter), is one of the few examples of targeted distribution to have come to light. To these can be added similar Italian overrepresentations in earlier reigns, *e.g. denarii* struck for

Aurelius as Caesar, and Liberalitas types of Antoninus in years of known *congiaria* (see previous chapter).

The most striking of the regional overrepresentations at the level of the design occurs in *denarii* struck 161/161-162. Here, the only designs to register overrepresentations are the Providentia designs struck on the separate coinages of Aurelius and Verus, which were found to be overrepresented in Italy (for Aurelius) and the Western Danube (Verus). The results are not perfect: Italy's overrepresentation of Providentia *denarii* occurs only in the 192 subset, while in the Western Danube, it is overrepresented only in the final group of hoards closing up to *c.* 250 (the three preceding subsets, for hoards closing up to 180, 192, and 211, returned normal readings), but they nevertheless correspond with overrepresentations in the same regions at the level of the issue (see **Tables 4.1-4.5**, above). There, too, Italy and the Western Danube were the only regions to return standardised residuals signifying a general overrepresentation of coins of the 161/161-162 period.

Britain, too, returned overrepresentations at the level of the design. One of these – the overrepresentation of coins struck for Commodus Caesar *c.* 175/175-176 – accords with a corresponding overrepresentation at the level of the issue, and might be connected to larger shipments of coins being sent to the province to finance the army, since the province was still in a state of upheaval. Whether there was an added ideological angle to sending a large number of *denarii* bearing the portrait of Commodus is unclear, although it is easy to understand the rationale behind a potential desire to push the image of the Caesar on a province that contained so many soldiers (note the timing, in *c.* 175: this coincides with an effort by Aurelius to promote the image and person of Commodus in the east, in the wake of the Avidius Cassius affair: see **footnote 56**, above). The χ^2 tests were unable to detect correspondences between overrepresentations at the level of the design and the issue for the four other periods for which Britain returned design-level overrepresentations – these being 161-164 (Lucilla), *c.* 164-180 (Lucilla), 168/168-169, and 169/169-170. Quite the opposite: in two of these periods –161-164 and 168/168-169 – overrepresentations at the level of the design crop up in regions *other than* Britain.[68]

Dissonances in the locations of overrepresentations at the level of the design and of the issue are not necessarily a problem. The same phenomenon has been noted in each of the previous reigns, and the explanation offered in their case applies here, too: *i.e.,* there is no reason why the state cannot have sent significant portion, if not most, of a single issue to one pre-arranged region, while reserving discrete batches from the same issue for dispatch to other regions for any number of reasons.

Instead of focussing solely on instances where the data for designs and issue periods do not align, we should pay equal attention to the way in which the data for Aurelius' reign – despite its various deficiencies – allowed us to see that regional overrepresentations at the level of the design do accord with overrepresentations at the level of the issue, *e.g.,* in the case of *denarii* struck *c.* 161/161-162, where an issue-level concentration in Italy is matched at the level of the design by an overrepresentation of Providentia *denarii* struck for Aurelius. Whether this signifies that an overrepresentation at the level of the <u>design</u> is the cause of an overrepresentation at the level of the <u>issue</u> is a matter for debate; in the case of 161/161-162, the data (see **Table 4.11**, below) show that Providentia was the single most prolific design – in purely numerical terms – on the silver coinage of both Aurelius and Verus, being present on a combined total of 1,282 *denarii* from this study's dataset (or 65% of the total 1,960 *denarii* for both emperors).[69] If the frequency at which a design appears in an empire-wide dataset of hoarded coins can be taken as an indication of the overall quantity in which that design was

---

[68] Britain was the only region to return an overrepresentation for the coins of 161-164 at the level of the issue, and one of two (including Spain) to have done so for 168/168-169. At the level of the design, however, only the Rhine and Italy returned overrepresentations – both for Fortuna (*RIC* III 185, 204-205, 586).

[69] Only the posthumous coinage struck for Divus Antoninus Pius rivals this, but this category is in fact an amalgamation of several designs that were merged for the purpose of testing. The bulk is formed of eagle designs (*RIC* III 429-443) and pyre designs (*RIC* III 435-436, 438) eagle designs, totalling 752 and 816 specimens respectively.

originally struck, then it is reasonable to suppose that Providentia represented the single greatest design by quantity struck in the years 161/161-162 – and that, therefore, they probably lie behind the issue-level overrepresentations we see for Italy and the Western Danube across these years.

Table 4.11: per-region totals for designs struck 161-162								
	Britain	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Aurelius								
Clasped hands	1	0	0	0	0	1	0	**2**
Concordia	33	43	25	54	103	351	17	**626**
Felicitas	0	1	1	2	1	12	2	**19**
Togate Aurel	1	0	1	0	0	2	1	**5**
Providentia	30	39	30	59	108	372	18	**656**
Verus								
Clasped hands	0	0	0	1	0	0	0	**1**
Concordia	1	0	1	5	3	15	1	**26**
Togate Verus	0	0	2	0	0	2	0	**4**
Providentia	28	33	17	53	133	340	17	**621**
Divus Pius								
Various	112	115	84	129	384	1300	54	**2178**
Qty	**206**	**231**	**161**	**303**	**732**	**2395**	**110**	**4138**

iv. Summary

Testing carried out at the level of the issue was the most productive part of this analysis because a) there were enough coins to guarantee testing of most regions in almost all issue periods; b) the turbulent nature of the reign reveals itself not just in where the state was sending this or that design (evidence for this is limited, anyway, on account of limited sample sizes barring testing), but, arguably, where it was prioritising overall coin supply in response to particular crises, *e.g.*, the British and Danubian theatres.

As in previous chapters, the standard deviations (range, average) for each subset of hoards were compared. The trend observed previously emerged here, too: *i.e.*, more interregional variance was suggested by the range and average of the standard deviations in the hoards closing by 180 than in the complete dataset of hoards closing up to *c.* 250, possibly indicating a gentle flattening of interregional difference as time wore on. However, distributional imbalances and concentrations at the level of the issue were not eradicated altogether: many of the regional overrepresentations observed in the earlier subsets (180, 192) continued to manifest in the subset of hoards closing by 211 and the complete dataset of hoards closing as late as *c.* 250.

Comparison of the standard deviations at the level of the issue for the final hoard group (*c.* 250) with the same from earlier reigns confirms the established pattern: *i.e.*, the coins of Trajan are more mixed than those of Hadrian and so on, likely reflecting the amount of time they spent in circulation relative to each other (see **Figures 4.14-4.17**). Aurelius' *denarii* fit this trend, but they are less mixed than we might have expected them to be – either a possible consequence of the Severan debasement of 194, which likely accelerated the withdrawal of *denarii* from circulation, and/or the decline in output from *c.* 170 onward that might have encouraged people to withdraw coins at a greater rate than earlier in the century. The possible impact of a gradual decline in economic integration (one factor of which is coin circulation), foreshadowing the greater fragmentation of the third century, might also have had a hand in slowing the degree of mixing.

Britain and Italy again stand out. In Britain, issue-level overrepresentations align with periods of military unrest and may reflect troop movements, such as the arrival of Sarmatians in the mid-170s. In Italy, an overrepresentation of *denarii* struck in 166-167 coincides with the double triumph and *congiarium* of 166 (in celebration of Verus' victories in the east) and is attributable to *denarii* of Verus alone rather than Aurelius, making mere coincidence unlikely. Parts of the Danubian frontier also appear to have been in receipt of a great deal of new *denarii* up to *c.* 166-168 (all in the Western Danube), to be overtaken from *c.* 170 by the Eastern Danube, which returned overrepresentations for the early-mid 170s.

Comparison between the Reka Devnia hoard and the wider dataset suggests higher mint output in the first half of the reign, followed, from *c.* 169/170, by a prolonged period of low output that continues without abatement over the course of the next reign (see **Figure 4.5** and next chapter, **Figure 5.2**). This can probably be ascribed to metal supply pressures, a possible rise in the price of silver, and the destabilising effects of the Marcommanic Wars and – particularly – the Antonine Plague, which does appear to have impacted the state's ability to guarantee the flow of metal from mines in both Spain, Dacia, and the Balkans. The topic of falling mint output will be explored at further length in the next chapter. Suffice it to say that the numbers of coins in hoards plummet in tandem with the apparent fall in mint output – the net effect of which was to make χ^2 testing at the level of the design unviable for many of the later issue periods of the reign. Among the designs that were tested (mostly confined to the years 161-169/170), no obvious instances of targeted distribution were found except the Italian overrepresentation of Verus' *denarii* linked to the triumphal *congiarium* of 166. Indeed, now we are in a position to look back on the preceding chapters, it is clear that, overall, little evidence has come forward to support targeted distribution of *denarii* with the key exception of Italian overrepresentations that are arguably tied to *congiaria*.[70]

There is no evidence that Commodus was emphasised in Italy in a manner similar to the promotion of Aurelius as Caesar under Antoninus. It is possible that this is down to the fact that Commodus' coinage (both as Caesar, *c.* 172-177, and latterly as co-Augustus, *c.* 177-180) is concentrated toward the end of the reign, where the fewest designs were available for testing. Only one regional concentration – in Britain, in the form of *denarii* struck 175-176 – emerged for Commodus (see **Table 4.10**), and even then, only in the complete dataset of hoards closing up to *c.* 250, since none of the earlier subsets produced sufficient coins to permit testing. Even so, it is logical that Aurelius' heir and co-emperor should have been emphasised on the coinage, so it might simply be the case that we are being blinded by a lack of data. We have no way of knowing, for instance, whether or to what degree Commodus' tour of the east

[70] To these can be added possible – but statistically unproven - evidence for a shipment of *denarii* bearing accessional types to Trajan in Germany in early 98 (**Chapter 1**, **pp. 68-70**).

in the wake of the revolt of Avidius Cassius was accompanied by a drive to promote his image on imperial coinage that was also shipped eastward.

No phenomena could be linked to the coinage of Divus Antoninus – except, curiously, an underrepresentation among the Italian hoards that originates in the subset of hoards closing by 192. This remains visible until the final group of hoards closing by *c.* 250. Faulty data or a lack of coinage do not appear to have been a problem here: *denarii* struck in the name of Divus Antoninus are datable to *c.* 161 and were therefore struck in the part of Aurelius' reign that appears to have produced the greatest volume of coinage. The quantity of Divus Antoninus *denarii* was such that they could be tested in virtually all regions and all hoard groups (180, 192, 211, and *c.* 250), and yet they produced no overrepresentations whatsoever.

The end of this chapter marks the effective conclusion of the interregional χ^2 analyses at both the level of the issue and the design – the first such tests to have attempted a systematic assessment of the distribution of the second-century silver coinages, even at the broadest level. The next chapter, on the silver coinage of Commodus, takes a fundamentally different approach to the evidence, as it seeks to explore and understand why there are too few Commodan *denarii* to permit testing.

Chapter 5: Commodus (180-192)

Introduction

9,046 Commodan *denarii* recorded to the level of the design were downloaded from the CHRE database (**Figure 5.1**). This is by far the smallest of the datasets assembled for any of the reigns in this study – so few, that it was impossible to subject them to χ^2 testing except at the highest level of the issue, and only in the case of the complete dataset of hoards closing up to *c.* 250. The number of coins in each of the subsets was simply too low. After briefly dwelling on the results of these tests, this chapter will take a different course from its predecessors: there will be no discussion of distribution at the level of the issue or of the coin; instead, the bulk of this chapter will instead discuss why so few *denarii* of Commodus were available for analysis in the first place – a problem that has, to date, received too little attention in modern scholarship.

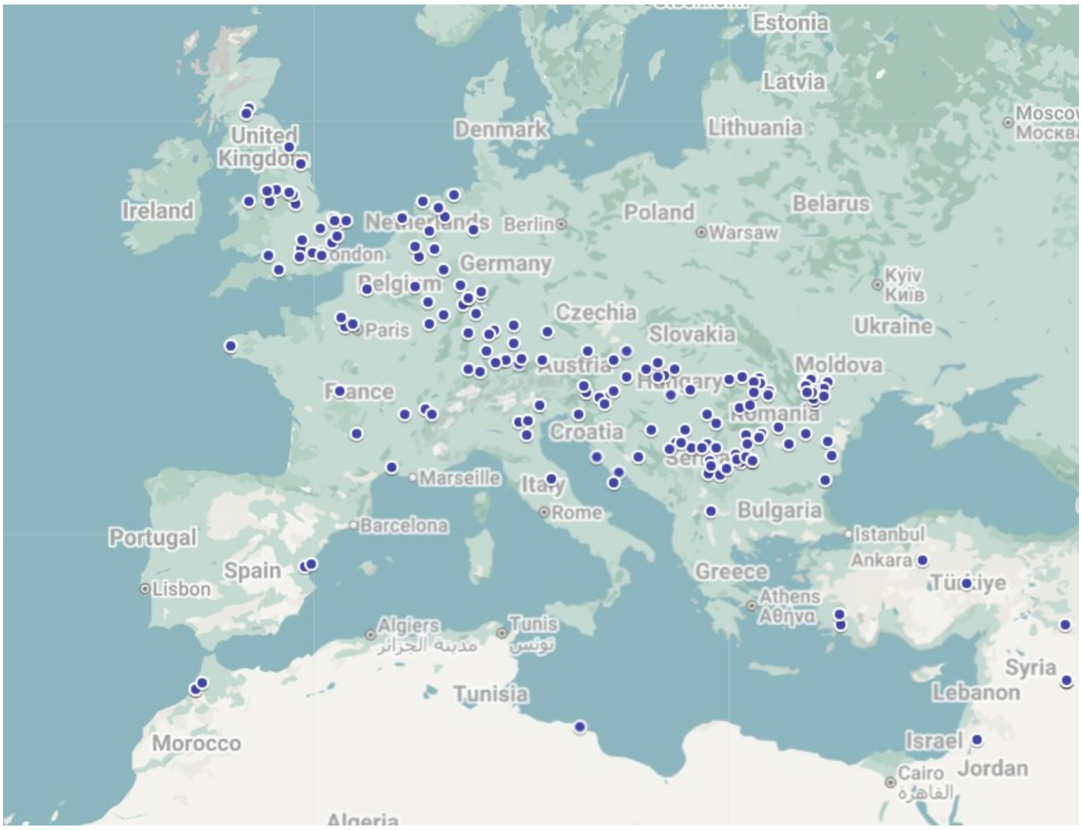

Figure 5.1: hoards containing *denarii* struck under Commodus in this study's dataset that were recorded to the level of the design on the CHRE database at the time of data collection (n=182). Find an interactive version of this map with links to CHRE records at:
https://www.google.com/maps/d/edit?mid=1_peSjwr_cU9FKhNCH9m0kpwof1UrpkA&usp=drive_link

i. The data: problems; results of limited χ^2 tests at the level of the issue

The coinage of Commodus holds plenty of interest, not least for its employment of a varied and, frequently, novel set of types to advance the iconographic programme of the reign.[1] To name a few: Commodus, depicted in heroic guise hunting a lion along with the legend *VIRT AVG* (and variants), *c.* 181-185 (*RIC* III 39, 114, 332, 451-452); *ROMVLO CONDITOR* appears on *denarii* in 184-189 (*RIC* III 204) on *denarii*, 184-189; Apollo as both *PALATINO* (*RIC* III 197, 197A, 206, 218) and *MONETAE* (*RIC* III 559, 569, 584, 594) occurs on all metals *c.* 184-191, as well as a unique depiction of the three *Monetae* (*RIC* III 500) on a *sestertius* of 186-187; Nobilitas (*NOBILIT AVG P M TR P XI IMP VIII COS V P P; RIC* III 139) first appears on *denarii* in 186, stressing Commodus' stellar descent through a line of *augusti* going all the way back to Nerva, and as the first emperor born to a reigning *augustus*; Jupiter, with the novel epithet *exsuperantissimus* (*IOVI EXSVPER;* 'most excellent'), debuts on all metals *c.* 186-187 (*RIC* III 152-153, 508), echoing the use of *exsuperantissimus* on inscriptions dedicated to Commodus around the empire; novel types depicting Janus (*RIC* 141, 460, 479) and Commodus, the latter cast as *PATER SENATVS* (*RIC* III 156-157, 502) and *AVCTOR PIETAT* (*RIC* III 146, 494, 523), appear across all metals at roughly the same time (*c.* 186-187); finally, Fortuna Manens ('abiding Fortune') types appeared *c.* 186-189 (*RIC* III 191, 534, 547), depicting a typical image of a seated Fortuna in the company of a bridled horse, the reason for which is still beyond us.[2] The list goes on. Then, of course, there is the blossoming of Herculean imagery *c.* 190-192, typified by obverse types depicting Commodus in the skin of the Nemean Lion, reverses proclaiming *HERCVLI ROMANO AVG* (and variants) on all metals (*RIC* III 250-254d, 581, 586, 591), and the joining together of Hercules with Commodus' initiative to re-found Rome as

[1] Delegido Morant 2014, pp. 525-541 provides a good overview of the silver types struck for Commodus and their role in the dissemination of an ever-changing imperial image. See also Kaiser-Raiss 1980, Szaivert 1986, and Smith and Niederhuber 2023.
[2] See Noreña 2011b, p. 254 on Nobilitas; Hekster 2002, p. 101 on Jupiter *exsuperantissimus*; Woods 2019 on Fortuna Manens for the theory that she refers to the emperor's survival of an otherwise unknown horse-riding accident.

Colonia Lucia Annia Commodiana. In these types, we see Commodus-Hercules at the head of a team of oxen, ploughing the bounds of a new city, paired with *HERC ROM COND* and *COL L AN COM* (and variants; RIC III 247, 560, 570, 616, 629).[3]

Despite all this, the coinage of Commodus represents a problem from an analytical point of view. The CHRE database yielded only 9,046 Commodan *denarii* recorded to the level of the design, compared to 18,248 for Trajan, 19,755 for Hadrian, 31,841 for Antoninus, and 23,372 for the reigns of Aurelius and Verus. The reasons for this shortage of data will be explored in later sections. For now, it is important to say that a dataset of just 9,046 *denarii* was wholly insufficient to support χ^2 testing at the level of the design, nor was it sufficient to carry out phased testing on discrete groups of hoards according to their terminal dates. Only at the very broadest level – *i.e.*, divided by region and issue period, with no control on hoard terminal date – was it possible to assess regional differences in distribution using χ^2. The results of these tests are presented **Table 5.1**, below.

Table 5.1: *Denarii* in hoards closing up to *c.* 250									
Period	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**	
178-192 (Crispina)	42	82	49	7	77	689	26	972	
179-180	6	24	2	0	6	63	4	105	
180	24	118	33	5	58	404	21	663	
181	15	117	23	5	58	249	11	478	
181-182	26	164	22	5	42	266	15	540	
183	20	118	20	7	60	200	16	441	
183-184	30	133	21	7	56	225	23	495	
184	17	48	10	0	28	89	5	197	
184-185	16	89	13	1	35	156	9	319	
184-189	8	40	12	3	24	57	3	147	
185	41	197	37	6	100	382	25	788	
186-187	50	214	58	6	89	355	16	788	
186-189	7	55	8	1	23	85	7	186	
187-188	15	127	30	2	66	193	11	444	
188-189	14	43	14	0	28	69	10	178	
189	8	36	10	1	16	85	3	159	
190	61	137	60	7	113	339	33	750	
190-191	10	16	7	2	25	42	1	103	
191-192	59	49	35	5	79	179	7	413	
192	80	153	68	7	130	416	26	880	
Qty	549	1960	532	77	1113	4543	272	9046	
Standardised residuals									

[3] See Hekster 2002, pp. 103-106 and pp. 146-162 on Commodus as both Hercules and gladiator.

Table 5.1: *Denarii* in hoards closing up to *c.* 250									
χ^2 = 350.14, df = 90, p-value < 2.2e-16									
Period	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Avg**	**St Dev**
179-180	-0.2433	-0.1294	-1.7230	-	**-2.0596**	1.7477	0.4297	-0.3297	1.4053
180	**-2.7196**	**-2.9313**	-1.0658	-	**-2.9458**	**4.8920**	0.1715	-0.7665	3.0410
181	**-2.7181**	0.5686	-1.0387	-	-0.4138	1.4038	-0.9286	-0.5211	1.4258
181-182	-1.6616	**3.4789**	-1.7933	-	**-3.2510**	0.5799	-0.3423	-0.4982	2.3500
183	-1.4119	1.5996	-1.2106	-	0.5084	-0.6243	0.7276	-0.0685	1.1973
183-184	-0.1436	1.7259	-1.5579	-	-0.9033	-0.6545	**2.0648**	0.0886	1.4756
184	1.2953	0.2596	-0.5483	-	0.4940	-0.6037	-0.4291	0.0780	0.7486
184-185	-0.9082	1.6631	-1.4138	-	-0.9617	0.2296	-0.2482	-0.2732	1.1118
184-189	-0.3608	1.0672	1.1221	-	1.2406	-1.4835	-0.6781	0.1513	1.1481
185	-1.1888	0.9943	-1.4848	-	-0.1236	0.2764	0.1956	-0.2218	0.9425
186-187	0.0923	**2.2492**	1.5717	-	-1.2168	-1.1147	-1.6398	-0.0097	1.6093
186-189	-1.3682	1.7577	-0.9476	-	-0.1944	-0.4345	0.5504	-0.1061	1.1244
187-188	**-2.4414**	**2.2843**	0.6429	-	1.1600	-1.3625	-0.7021	-0.0698	1.7469
188-189	0.8254	0.1895	0.9933	-	1.0321	-1.8068	1.9355	0.5282	1.2733
189	-0.6242	-0.1775	0.1499	-	-0.9852	1.0205	-0.8427	-0.2432	0.7498
190	**2.0605**	**-2.8303**	**2.2626**	-	1.7134	-0.9965	**2.1255**	0.7225	2.1302
190-191	1.4362	-1.5823	0.3659	-	**3.2974**	-0.9526	-1.1945	0.2284	1.8759
191-192	**6.5529**	**-4.7779**	**2.0902**	-	**3.6017**	-1.2487	-1.5650	0.7755	4.0868
192	**3.3554**	**-3.6248**	**2.1085**	-	1.5966	-0.2176	-0.1617	0.5094	2.4458
								Range	3.3382
								Average	1.6783

A note on the test: the 972 *denarii* of Crispina were excluded from analysis on the basis that the internal structure and dating of this coinage remains an open question; conventionally dated to *c.* 178-192, even the compromise dates advanced by scholars like Hekster are still too broad to assign Crispina's coins a place in these tests.[4] The low quantity of *denarii* from Italy (just 77 across the whole reign) also resulted in their exclusion on the grounds that they would

[4] The true size and duration of Crispina's coinage has long been open to question. Mattingly and Sydenham (*RIC* III, p. 135), date Crispina's fall – and, therefore, the end of her coinage – to *c.* 182/183. This was based on an erroneous reading of passages in the *SHA* (Commodus 5.9) and Cassius Dio (73.4.6) that identify her as one of Lucilla's co-conspirators in the unsuccessful plot of 182/183: Hekster 2002, p. 72, n. 181. This would appear to be backed by the fact that Alexandrian tetradrachms struck for Crispina are now understood to date no later than 178-182: *RPC* IV.4, pp. 47-48. The imperial coinage struck at Rome, however, still leaves room for doubt that Crispina's coinage dates to later than 182: if the 1,000 *denarii* gathered by this study for χ^2 testing were all struck in the narrow window between beginning of the reign and Crispina's supposed disgrace in 182/183, they would outnumber the quantity of coins struck for Commodus over the same period. This makes far less sense than a longer period of striking over several more years. When this period ended is up for debate; 188 has been advanced on the basis of Crispina's banishment to Capri, but epigraphic evidence dating as late as 191 suggests that she continued to be honoured as empress until the end of the reign; Hekster 2002, *ibid.*; *CIL* 8.2366; Duncan-Jones 2006, pp. 224-225.

have destabilised the test. Some regions are represented by just one or two hoards: the results for Spain derive entirely from the Llíria hoard (5,990 *denarii* closing 209); the data for Eastern Danube is dominated by the enormous Reka Devnia hoard, which contains 3,743 of the total 4,543 *denarii* we have for the entire region; and, around half of the 272 *denarii* for the Eastern Mediterranean derive from the Tell Kalak (Jordan) hoard alone, with just hoards from six other locations around Turkey, Libya, and Syria sharing the modest number of remaining coins between them.[5]

Turning to the results: the series of underrepresentations across Britain, Spain, and the Western Danube appear to be related to the sizeable overrepresentation in the Eastern Danube for the year 180. Here we might note a potential point of agreement with Duncan-Jones, who observed that *denarii* struck for Divus Aurelius in 180 form a higher proportion of coin finds in Poland, the Balkans, and Syria (where they represent around 8-12% of his database of hoarded Commodan coins), than in the western Empire and Britain (where the figure sits around 1%).[6] Polish hoards have not been tested here, and there is no suggestion in our results that there exists a particular concentration of Divus Aurelius *denarii* in the Eastern Mediterranean, but it is interesting to see that, in the case of the Danubian frontier, the results of the χ^2 tests agree on the presence of a significant number of new *denarii* dating to 180. Duncan-Jones offers no explanation for the existence of a concentration in eastern Europe and the Balkans; at a stretch, we might venture a connection with the peace Commodus concluded along this stretch of the frontier in 180 as a result of his second German expedition. Alternatively, the state might have financed something in this part of the world a little later, hence the overpopulation of *denarii* of 180; Commodus' third German expedition, for instance,

[5] **Turkey**: Erimtan Collection (32 Commodan *denarii*), Kiziltepe (9), Haydere (38), and 'Eastern Turkey' (15): **Libya**: 'unknown findspot' (6). **Syria**: Dura Europos hoards 3, 4, 5, 19, and 21 (17). For more detail on Tell Kalak, see Metcalf 1975.
[6] Duncan-Jones 1999, pp. 75-79.

led to successes in and around Dacia that saw him proclaimed imperator for the fifth time in 182.[7] Both of these suggestions are no more than guesswork.

The remaining over- and underrepresentations presented in **Table 5.1** are just as hard to rationalise with reference to known points on the historical map. Standardised residuals indicating overrepresentation (*i.e.,* a probably significant quantity of incoming new *denarii*) crop up in almost every region in a way that defies explanation within the limits of our present knowledge of the reign. It is very hard to guess at what might lie behind the set of overrepresentations that appear in Spain *c.* 181-182, 186-187, and 187-188, in the Eastern Mediterranean *c.* 183-184, and in all regions except the Eastern Danube over the period 190-192. Given the paucity of reliable written sources for the second century, this is hardly surprising, and it is probably unwise to go to any great lengths to centre explanations for one or another of these results on the few events that are known to us only in an abbreviated form. Only in cases where the relationship between the occurrence of standardised residuals signifying over- or underrepresentation and the mention of (for example) a war or campaign seems to be clear (for instance, the overrepresentations occurring in Britain at the same time as Antoninus' British campaign, *c.* 138-144: see **Chapter 3**, **Table 3.5** and **pp. 126-129**) can such a connection be justified.

It might have been expected that regions which saw major military conflict would have returned standardised residuals indicating significant influxes of new *denarii* as in previous reigns, but the dataset for the reign of Commodus does not offer much on this front. The only significant war of the reign was in Britain (*c.* 180-184), and even this is described in only the sketchiest of terms by the extant sources.[8] As can be seen in the table of results above, χ^2 detected no significant influxes of *denarii* into Britain over the period corresponding with the

---

[7] Kienast 2017, pp. 140-141.

[8] The war was a continuation of the conflict pursued by Aurelius. Cassius Dio 72.8.2-6, 73.8; *SHA* Commodus 6.2, 13.5. Victory in Britain gave rise to the *aes* reverses *BRITT P M TR P VIIII IMP VII COS IIII P P S C* and *VIC/VICT BRIT* (*RIC* III 437, 440, 451-452), as well the addition of *BRIT* to the emperor's suite of titles from *c.* 184.

war itself. Quite the opposite: the standardised residuals suggest that the supply of new *denarii* up to *c.* 181 was underrepresented (*i.e.*, lower) in comparison to the Rhine, Eastern Danube, and Eastern Mediterranean. After this time, and until *c.* 189/190, the quantities of coins for Britain in each year of issue were not sufficient for χ^2 to return results suggesting the arrival of significant quantities of new *denarii*.[9] This could come as a surprise given the army was still fighting a war inside the province, but it might be that the enormous quantities of new (and, presumably, older) *denarii* sent to fund wars under Hadrian, Pius, and Aurelius – most of which will probably have remained in British circulation – did not need topping up.[10] How far the central or provincial governments leaned on redistributive supply of older *denarii* is also uncertain. There is also the consideration that the production of silver appears to have entered a slump in the latter part of the reign of Aurelius that – as will be seen below – carried on into the reign of his son. That being the case, an increased reliance on stocks of older *denarii* would be unsurprising.

There are few other significant military events of the reign about which we have knowledge. The second and third German expeditions of 178/180 and 181-183 have been mentioned above as, perhaps, being associated with the overrepresentation of *denarii* of 180 along that part of the frontier. The so-called *Bellum Desertorum* of the mid-180s appears to have been an insurrection involving dissatisfied elements of the army and populations of Upper

[9] This corroborates research undertaken by Duncan-Jones, who applied standardised percentage residual tests to his own large dataset of Commodan *denarii*. Of particular interest are his set of standardised residuals for Britain, which, in most cases, were in the negative – *i.e.*, suggestive of a dearth of coins in comparison to the other regions under survey: Duncan-Jones 1999, pp. 71-79. Tests based on standardised percentage residuals, also known as Pearson tests, are related to χ^2 in that they also compare actual and expected values to produce a standardised residual value. An χ^2 test differs from (and arguably exceeds) a Pearson test in that it produces a p-value to tell the researcher whether there might be a significant and independent relationship between their variables. The lower the value, the more likely it is that a standardised residual that sits outside the 'normal' range is not the product of random chance, but of something more interesting. See Introduction for a fuller explanation of how χ^2 functions.

[10] Evidence for which is presented in previous chapters; see pp. 100-107 (Hadrian), pp. 118-120 (Antoninus), pp. 182-186 (Aurelius).

Germany which is known to us through the accounts of Herodian (1.10), the *SHA* (Commodus 16.2 and Pescennius Niger 3.3-3.5), and a handful of inscriptions.[11] Despite its possible importance – Commodus was hailed imperator for the eighth time in 186 – there is no suggestion in the results of the χ^2 tests that significant quantities of new *denarii* moved into the region as a result. The same can be said of the poorly understood conflict, recorded by Cassius Dio, that appears to have taken place in and around Dacia *c.* 185, and of an even more obscure border conflict in Africa in which Pertinax, as governor, took a leading role.[12] The fact that none of these conflicts are reflected in the results of the χ^2 tests is either a comment on their size and relative (in)significance, in fiscal terms, or it tells us the state was financing its activities in these areas predominantly in old coinage rather than new.

The seemingly unremarkable quantities of new *denarii* arriving in Britain from the start of the reign appear to persist until *c.* 189/190, after which time χ^2 suggests an uplift in supply that carries on until the end of the reign in 192. This period of relative quiet until the latter two years of the reign is true of most of the other regions under survey (see again **Table 5.1**). Barring a few instances of over- and underrepresentation here and there in various periods and regions, the occurrence of under- and overrepresentations among the χ^2 results is comparatively sparse when compared with those of the preceding four reigns. This might be a product of the smaller size of the Commodan dataset (just 9,046 *denarii*) which might itself be reflective of the number of Commodan *denarii* available in antiquity.

[11] Herodian 1.10; *SHA* Commodus 16.2, Pescennius Niger 3.3-5. Hekster 2002, pp. 65-67, discusses the epigraphic evidence, which includes an inscription recording the award of the honorific *pia fidelis constans Commoda* to the *legio VIII Augusta*.

[12] Cassius Dio (72.8.1) only appears to make passing mention of this Dacian episode because two of its most important participants, Pertinax and Didius Julianus, would later go on to occupy the throne. The fact that Dio mentions it in the same breath as the British war suggests a date in the first half of the reign. Kienast (2017, p. 140), too, accepts this dating. For the African war, see *SHA* Pertinax 4.2; Commodus 13.5.

ii. Where are the coins?

Other studies of second-century coin distribution have made note of the perceptible decrease in the available quantity of Commodan *denarii* in comparison to those of previous reigns. Duncan-Jones and Depeyrot and Moisil all believed that the relative quantities of *denarii* per reign in their respective datasets to be a good indicator of the total quantities of coins originally struck; Duncan-Jones was speaking of an amalgamated dataset of nearly 100,000 hoarded *denarii*; Depeyrot and Moisil of the Frâncești (Romania) hoard of 1,365 *denarii* closing in 219.[13] Both studies noted a precipitous drop in the quantity of Commodan coins relative to the high points under Antoninus and Aurelius, although neither dwelled particularly long on what might have brought about such a steep fall in output volumes.[14] This is not a phenomenon confined to the *denarii*, output of *aes* also appears to have gone into sharp decline that reached a crescendo in the Severan period, but this was probably influenced by a slightly different set of factors (although the sudden need to produce many more base *denarii* post-194 must have played a part).[15]

Figure 5.2, below, shows the frequency of *denarii* per annum in both the Reka Devnia hoard and the rest of the dataset for Aurelius and Commodus. It is striking for two reasons: the first and most obvious is how closely both datasets mirror each other. That the frequency of coins per issue (or here, *per annum*) observed in an amalgamated dataset made up of very many hoards should be mirrored so closely by the contents of one, large hoard like Reka

---

[13] Duncan-Jones 1994, Appendix 10, pp. 261-266; Depeyrot and Moisil 2004.
[14] Duncan-Jones 1994, p. 124; Depeyrot and Moisil 2004, pp. 36-*ff.*
[15] It is well known that under the Severans, the mint effectively gave up on supplying *aes* to regions north of the Alps: Abdy 2012, pp. 503-505; Hobley 1998, p. 128. It would not be surprising if this followed difficulties under Commodus. Hobley, speaking of the distribution of Commodan *aes* across the western empire, was forced to conclude that "the low level of [available] coins makes it difficult to make any meaningful comments." Walker (1988, p. 299), on the Bath assemblage, also had trouble, noting a steep drop in the number of coins per annum under Commodus (19.67) when compared with the rest of the second century. This is mirrored in the assemblage from Coventina's Well (Carrawburgh, Allason-Jones and McKay 1985, pp. 52, 55-76 and plate XIV), in the profiles or virtually all Reece's 140 Roman sites from Britain (Reece 1991, pp. 29-38, Table II: *140 Sites Permills*), and by coins recorded on the databases of the PAS and the CHRE project.

Devnia has already been established by Spoerri Butcher and Hellings (2017) and in other chapters of the present study.[16] The second notable feature more closely concerns the data for the reigns of Marcus Aurelius and Commodus. After a period of comparatively high mintage at the beginning of Aurelius' reign, *c.* 161-162, volumes appear to have declined to a much lower level beginning in the later 160s. Under Commodus, this decline was punctuated by relatively brief spikes at the beginning, in the middle, and at the end of the reign, but these hardly amounted to a return to previous volumes. In general, the *denarii* of Commodus are by far the least common of any reign of the second century, lower even than the volumes implied by the frequencies of Trajanic and Hadrianic *denarii* at the other end of the century.

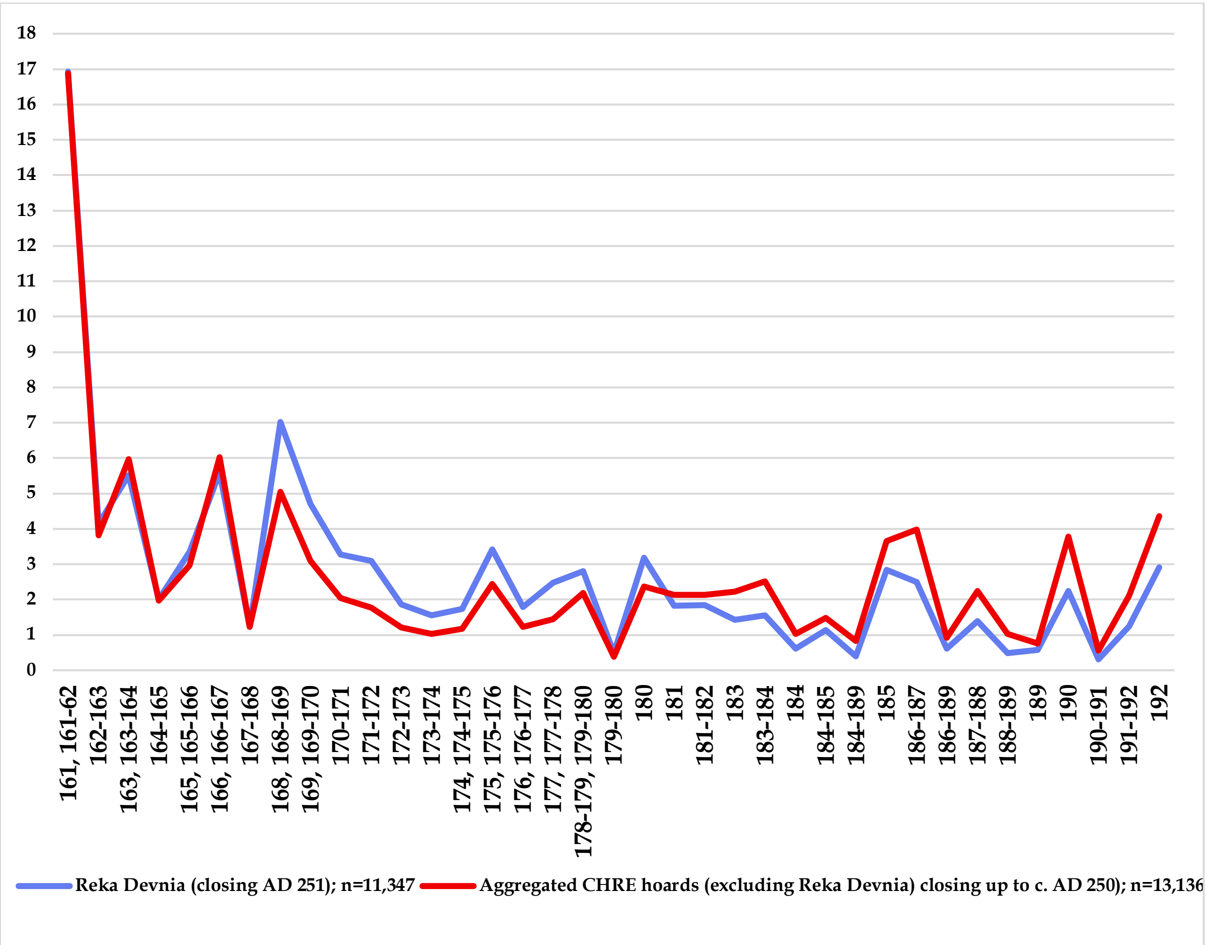

Figure 5.2: Relative frequencies of denarius issues of Aurelius and Commodus, expressed as percentage of the total number of coins in each dataset

[16] Spoerri Butcher and Hellings (2017, esp. figures 1-4) See earlier chapters of this study for similar results for the reigns of Trajan, Hadrian, Antoninus, and Aurelius.

How and when this scarcity manifested itself is open to question, but we should immediately reject any notion that the assassination of Commodus and his subsequent damnation by senatorial decree in 193 (Cassius Dio 74.2) has anything whatsoever to do with it. Few people would credit the Roman state with the ability to withdraw and recycle coins on such a scale. Even if it wanted to, there was insufficient time following the 193 decree for the state to have made much impact before the rehabilitation of Commodus' memory under Septimius Severus in 195.[17] A more serious line of enquiry relates to the impact of the downturn of production from the late 160s, and the Severan debasement of 194, both of which probably led to significant withdrawals of second-century coins.[18] When and at what pace people began withdrawing older, finer *denarii* from circulation in the years following the debasement has been a matter of debate, with some sides favouring the years immediately following the event, *c.* 194-200, while others have advanced dates as late as the mid-third century.[19] Regardless of the date, however, there is nothing in the fabric of *denarii* struck during the reign of Commodus that that might have enticed private individuals or the state to withdraw them at

[17] On the outlawing of coinage in the Roman period, see Heinrichs 2007. Epigraphic and numismatic sources demonstrate that as early as 195, Septimius Severus had effectively reversed the edict of damnation by deifying Commodus and placing himself and his sons within the lineage of the Antonine house: see Hekster 2002, pp. 189-195. Language used in a dedicatory inscription in North Africa (*CIL* 8.9317), lauding Severus as *divi Commodi fratri*, mirrors Cassius Dio's claim (76.7.4) that Severus caused anxiety among senators by styling himself as the brother of Commodus. *Sestertii* and *dupondii* dated *c.* 195-196, bearing the reverse legend *DIVI M PII F P M TR P III COS II P P S C*, also stress Severus' claim to descent from Aurelius and his predecessors: *RIC* IV.1 (Septimius Severus) nos. 686, 700-702, 712.

[18] Gitler and Ponting 2003 (esp. pp. 55-57); Butcher and Ponting 2012, pp. 76-77 and 2022, p. 277. In 194, the mint moved from an average fineness of around 67% to a new low of around 45%.

[19] Many hoards closing with pre-Severan emperors of the second century could, of course, have been closed as early as 194/195; one perfectly legitimate view is that hoards solely or mainly composed of pre-reform *denarii* are of an earlier date than those containing ever greater proportions of post-reform Severan *denarii* and radiates of the 240s and 250s (see *e.g.,* Murphy 2020, pp. 146-149). Another (not necessarily incompatible) view, articulated by Butcher and Ponting (2022), holds that purer pre-reform and baser post-reform *denarii* temporarily co-existed as two more-or-less separate denominations, with mass withdrawal and hoarding of the earlier *denarii* only truly getting underway in the decade or two following 200 when the quantity of baser post-reform *denarii* entering circulation had finally reached a critical mass. The fact that many hoards contain both 'good' pre-reform *denarii* and varying quantities of 'bad' post-reform Severan *denarii* and radiates dating is not necessarily proof that people did not, or did not continue, to discriminate between different grades of silver coin (if ever they did).

a different rate from those of the reigns that came before.[20] We now know – *contra* Walker (1977) – that the silver standard to which Commodus' *denarii* were struck was virtually identical to the standard maintained by Aurelius, which was itself only around 10-12% less fine than those struck up to the last significant debasement in 156-157.[21] The inescapable conclusion must be that Commodan *denarii* will have been withdrawn at more or less the same rate as those of Aurelius and Antoninus – not to mention the other emperors of the second century – whose surviving *denarii* well outnumber those of Commodus.

Any attempt to pin the absence of Commodan *denarii* on withdrawals from the 170s and/or in the wake of the debasement of 194 is to look at the problem from the wrong direction: it is precisely *because* considerable numbers of second-century *denarii* ended up in hoards that we possess the present dataset.[22] People could only withdraw what was available to them at the time; the hoards they created should, therefore, be viewed as a respectable representation of the general mixture of second-century silver that was still around.

The table in **Annexe 5** shows the proportions at which the *denarii* of Antoninus, Aurelius, and Commodus occur in 184 hoards closing *c.* 180-260. This table is long, and it is not necessary to examine every line of data. Rather, it is important to understand that the Commodan portion of these hoards is normally smaller, in proportional terms, than the

[20] The state habitually used older coins as a source of silver from the time of Nero onwards: Butcher and Ponting 2014, pp. 224-226.

[21] Butcher and Ponting 2014, p. 701: the mint under Nero reduced the silver purity of the *denarius* to around 80% in 64. In 68, purity was revised upward to 90%, only to fall back to 80% until Domitian's return to a very fine coin on the pre-Neronian standard in 82. This experiment ended around 85, with the *denarius* reverting to 90% fine until 100, when the mint under Trajan finally settled on the first Neronian standard of 80%. This is essentially where the *denarius* remained through the reigns of Trajan, Hadrian, and Antoninus Pius until 156-157, at which time there was a significant reduction to a new standard of around 70%. This was possibly followed by one further reduction to 67% under Aurelius around 178-179: Butcher and Ponting 2012, pp. 72-75, and 2014, pp. 452-460 and figures 9.4, 12.1, 13.2, 14.4, 14.8.

[22] 162 (73%) of the 219 hoards containing Commodan material in this study's dataset terminate on or after 194. Many more containing coins struck pre-194 might have been sealed or deposited after this time. The commencement and pace of mass withdrawals following the Severan debasement has been the subject of debate: see above, **footnote 19**.

portions made up of earlier *denarii* struck for Antoninus and Aurelius. This is as true of hoards closing near the beginning of this period (180) as it is of hoards that close 20, 30, or even 50 years later. Taken together, the average size of the Commodan portion of these hoards is just 4.62% – smaller, by quite some margin, than the average size of the portions composed of *denarii* of Antoninus and Aurelius, which come in at 14.44% and 10.60% respectively. **Table 5.2**, below, condenses all this information, showing that the proportions of *denarii* of all three reigns declines as closing dates extend further into the third century. Even so, and regardless of closing date, the proportional relationship between reigns never changes: *denarii* of Antoninus almost always form the greater part, followed by Aurelius, with Commodus always at the bottom.

Table 5.2: Average quantities of *denarii* (%) of Antoninus, Aurelius, and Commodus in hoards closing *c.* 180-260

***Denarii* in hoards closing**	**Antoninus Pius**	**Marcus Aurelius**	**Commodus**
180-200	23.01	18.36	5.60
200-220	18.67	10.97	6.43
220-240	8.81	6.49	4.15
240-260	2.88	3.05	1.77
All hoards, 180-260	*14.44*	*10.60*	*4.62*

The contents of the Reka Devnia hoard, which were compared to the amalgamated total of *denarii* drawn from the CHRE database in **Figure 5.2** above, shows how one large hoard can mirror the relative quantities at which coins of each reign occur in a large dataset composed of many dozens of hoards. **Table 5.3** gives the total number and proportion of *denarii* for the reigns of Antoninus, Aurelius, and Commodus in the 12 largest hoards (those containing 2,000 or more coins) in this study's dataset. In all but four hoards, the proportion of Commodan *denarii* is far lower than those of preceding two reigns.[23]

[23] Of these four, Jablanica and Krog (closing 249 and 259), contain virtually no *denarii* at all (including Severan *denarii*), which is hardly unusual for late hoards mainly composed of radiates of the 240s and 250s. The Abrud hoard (251-252), with a similarly late closing date, contains as many Commodan *denarii* as the rest of the first and second centuries combined – unusual in the context of the other hoards in this table, but it is hard to say with confidence what should be read into this. The fourth hoard is Llíria

Table 5.3: number and proportion of Antonine, Aurelian, and Commodan *denarii* in the 12 largest hoards (containing 2,000 or more coins) in the dataset								
			Antoninus		Aurelius		Commodus	
Hoard and CHRE no.	*tpq*	**Hoard total**	**Total *denarii***	**As % of hoard total**	**Total *denarii***	**As % of hoard total**	**Total *denarii***	**As % of hoard total**
Măgura (5275)	196-197	2830	617	**21.80**	341	**12.05**	74	**2.61**
Llíria 1999 (12824)	209	5990	1387	**23.16**	1469	**24.52**	1952	**32.59**
Čortanovci (16532)	210-213	2459	527	**21.43**	308	**12.53**	112	**4.55**
Kecel I (5281)	214	2596	858	**33.05**	733	**28.24**	303	**11.67**
Tell Kalak (5252)	222-225	2350	470	**20.00**	377	**16.04**	141	**6.00**
E. of England (580)	231	3124	329	**10.53**	172	**5.51**	1	**0.03**
Köln 1909 (5289)	236-238	22500	386	**1.72**	258	**1.15**	121	**0.54**
Jablanica (2799)	249	2211	1	**0.05**	1	**0.05**	3	**0.14**
Reka Devnia (3406)	243-251	101096	13717	**13.57**	11989	**11.86**	3743	**3.70**
E. Turkey (4843)	249-251	2711	87	**3.21**	72	**2.66**	15	**0.55**
Abrud (3133)	251-252	2060	33	**1.60**	26	**1.26**	73	**3.54**
Krog (8090)	259	2290	-	**-**	-	**-**	1	**0.04**

An inspection of the numbers of *denarii* emerging from hoards outside the empire, in the European Barbaricum, yielded the same results. Of a combined total of 21,371 *denarii* from hoards in Denmark, Poland, Belarus, Moldova, and Ukraine, issues of the reign of Antoninus were by far the most common, at 9,366 *denarii*. Compare this with 8,473 *denarii* struck for Aurelius, and 3,532 of Commodus.

The driving point to all this is that the *denarii* of Commodus must surely have been less available to hoarders than those of his immediate second-century predecessors, and that this lack of availability cannot be laid at the door of factors such as withdrawals triggered by *e.g.* the decline in mint output in the later second century or the Severan debasement. These events, on the contrary, are the main reason for the withdrawal and hoarding of many second-century *denarii* in the years and decades either side of the turn of the third century: people removing second-century coins from circulation were, after all, simply drawing on what was available to them at the time, and presumably in a manner that reflected the general mixture

(closing in 209), which, unusually, contains roughly the same number of Commodan coins (1,952) as are present for Antoninus (1,387) and Aurelius (1,469).

of reigns that was then available.[24] It therefore follows that if Commodan *denarii* are noticeably less common among hoards of second-century *denarii* that are likely to have been created in the later second century and into the Severan period, the unavoidable conclusion must be that his silver coinage was significantly smaller than has been acknowledged by all but a handful of scholars to date.

iii. The size of the coinage

How much smaller was Commodus' silver coinage? On a superficial level, it might be noted that *RIC* III lists far more *denarius* types for Aurelius than for Commodus (514 and 274 respectively), even though their reigns were of comparable lengths (19 and 12 years). This difference could imply a smaller coinage, but it goes without saying that fewer types in *RIC* do not necessarily mean a drop in output occurred. No sensible person would say that Tiberius' *PONTIF MAXIM* coinage was small on the grounds that it has only three references in *RIC* I, for instance.

A better indication of size would be provided by counting the total number of dies known for each type as the basis for an estimation of the original die population. In order to gain an idea of the results such an exercise might yield, the author of the present study selected 40 records from the Online Coins of the Roman Empire (OCRE) website for further examination. These 40 records represent the same number of *RIC* types, and, between them, contain total of 564 images. The selection was made more or less at random, with the only criteria being: 1) that each record should contain at least two pictured coins; 2) that the records/types selected should date to all parts of the reign in order to guarantee even

[24] Brickstock 2024, p. 19, notes that *denarii* of Trajan and Aurelius were being used to create coin moulds in the third-century Lingwell Gate and Fulford assemblages, which he dates to the 230s and 240s, if not later.

coverage; and 3) that records/types in the names of all members of the imperial family should also be selected.

The coins in question come from institutions that share their images with the OCRE project, prominently the PAS in England and Wales, the British Museum, the Fitzwilliam Museum, the American Numismatic Society, and the Valencian Museum of Prehistory. These are joined by various other American, German, Austrian, and Swiss museums and university collections. Provenances vary: all PAS coins have a findspot within England and Wales. All the images from the Valencia Museum belong to the Llíria hoard from eastern Spain.[25] Some of the coins from the collection of ANS originate from the Tell Kalak (Jordan) and Larnaca (Cyprus) hoards.[26] No findspots or provenances of any kind are given for the remaining coins. Some – *e.g.,* those from German museums or the British Museum – might have been found locally or regionally, but this cannot be assumed, and many will have come from much further afield.

The pictures within each record were manually compared against each other in the hope of locating die links. The more die links, the greater the possibility that we are dealing with a smaller coinage. Conventional wisdom would have it that even one or two confirmed die links among an essentially random group of second-century imperial *denarii* from a reign of the length of Commodus would be of interest. The results of this relatively small-scale die survey speak for themselves: this exercise alone yielded 69 instances of shared dies between 138 coins within 24 of the 40 types selected for examination, or 24.4% of the 564 coins surveyed. Most die-links occur between two coins at a time but on occasion (*e.g.*, *RIC* III 168(a) and *RIC* III 237) there are instances of links occurring between small groups of three to five coins. The full list of die links, ordered chronologically and by *RIC* reference, is presented in **Table 5.4**, below. For interest, the alleged scarcity of each type, noted in *RIC* III, is given along

[25] CHRE no. 12824.
[26] CHRE nos. 5282 (Tell Kalak) and 5263 (Larnaca).

with the *RIC* reference. The number of images per OCRE record is also given – these occasionally stand at variance with a type's supposed scarcity, and it is to records containing the highest numbers of pictured specimens (*e.g. RIC* III 9(a) and 241) that some of the greatest die link totals belong.

Table 5.4: die links among Commodan *denarii* with images on OCRE

Date	*RIC* ref. and scarcity rating	Qty. images on OCRE	Die links
178/180 -191	276 (S)	11	O: *CRISPINA AVGVSTA.* R: *CERES.* Ceres standing left. **No links**
	278 (S)	9	O: *CRISPINA AVGVSTA.* R: *CONCORDIA.* Concordia standing left. **No links**
	283 (S)	13	O: *CRISPINA AVGVSTA.* R: *IVNO.* Juno standing left. **No links**
	286a (S)	14	O: *CRISPINA AVGVSTA.* R: *VENVS.* Venus standing left. **No links**
180	9(a) (C)	17	O: *M COMMODVS ANTONINVS AVG.* R: *TR P V IMP IIII COS II P P.* Trophy and captives. 1. ANS 1944.100.49668 = Llíria, Valencia 40054 (**obv and rev**) 2. Llíria, Valencia 40051 = Göttingen University AS-02290 (**obv**) 3. Llíria, Valencia 40053 = Albert-Ludwigs University 02574 (**obv**) 4. ANS 1944.100.49668 = Llíria, Valencia 40054 (**rev**) 5. Vienna RÖ 13203 = Albert-Ludwigs University 02574 (**rev**) 6. Llíria, Valencia 40047 = Llíria, Valencia 40048 (**rev**)
	266 (C)	10	O: *DIVVS M ANTONINVS PIVS.* R: *CONSECRATIO.* Eagle standing left. 1. Llíria, Valencia 44800 = PAS SOM-9F66C1 (**obv and rev**)
	267 (S)	14	O: *DIVVS M ANTONINVS PIVS.* R: *CONSECRATIO.* Eagle standing left. **No links**
	269 (C)	33	O: *DIVVS M ANTONINVS PIVS.* R: *CONSECRATIO.* Eagle standing right. **No links**
	271 (S)	11	O: *DIVVS M ANTONINVS PIVS.* R: *CONSECRATIO.* Eagle standing left. **No links**
	272 (S)	24	O: *DIVVS M ANTONINVS PIVS.* R: *CONSECRATIO.* Eagle standing right. 1. Llíria, Valencia 44842 = PAS GLO-5A576B (**obv and rev**) 2. Llíria, Valencia 44838 = ANS 1948.19.1334 (**rev**) 3. Llíria, Valencia 44846 = Llíria, Valencia 44848 (**rev**)

Table 5.4: die links among Commodan *denarii* with images on OCRE			
Date	***RIC* ref. and scarcity rating**	**Qty. images on OCRE**	**Die links**
			4. Llíria, Valencia 44844 = Llíria, Valencia 44852 = Llíria, Valencia 44845 = BM 1935,0708.1 (**rev**)
	273 (S)	22	O: *DIVVS M ANTONINVS PIVS.* R: *CONSECRATIO.* Eagle standing right. 1. ANS 1944.100.49140 = BM 1969,1204.5 (**obv**) 2. Llíria, Valencia 44857 = Albert-Ludwigs University 02626 (**rev**) 3. Frankfurt University T0643 = Bonn University R.29.097 (**rev**) 4. Albert-Ludwigs University 02590 = Rostock University R1081 (**rev**)
	275 (S)	13	O: *DIVVS M ANTONINVS PIVS.* R: *CONSECRATIO.* Funeral pyre. **No links**
	10 (C)	3	O: *M COMMODVS ANTONINVS AVG.* R: *LIB AVG TR P V IMP IIII COS II P P.* Liberalitas standing left. 1. BM 1937,0607.32 = British Museum R.14147 (**rev**)
181	12 (C)	8	O: *M COMMODVS ANTONINVS AVG.* R: *TR P VI IMP IIII COS III P P.* Roma seated left. 1. BM 1843,1024.369 = PAS NCL-30DA23 (**obv**)
	14 (C)	6	O: *L AVREL COMMODVS AVG.* R: *TR P VI IMP IIII COS III P P.* Roma seated left. **No links**
	15B (C)	2	O: *L AVREL COMMODVS AVG.* R: *TR P VI IMP IIII COS III P P.* Felicitas standing left. 1. Tell Kalak, ANS 1956.127.1123 = ANS 1995.11.315 (**rev**)
	17 (C)	8	O: *L AVREL COMMODVS AVG.* R: *TR P VI IMP IIII COS III P P.* Pax standing left. 1. ANS 1944.100.49671 = ANS 1944.100.49672 (**obv**)
	19 (C)	7	O: *L AVREL COMMODVS AVG.* R: *TR P VI IMP IIII COS III P P.* Providentia standing left. **No links**
181-182	26B (C)	5	O: *M ANTONINVS COMMODVS AVG.* R: *TR P VII IMP IIII COS III P P.* Roma seated left. 1. Tell Kalak, ANS 1956.127.1129 = Tell Kalak, ANS 1956.127.1130 (**obv**)
	36A (C)	17	O: *M COMMODVS ANTONINVS AVG.* R: *LIB AVG V TR P VII IMP IIII COS III P P.* Liberalitas standing left. 1. Larnaca, ANS 1911.23.359 = Phillipps University MR 336 (**rev**)
	106C (C)	7	O: *COMM ANT AVG P BRIT.* R: *ANN P M TR P X IMP VII COS IIII P P.* Annona standing left. 1. Göttingen University AS-02305 = Ruhr University M2589 (**obv and rev**)
184-185	117(a) (C)	7	O: *COMM ANT AVG P BRIT* R: *P M TR P XI IMP VII COS V P P.* Jupiter seated left. 1. Albert-Ludwigs University 02590 = Rostock University R1081 (**rev**)
185	122a (C)	5	*O: M COMM ANT P FEL AVG BRIT.* *R: P M TR P XI IMP VII COS V P P.* Victoria advancing left. 1. Tell Kalak, ANS 1956.127.1176 = British Museum BNK,R.609 (**rev**)
	131 (C)	5	*O: M COMM ANT P FEL AVG BRIT.*

Table 5.4: die links among Commodan *denarii* with images on OCRE			
Date	***RIC* ref. and scarcity rating**	**Qty. images on OCRE**	**Die links**
			R: *P M TR P XI IMP VII COS V P P*. Fortuna seated left. **No links**
	139 (S)	10	O: *M COMM ANT P FEL AVG BRIT.* R: *NOBILIT AVG P M TR P XI IMP VIII COS V P P*. Nobilitas standing right. 1. Tell Kalak, ANS 1956.127.1180 = Llíria, Valencia 40919 (**obv**) 2. Tell Kalak, ANS 1956.127.1179 = Llíria, Valencia 40923 (**rev**) 3. Tell Kalak, ANS 1956.127.1180 = Albert-Ludwigs University 02594 (**rev**) 4. Llíria, Valencia 40917 = Fitzwilliam Museum CM.RI.1584-R (**rev**)
	146 (S)	12	O: *M COMM ANT P FEL AVG BRIT.* R: *AVCT PIET P M TR P XII IMP VIII COS V P P.* Pietas standing left. 5. Fitzwilliam Museum CM.RI.1586-R = British Museum R.14191 (**rev**)
186-187	150a (S)	13	O: *M COMM ANT P FEL AVG BRIT.* R: *HILAR AVG P M TR P XII IMP VIII COS V P P.* Hilaritas standing left. **No links**
	152 (S)	9	O: *M COMM ANT P FEL AVG BRIT.* R: *IOV EXSVP P M TR P XII IMP VIII COS V P P.* Jupiter seated left. **No links**
	155 (S)	10	O: *M COMM ANT P FEL AVG BRIT.* R: *NOBILIT AVG P M TR P XII IMP VIII COS V P P.* Nobilitas standing left. **No links**
	157 (S)	31	O: *M COMM ANT P FEL AVG BRIT.* R: *PATER SENAT P M TR P XII IMP VIII COS V P P*. Commodus standing left. 1. BM 1937,0607.41 = Johannes Gutenberg University 505 (**obv**) 2. Llíria, Valencia 44084 = Bonn University R.29.013 (**obv**) 3. ANS 1960.170.377 = Llíria, Valencia 44091 (**rev**) 4. ANS 1944.100.49691 = Swiss National Museum AG.R-2399 (**rev**) 5. Llíria, Valencia 44089 = Llíria, Valencia 44081 (**rev**)
	168(a) (C)	45	O: *M COMM ANT P FEL AVG BRIT.* R: *P M TR P XIII IMP VIII COS V P P*. Libertas standing left. 1. Llíria, Valencia 44221 = Llíria, Valencia 44224 (**obv and rev**) 2. Llíria, Valencia 44220 = Llíria, Valencia 44239 (**obv**) 3. Llíria, Valencia 44201 = Llíria, Valencia 44207 (**obv**) 4. Llíria, Valencia 44229 = Llíria, Valencia 44233 (**obv**) 5. Llíria, Valencia 44218 = Llíria, Valencia 44235 (**obv**) 6. Llíria, Valencia 44203 = Llíria, Valencia 44236 (**obv**) 7. Llíria, Valencia 44200 = Llíria, Valencia 44204 (**rev**) 8. Llíria, Valencia 44216 = Llíria, Valencia 44229 = Llíria, Valencia 44233 (**rev**) 9. Llíria, Valencia 44225 = Llíria, Valencia 44228 (**rev**) 10. Llíria, Valencia 44205 = Llíria, Valencia 44239 (**rev**) 11. Llíria, Valencia 44201 = Llíria, Valencia 44202 (**rev**) 12. Llíria, Valencia 44209 = Llíria, Valencia 44223 (**rev**) 13. Llíria, Valencia 44219 = Llíria, Valencia 44226 (**rev**) 14. Llíria, Valencia 44220 = PAS WMID-8A8E02 (**rev**) 15. Llíria, Valencia 44218 = Llíria, Valencia 44231 (**rev**)

Table 5.4: die links among Commodan *denarii* with images on OCRE			
Date	***RIC* ref. and scarcity rating**	**Qty. images on OCRE**	**Die links**
187-188	169 (S)	9	O: *M COMM ANT P FGEL AVG BRIT.* R: *P M TR P XIII IMP VIII COS V P P.* Salus seated left. 1. Kiel University AG047 = Fitzwilliam Museum CM.RI.1598-R (**rev**)
	176 (S)	10	O: *M COMM ANT P FEL AVG BRIT.* R: *MIN VICT P M TR P XIIII COS V P P.* Minerva standing left. 1. Llíria, Valencia 44299 = Tell Kalak, ANS 1956.127.1200 (**rev**)
188-189	191a (S)	7	O: *M COMM ANT P FEL AVG BRIT.* R: *FORTVNAE MANENTI C V P P.* Fortuna seated left. 1. ANS 1995.11.306 = PAS BM-AA3304 (**rev**)
190	205 (S)	11	O: *M COMM ANT P FEL AVG BRIT P P.* R: *APOL MONET P M TR XV COS VI.* Apollo standing right. 1. Bonn University R.29.020 = Göttingen University AS-02320 (**obv**)
	224 (C)	20	O: *M COMM ANT P FEL AVG BRIT P P.* R: *ROM FEL P M TR P XVI COS VI.* Roma seated left. 1. BM 1844,0425.1366 = ANS 1944.100.49708 (**obv**) 2. Llíria, Valencia 44564 = ANS 1948.19.1398 (**rev**) 3. Llíria, Valencia 44567 = Fitzwilliam Museum CM.RI.1610-R (**rev**)
190-191	233 (C)	15	O: *L AEL AVREL COMM AVG P FEL.* R: *P M TR P XVII IMP VIII COS VII P P.* Fides standing left. **No links**
192	235 (C)	10	O: *L AEL AVREL COMM AVG P FEL.* R: *P M TR P XVII IMP VIII COS VII P P.* Fortuna Felix standing left. **No links**
	237 (C)	43	O: *L AEL AVREL COMM AVG P FEL.* R: *P M TR P XVII IMP VIII COS VII P P.* Victoria advancing left. 1. BM BNK,R.617 = ANS 1944.100.49716 (**obv**) 2. Llíria, Valencia 44706 = Llíria, Valencia 44686 (**obv**) 3. MFA Boston 12.546 = Tell Kalak, ANS 1956.127.1230 (**rev**) 4. PAS NMS-F11B22 = Tell Kalak, ANS 1956.127.1229 (**rev**) 5. Llíria, Valencia 44697 = Llíria, Valencia 44689 (**rev**) 6. Llíria, Valencia 44687 = Llíria, Valencia 44708 = Llíria, Valencia 44702 = ANS 1944.100.49716 = BM BNK,R.617 (**rev**)
	241 (C)	38	O: *L AEL AVREL COMM AVG P FEL.* R: *LIB AVG P M TR P XVII COS VII P P.* Libertas standing left. 1. Llíria, Valencia 44724 = Llíria, Valencia 44728 (**obv**) 2. Llíria, Valencia 44734 = Bonn University R.29.029 (**obv**) 3. ANS 1944.100.49710 = Llíria, Valencia 44731 (**rev**) 4. Tell Kalak, ANS 1956.127.1222 = Llíria, Valencia 44722 (**rev**) 5. ANS 1960.170.379 = Göttingen University AS-02326 (**rev**) 6. Llíria, Valencia 44733 = Llíria, Valencia 44741 = Göttingen University UK-01278 (**rev**) 7. Llíria, Valencia 44724 = Llíria, Valencia 44728 = Llíria, Valencia 44737 (**rev**)

These are the die links that could be identified among a sample of hoarded and singly found *denarii* on one website. Several points of interest emerged. First, it is striking that so many die links exist between coins from the Llíria (Valencia) hoard.[27] These are to be found on coins dating to almost all years of the reign, with a particularly high number of links belonging to *RIC* III 168(a), struck 186-187 (**Figures 5.3** and **5.4**). The chronological spread of the die links, added to the fact that many of the coins exhibit signs of wear, decreases the likelihood that the Llíria hoard somehow preserves a parcel (or parcels) of coins sent fresh from the mint at Rome. There are, besides, die links between Llíria coins and others from entirely different contexts that cannot be so easily explained away. These include links between Llíria coins and singly found *denarii* recorded by the PAS in Britain (see *e.g., RIC* III 266, 272, and 168(a): **Figures 5.5-5.7**), as well as others held by the American, British, and European museums (*e.g., RIC* III 139, 241, and 273: **Figures 5.8-5.10**).

Figure 5.3: obverse die link between two Llíria hoard *denarii*. *RIC* III 168(a), struck 186-187

Figure 5.4: reverse die link between two Llíria hoard *denarii*. *RIC* III 168(a), struck 186-187

Figure 5.5: obverse and reverse die links between Llíria hoard and British single find PAS SOM-9F66C1. *RIC* III 266, struck 180

[27] The Llíria hoard's abnormal structure has already been commented on: see above, **footnote 23**.

Figure 5.6: obverse and reverse die links between Llíria hoard and British single find PAS GLO-5A576B. *RIC* III 272, struck 180

Figure 5.7: reverse die link between Llíria hoard and British single find PAS WMID-8A8E02. *RIC* III 168(a), struck 186-187

Figure 5.8: reverse die link between Llíria hoard and Fitzwilliam Museum CM.RI.1584-R. *RIC* III 139, struck 185

Figure 5.9: obverse die link between Llíria hoard and Bonn University R.29.029. *RIC* III 241, struck 192

Figure 5.10: reverse die link between Llíria hoard and Albert-Ludwigs University 02626. *RIC* III 273, struck 180

The Llíria hoard is not alone: at the other end of the empire, the hoard from Tell Kalak, Jordan, also contains internal die links (see *RIC* III 26B: **Figure 5.11**), as well as links with a range of coins from Llíria (*e.g.*, *RIC* III 139, 176, 241: **Figures 5.12-5.15**), British single finds (*e.g.*, *RIC* III 237: **Figure 5.16**), and other unprovenanced coins from collections in America and Europe (*e.g.*, *RIC* III 15B, 139, 237: **Figures 5.17-5.19**). The Larnaca hoard, also held by the ANS, likewise shares dies with a coin in the collection of Philipps University, Marburg (*RIC* III 36A: **Figure 5.20**).

Figure 5.11: obverse die link between two Tell Kalak hoard *denarii*. *RIC* III 26B, struck 181-182

Figure 5.12: obverse die link between Tell Kalak hoard and Llíria hoard. *RIC* III 139, struck 185

Figure 5.13: reverse die link between Tell Kalak hoard and Llíria hoard. *RIC* III 139, struck 185

Figure 5.14: reverse die link between Tell Kalak hoard and Llíria. *RIC* III 176, struck 187-188

Figure 5.15: reverse die link between Tell Kalak hoard and Llíria hoard. *RIC* III 241, struck 192

Figure 5.16: reverse die link between Tell Kalak hoard and British single find PAS NMS-F11B22. *RIC* III 237, struck 192

Figure 5.17: reverse die link between Tell Kalak and ANS 1995.11.315. *RIC* III 15B, struck 181

Figure 5.18: reverse die link between Tell Kalak hoard and Albert-Ludwigs University 02594. *RIC* III 139, struck 185

Figure 5.19: reverse die link between Tell Kalak hoard and Museum of Fine Arts, Boston 12.546. *RIC* III 237, struck 192

Figure 5.20: reverse die link between Larnaca hoard and Philipps University MR336. *RIC* III 36A, struck 181-182

Another interesting feature of this investigation was that even small groups of coins yielded at least one die link. See *RIC* III 266, for example: the OCRE record for this type (which was rated 'common' by Mattingly and Sydenham in *RIC* III) contains only ten coins, two of which – one from Llíria and a single find from Somerset – were found to share both obverse and reverse dies (see above, **Figure 5.5**). The OCRE records for *RIC* III 12 and *RIC* III 122a, also rated 'common', contained even fewer coins (eight and five respectively), despite which they each returned a pair of die linked *denarii* from entirely different contexts (**Figures 5.21-5.22**).

Figure 5.21: obverse die link between British Museum 1843,1024.369 (left) and British single find PAS NCL-30DA23 (right). *RIC* III 12, struck 181

Figure 5.22: reverse die link between Tell Kalak hoard (left) and British Museum BNK,R.609 (right). *RIC* III 122a, struck 185

The contrast between *RIC* III's rarity ratings and the ease with which die links were located among the sample of 564 coins surveyed here is a curiosity that begs an answer from the revised edition of *RIC* III which is now (as of 2025) in preparation. Conversely, the *denarii* of Crispina, which Mattingly and Sydenham rated as either scarce or rare, exhibited no die links whatsoever. The number of coins (of all metals) of Crispina reported to the PAS suggests a degree of scarcity when compared to the number of coins struck for Commodus, as do the relative quantities of her *denarii* from both the Llíria and Reka Devnia hoards.[28] A total of 47 *denarii* (these being very nearly all the *denarii* of Crispina pictured on the OCRE website) were examined; the complete lack of die links is either a product of modern factors – *i.e.*, the coins that have been uploaded to OCRE simply do not happen to share dies – or it points to a larger coinage issued over a longer period of time than has traditionally been thought.[29]

The existence of so many die links leads to the almost inevitable conclusion that the present scarcity of Commodan *denarii* does indeed point to a level of output that was far lower than at any point in the preceding century – confirming the picture painted by the relative frequences of coins per annum plotted in **Figure 5.2**, above. Even though overall mintage appears to have been at a much lower level than before, possible peaks and troughs in the volume of output are still discernible, with high points *c.* 180, *c.* 185-187, and 191-192. Curiously, these periods of apparently high(er) output coincide with the years that produced the highest number of die links. A simple year-by-year count of the number of die links shows that over half (49 out of 70) instances of shared dies belong to 180-181 (16), 186-187 (20), and 191-192 (13). See **Figure 5.23**, below:

[28] As of mid-2025, 1,530 Commodan coins of all metals have been reported to the PAS, of which 166 (or 10.84%) are of Crispina. Crispina represents just 4.15% (81 coins) of the 1,951 Commodan *denarii* from the Llíria hoard: Delegido Morant 2014, p. 545. For Reka Devnia, the figure is higher: 596 out of 3,743 *denarii* (or 15.92%). This figure is matched by this study's own dataset, where *denarii* of Crispina number 972 (10.74%) of the overall total of 9,046 Commodan *denarii*. Discussions pertaining to the size and duration of Crispina's coinage were summarised above: see above, **footnote 4**.

[29] Two *denarii* of the *DIS GENITALIBVS* reverse type (*RIC* 281b) sharing both obverse and reverse dies, kindly shown to the author by Pablo Cerdà Insa (University of Valencia), demonstrate the existence of die links among denarii of Crispina. One, lacking a known provenance, comes from the open market (Münzen und Medaillen, Auction 45, 9.6.2017, lot 750); the other, now in a private collection, was reportedly found in Apulia.

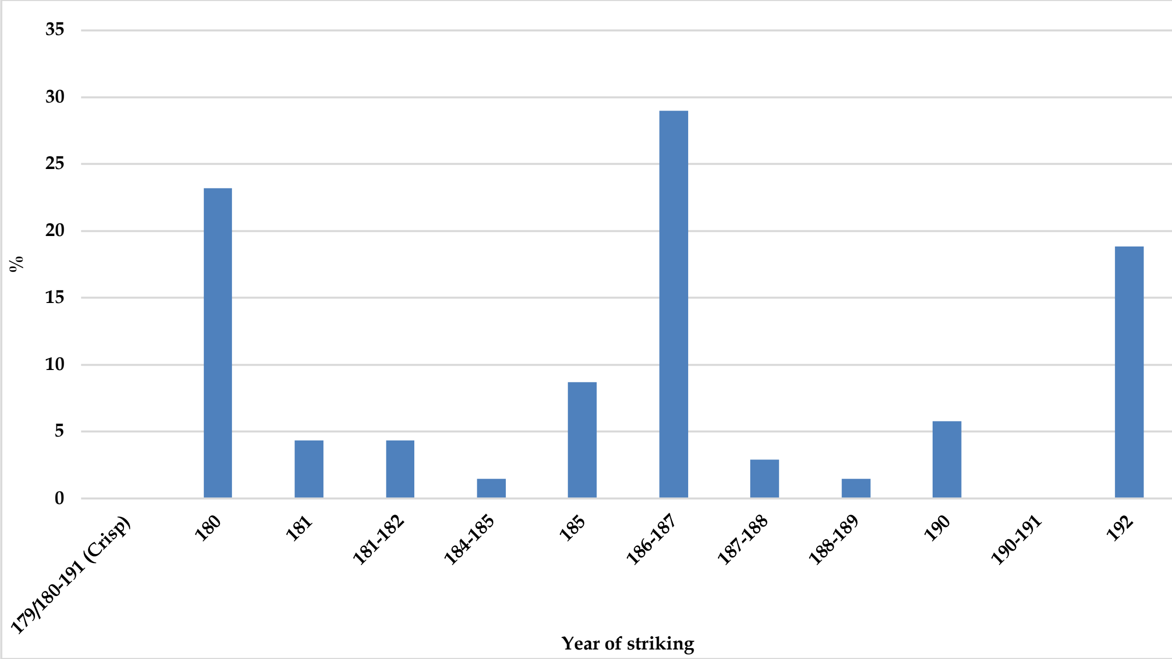

Figure 5.23: Distribution of die links observed on *denarii* of Commodus, expressed as percentage of *denarii* in die survey

A commonsense approach might argue that if a sample of essentially random coins from a variety of sources produces more die links, then the part of the coinage from which it is drawn must have been struck in smaller numbers. This is at odds with the fact that the frequencies observed in **Figure 5.2** point to comparatively *heavy* output in the years that produced the most die links. Spoerri Butcher and Hellings (2017) have shown that relative frequencies of coins in the Reka Devnia hoard can be used as a good indicator of their general presence among the wider coin population. Depeyrot, similarly, argued that the Liberalitas type (*RIC* III 36a) of 181-182 occupied almost half of that year's output on the basis that it constitutes 45% of all coins of that same year from Reka Devnia.[30] That Liberalitas constituted a large proportion of output over the period 181-182 might well be true – its high proportion in Reka Devnia is mirrored in the rest of the CHRE dataset – but it does not escape the fact that the OCRE record for this type, which contains only 17 coins, yielded two coins (from the Larnaca hoard and the collection of Philipps University, Marburg: **Figure 5.20**) that were struck by the

[30] Depeyrot 2004, esp. pp. 283-290.

same reverse die.[31] In another work, Olivier Hekster stated – without providing evidence – that that the Nobilitas type struck in 185 (*RIC* III 139) was struck in "massive numbers".[32] This, too, stands at odds with the three instances of shared reverse dies that emerged among the ten coins within the OCRE record for *RIC* III 139, which are split between the Tell Kalak hoard (ANS), the Llíria hoard (Valencia), and the collections of Albert-Ludwigs University and the Fitzwilliam Museum (**Figures 5.8, 5.13, 5.18**).

Further examination of more coins from other sources is needed in order to confirm whether between output and quantity of die links is representative, but it is worth observing that even though output appears to have been higher in the years 180, 185-187, and 191-192, it was only high in a relative sense: **Figures 6.6** and **6.7** in the next chapter show that these years of high output are barely equivalent to the points of *lowest* output under Trajan, Hadrian, Antoninus, and Aurelius (up to the late 160s). In other words: the numbers of coins in question are still very low, so it is perhaps unsurprising that they still produced a number of die links. The in-between years of lower production still produced die links, but fewer, possibly commensurate with the comparatively low numbers of coins available to us today.

The obvious next step is to subject all the *denarii* surveyed here, along with additional coins from hoards and other sources not yet on OCRE, to an automated die study.[33] It is now

---

[31] A search of the CHRE database yielded 600 Commodan *denarii* struck 181-182, of which 210 (35%) are the Liberalitas type. The ten other types represented in this dataset comprise around 10% apiece of the remaining coins. Without the Reka Devnia hoard, the grand total decreases to 381 *denarii*, but the dominance of Liberalitas and its relationship to the other types remains the same (112 coins; 29.39% of the total).

[32] Hekster 2002, p. 96.

[33] Increasingly successful computer-aided die studies have been taking place for some years, see *e.g.*, Kampel and Zaharieva 2008; van Alfen 2017; Taylor 2020; Heinecke *et al* 2021, Deligio *et al* 2022. Until recently, it was only feasible to survey and analyse the dies used to strike much smaller batches of coins, such as discrete issues from particular reigns (*e.g.*, Woytek and Blet-Lemarquand 2017 and Beckmann 2017 on the 'restored' Caius and Lucius *denarii* and Antonian legionary *denarii* of the second century), portions of the gold coinage (*e.g.*, Beckmann 2007 and 2012 on the *aurei* of Trajan and Diva Faustina I), or the coinages of short-lived emperors (*e.g.*, Bland 1993 on Jotapian). A recent paper pointed out that a survey of 800 coins would involve around 450 hours of labour and more than 300,000 individual comparisons: Heinecke *et al* 2021, p. 13; Natarajan *et al* 2021. The paucity of studies exploring the coinages of longer reigns – *e.g.*, von Kaenel's (1986) painstaking die catalogue of almost the entire

possible for software to use feature-mapping technology to accurately identify dies and to create clusters based on the total number of dies present across a given sample, enabling us as never before to make estimates of present die coverages represented in very large samples.[34] Emanuel Mayer's complete die study of all Julio-Claudian gold and silver struck *c.* 14-68 (forthcoming) deserves particular mention as an example of how die recognition technology can be applied to great effect on large and previously impractical datasets of imperial coins. Applying the same or similar methods to the coinages of Aurelius Commodus would be enormously beneficial to our understanding of the size of their coinages.

iv. Why so small?

If the coinage was indeed smaller than those that came before it, we must ask when silver output began to fall, and why. The former is perhaps a little easier to answer than the latter. It was noted above that the incidence of die links among the sample dataset of 564 Commodan *denarii* taken from OCRE is just as common among coins of the early reign as its middle and closing years. If the frequency of die links among this sample is to be taken as indicative of the intensity of output, then we ought to conclude that output was already in a state of some decline by the time Commodus became sole ruler in 180. If this was the case, then the problem must date, at the earliest, to the reign of his father – a possibility raised in the previous chapter on Aurelius, where it was observed that volumes of *denarii* struck at the mint appeared to decline from *c.* 169/170 (see **Figure 4.5** in the previous chapter). To confirm this, a small-scale exploratory survey of *denarii* struck during the reign of Marcus Aurelius was undertaken. The results were highly revealing. A total of 12 OCRE records were selected almost at random,

coinage of Claudius, which drew on extensive quantities of material from public collections, hoards, and site assemblages – are proof of how laborious such projects can be.

[34] For attempts to calculate die coverage, see Beckmann (2012a, pp. 95-100 and 2017, pp. 143-144), who employed formulae used by Esty (2006, 2011, pp. 43-58) on large datasets with known numbers of dies (*e.g.,* the *denarii* of Publius Crepusius, *RRC* 360/1 and 361/1).

with the sole proviso that care should be taken to select coin types/records from the beginning, middle, and end of the reign. The sources of these coins are the same as with the Commodan *denarii* discussed above: the Llíria hoard (Valencia Museum), the Tell Kalak hoard (Jordan; now ANS), British PAS finds, and coins from the collections of the same set of British, American, and European collections as above. **Table 5.6**, overleaf, contains the full list of results.

No die links whatsoever were observed for *denarii* struck pre-175, but a larger sample would be needed to confirm whether this is reflective of the truth. As is stands, however, the sudden proliferation of die links from *c.* 175/176 onwards suggests that the circumstances that led to a substantially lower level of output in the reign of Commodus had their origins in this part of his father's life, with silver volumes seeming to go into steep decline in the final five-or-so years of the reign.

Table 5.6: die links among Aurelian *denarii* with images on OCRE

Date	*RIC* no. and scarcity rating (in brackets)	Qty. images on OCRE	Die links
161-162	35 (C)	23	O: *IMP M AVREL ANTONINVS AVG* R: *CONCORD AVG TR P XVI COS III.* Concordia seated left. **No links**
	40 (C)	20	O: *IMP M AVREL ANTONINVS AVG* R: *CONCORD AVG TR P XVI COS III.* Concordia seated left. **No links**
165-166	148 (C)	16	O: *M ANTONINVS AVG ARMENIACVS.* R: *PIETAS AVG TR P XX COS III.* Pietas standing left. **No links**
166	164 (C)	34	O: *M ANTONINVS AVG ARM PARTH MAX.* R: *TR P XX IMP III COS III.* Pax standing left. **No links**
171-172	259 (C)	32	O: *M ANTONINVS AVG TR P XXVI.* R: *IMP VI COS III VIC GER.* Roma seated left. **No links**
175-176	349 (C)	12	O: *M ANTONINVS AVG GERM SARM.* R: *TR P XXX IMP VIII COS III.* Mars advancing right. 1. Valencia (Llíria) 39053 = BM R.14124 (**rev**)
	352 (C)	22	O: *M ANTONINVS AVG GERM SARM.* R: *TR P XXX IMP VIII COS III.* Roma standing left. 1. Tell Kalak, ANS 1956.127.1933 = Llíria, Valencia 39060 (**rev**)

Table 5.6: die links among Aurelian *denarii* with images on OCRE			
Date	***RIC* no. and scarcity rating (in brackets)**	**Qty. images on OCRE**	**Die links**
			2. Tell Kalak, ANS 1956.127.880 = ANS 1935.117.430 (**rev**) 3. Llíria, Valencia 39063 = BM 1919,0711.2 (**rev**)
176-180	417 (C)	10	O: *M AVREL ANTONINVS AVG.* R: *COS III P P.* Mars standing right. 1. Llíria, Valencia 39204 = Selby Hoard, BM 2013,4909.101 (**obv**) 2. Llíria, Valencia 39206 = Llíria, Valencia 39203 (**rev**) 3. Llíria, Valencia 390207 = Albert-Ludwigs University 02274 (**rev**)
	424 (C)	12	O: *M ANTONINVS AVG.* R: *COS III P P.* Annona standing left. 1. Tell Kalak, ANS 1956.127.887 = PAS HAMP-8F18EF (**obv and rev**)
177-178	384 (C)	12	O: *M AVREL ANTONINVS AVG.* R: *TR P XXXII IMP VIIII COS III P P.* Mars standing right. 1. Llíria, Valencia 39127 = Llíria, Valencia 39130 (**obv**) 2. Llíria, Valencia 39125 = Llíria, Valencia 31926 (**rev**) 3. Llíria, Valencia 39129 = Llíria, Valencia 39131 (**rev**)
179	402 (C)	10	O: *M AVREL ANTONINVS AVG.* R: *TR P XXXIII IMP X COS III P P.* Fortuna seated left. 1. Llíria, Valencia 39153 = BM BNK,R.543 (**obv**) 2. ANS 1944.100.49130 = Llíria, Valencia 39153 (**rev**)
	403 (C)	14	O: *M AVREL ANTONINVS AVG.* R: *TR P XXXIII IMP X COS III P P.* Salus seated left. 1. Llíria, Valencia 39164 = Llíria, Valencia 39161 (**obv**) 2. Llíria, Valencia 39160 = ANS 1944.100.49131 (**rev**) 3. Llíria, Valencia 39164 = Llíria, Valencia 39163 (**rev**)

It has already been shown (see above, **Figure 5.2**) that both the Reka Devnia hoard and the rest of the CHRE dataset contain far fewer *denarii* per issue for the 170s than the 160s; the die links presented here, which belong to the same period, strengthen the argument that the observed quantities of coins per issue can be used as a barometer for the intensity of production and that production did indeed decline from *c.* 175 onward. A selection of the die links observed in the *denarii* of Aurelius are presented below, in **Figures 5.24-5.26**.

A decline in output from the late reign of Aurelius, which either plateaued or continued to decline into the reign of Commodus, must be connected to some problem in the either the price or the supply of silver. We are now aware that the silver standard of the *denarius* remained relatively stable through the reign Aurelius (following the last significant debasement *c.* 156-157, when the average purity was reduced from around 78% to 70%). There

Marcus Aurelius: selected die links

Figure 5.24: reverse die link between Tell Kalak hoard and Llíria. *RIC* III 352, struck 175-176

Figure 5.25: reverse die link between Llíria hoard and Selby hoard. *RIC* III 417, struck 176-180

Figure 5.26: obverse and reverse die link between Tell Kalak hoard and British single find PAS HAMP-8F18EF. *RIC* III 424, struck 176-180

is evidence for a further, smaller reduction in purity to around 67% in the final year of Aurelius, suggestive of a mint that was trying to cope with a growing shortage of silver that was not going away, but this awaits verification in Butcher and Ponting's forthcoming reassessment of their data for the second-century silver.[35] The nature of the problem is hard to get at, but the first appearance of the die links presented here coincides with the time when Spanish sources of silver are thought to have fallen offline.[36] It is possible that new (and probably Balkan) sources of silver brought in to replace Spanish mines were insufficient for the size of coinage the state wanted to strike, or that supplies of bullion from these replacement sources, as well as tax revenues, were interrupted by the Marcomannic Wars and

[35] See above, **footnote 21**, for a summary of Butcher and Ponting's work on the metallurgy of the *denarius* between 64 and 192.

[36] On the environmental evidence, see McConnell *et al* 2018, who note a serious drop in lead emissions associated with the smelting of ore from the late 160s and 170s. See also Wilson 2007, esp. p. 115, and Wilson 2026.

the Antonine Plague in the 160s, 170s, and 180s.[37] These factors combined could have brought about a rise in the value of silver that, in turn, contributed to a rise in the cost of striking *denarii* at Rome.

That further debasements did not occur is explicable with reference to two factors. The first is the possible drop in the weight standard in the final part of the second century. Duncan-Jones took the weights of 3,417 *denarii* from four hoards, arriving at median weights for second-century *denarii* struck up to 180 that cluster, in the main, around *c.* 3.20g-3.30g.[38] Depeyrot and Moisil, using an index of the annual quantity of silver used to strike the *denarii* in the Frâncești hoard, argued for a reduction in weight from a second-century standard of *c.* 3.20g to an average of 2.94g under Commodus.[39] This agrees with the average weight of Commodan *denarii* taken from the 2,461 specimens from the Reka Devnia hoard, which comes to 2.92g (with a standard deviation: 0.39), and with the average weight of the 306 Commodan *denarii* held by the American Numismatic Society (2.96g; standard deviation 0.36). It remains possible, therefore, that the weight of the *denarius* was further reduced under Commodus – a

[37] Spanish mines at Rio Tinto had largely ceased by 170/180, not because the seams of ore had been exhausted, but because abandonment of the works likely caused extensive flooding that could not be reversed. The cause of their abandonment might have been the Moorish invasion (see previous chapter, **p. 202**) or, equally likely, the Antonine Plague: Wilson 2026, p. 119. See also Wilson *op. cit.*, pp. 114-118 and Table 5.1, who notes that the end of serious exploitation at the Roşia Montana gold mines around 167 can convincingly be laid at the door of depopulation caused by the Plague and exacerbated by the Marcomannic Wars. Activity at Roșia Montana limped on in a reduced form until the final abandonment of Dacia in the 260s. Wilson proposed Upper Moesia as a potential candidate for significant silver exploitation following the closure of the Spanish mines (Wilson 2007, p. 115), which, if true, would have meant that one of the Roman state's primary sources of silver in the later second century was also vulnerable to disruption wrought by the plague and the Marcomannic Wars. Investigations led by Butcher and Ponting (2012), using bismuth trace elements within the coins themselves, appeared to confirm this, claiming that the new source(s) of silver must have been located somewhere within the Balkan provinces. The reliability of these techniques has now been cast into doubt (see Wood, Butcher, and Ponting 2023), but recent research has shown that sources of silver in Dalmatia and Moesia Superior were exploited between the second and fourth centuries: see Mladenović 2025, esp. pp. 195-204 and pp. 217-221. The scale of the workings (revealed by extensive spoil heaps and slag deposits) indicate that these mines were highly productive when operational.
[38] Duncan-Jones 1994, pp. 183-186. The hoards upon which he based his calculations are Măgura (CHRE no. 5275), Faverges-Viuz (no. 3510), Londonthorpe (no. 1264), and Little Brickhill (aka Bletchley 1967 and Bletchley 1987, CHRE nos. 52 and 49 respectively).
[39] Depeyrot and Moisil 2004, pp. 37-39.

solution that would go some way to explaining why there were no further debasements – but this idea founders on two pieces of evidence. The first comes in the form of the average weight of the far greater total of 2,040 Commodan *denarii* in the collection of the British Museum (excluding plated, incomplete, or holed specimens), the average weight of which sits at 3.15g (standard deviation: 0.31). To this should be added crucial research carried out by Butcher and Ponting, who lay out in great detail that extrapolating ancient weight standards by averaging out weights of debased silver coins can be fraught with difficulty. *Denarii*, they point out, preferentially leach the base metal component of their alloys into the soil, resulting in coins that look acceptable on the surface while hiding a honeycomb-like interior of voids left by the disappeared base metal.[40] The more base metal in the alloy of the *denarius*, the more unreliable their weights, resulting in a set of readings that reflect the degree of metal lost rather than the original standard to which they were struck. Despite all this, Butcher and Ponting were mindful to add the caveat that they do not definitively rule out a slight weight reduction under Commodus; if the average of the British Museum coins is anything to go by, it is possible that a slight reduction occurred from the standard of *c.* 3.20/3.30g (put forward by Duncan-Jones and Depeyrot and Moisil) to one of *c.* 3.15g (or less) under Commodus, but for now this remains an unresolved question.[41]

More significant is the evidence, presented here for the first time, of the die links among the coins detailed above in **Tables 5.5-5.6**, which strongly indicate a significant reduction in output that began during the later years of Aurelius (from *c.* 175) and lasted through the entire reign of Commodus. A reduction in output – perhaps in unison with a drop in the weight standard – could well be interpreted as a measure adopted by the mint in order

[40] Butcher and Ponting 2012, pp. 66-68; Butcher 2024.

[41] Butcher (2024) endorses a formula first put forward by Caley (1955) for estimating original weight standards (original weight = (present weight x theoretical specific gravity) ÷ present specific gravity), which removes the need to guess ancient weight standards through averages by factoring in the probable loss of mass endured by the coins while in the ground.

to cope with a shortfall in the supply of silver, and would provide a plausible explanation for Butcher and Ponting's inability to detect further debasements between the years 180-192.

If the supply or cost of silver was a barrier preventing the mint from striking the number of coins it wanted, why did it not simply order another debasement? Given that later regimes elected to deal with their own problems by means of debasement does not mean that the mint of Aurelius and Commodus operated under the same mindset: apart from the step down to a new standard of 80-90% (from a near 100% purity) under Nero, the *denarius* suffered no further significant reductions in purity until the new standard implemented by Antoninus in 156-157, when purity fell from around 78% to 70%. The later first and second centuries were, largely, a time of stability insofar as the silver standard of the *denarius* was concerned. Therefore, the potential human impact of the debasement of 156-157 – which, though relatively insubstantial, was still the only one within most people's living memory – should not be underestimated. The various reductions and subsequent restorations of fineness seen in the first century suggest that the state preferred to produce a silver coinage of the highest possible purity that circumstances would allow.[42] A possible window onto the mint's thinking can be found in Butcher and Ponting's data for the reign of Aurelius (see a reproduction of their table of results in **Table 5.7**, below), which show at least three possible attempts, in 165, 175, and 177-178, to move back in the direction of the pre-156-157 standard of around 78-80%. More tests need to take place on a larger number of coins before anything can be said for certain (note the high standard deviations for the years just mentioned) but if these results really do evidence attempts at a restoration of silver purity under Aurelius, then they were clearly short-lived and unsustainable.

[42] See, *e.g.*, discussion in Butcher and Ponting (2014, pp. 235, 450-453) on why the mint under Nero improved the purity of the *denarius* (to a revised standard of 90%) only four years after reducing it to a fineness of 80%.

Table 5.7: Silver bullion content of the *denarii* of Marcus Aurelius (Reproduction of Butcher and Ponting 2012, Table 4).			
Date	Weight % silver bullion (Ag+Au+Bi+Pb)		
	Mean	Standard Deviation	Number
161	68.4	1.1	3
161-162	69.2	1.4	4
162-163	68.8	2.6	4
163-164	71.1	1.9	7
164-165	76.9	5.1	2
165	82.1	6.8	3
165-166	76.9	1.8	3
166	75.5	1.9	2
166-167	74.7	4.3	4
167-168	70.4	.	1
167-178	71.6	.	1
168	74.1	.8	3
168-169	72.4	3.7	2
169-170	70.7	.2	2
170-171	71.1	3.3	2
171-172	70.2	1.2	2
172-173	70.7	3.5	2
173-174	71.9	1.6	2
174	71.1	.	1
174-175	72.0	.	1
175	78.8	4.6	2
175-176	75.0	6.5	3
176-177	74.1	8.2	4
177	72.7	.	1
177-178	80.2	14.4	2
178-179	66.6	.8	4

It is noticeable that one of the final possible attempts at a restoration of the silver standard occurs almost exactly at the same time (*c.* 175) as the first probable downturn in mint output, as signalled by the first occurrence of die links in the sample of Aurelian *denarii* taken from OCRE (see **Table 5.5** above). It is almost as if the mint, having come to the realisation that further improvements and restorations were not sustainable, deemed a standard of around 67-70% to be a point beyond which it simply did not wish to venture, and that any measure was deemed reasonable if it protected the *denarius* from further debasement. Some comfort for mint and treasury officials might have been found in the knowledge that there were probably still sufficient *denarii* in circulation, particularly those struck under Antoninus (under whom production had been very high) and, most recently, the first half of the reign of Aurelius (before production plummeted).

5: Commodus

Monetary manipulation in response to fiscal strain was hardly new to the Roman world; the mint could and did resort to measures such as lowering (and sometimes restoring) metal purity and weight standards in order to deal with problems like rising state expenditures (construction projects, wars, largesse, payments beyond the frontiers, *etc.*), shortages in the supply of metal, or fluctuations in the value of bullion.[43] It should not come as a surprise, then, that the mint under Aurelius and Commodus appears to have taken action to deal with a mounting crisis of its own by suppressing output in response to an evident shortfall in the supply of silver. A precedent already existed in the downturn of silver production under Caligula, Claudius, and Nero (up to the year 64), which was possibly triggered by a change in the value of silver that made the striking of *denarii* temporarily unprofitable.[44] It is possible that the same set of circumstances were at play in the later second century, and that the end result was the same: *i.e.,* the mint chose to mitigate the effects of something outside of its control by reducing output. In the Julio-Claudian period, this period of low production only ended with the debasement of Nero in 64, the key motivator for which must have been to make the production of silver a profitable exercise once again.[45]

The circumstances behind the measures adopted in 37-64 and *c.* 175-192 might have been different, but much of their interest lies in the mindset they betray – namely, that a 'good' coinage was often (if not always) the aim, even if it frequently proved unachievable.[46] Nero attempted to restore the coinage to a higher purity of 90% in 68; Domitian tried to return to the pre-Neronian standard of a pure bullion coin in 82. It is argued here that in the mid-late 170s and 180s, the mint was unable to revert to a previous standard, much as it might have wanted to (*e.g.*, despite attempts at a restoration under Aurelius; see above), but it could – and did – curtail output in order to prevent debasement.

---

[43] Howgego 1995b, pp. 115-120; Yarrow 2012, pp. 424-425.
[44] Duncan-Jones 1994, p. 105; Butcher and Ponting 2014, pp. 174-178 and p. 234.
[45] The debasement also had the (probably not unintended) effect of bringing the standard of the *denarius* into line with eastern drachms: Butcher and Ponting 2014, p. 450.
[46] Butcher and Ponting 2014, p. 450, cite this as a probable reason behind the Neronian restoration.

It is possible that suppressing the rate of production was only ever meant to be a temporary measure, with striking to be returned to pre-175 levels when circumstances permitted. The fact that the die links do not go away indicates that coin production was maintained at a comparatively low level for the remainder of Aurelius' reign and the entire reign of Commodus. This in turn pushes us toward concluding that: a) the problems impacting coin production – probably connected to the metal supply and the profitability of striking silver – were themselves not going away, and b) that the decision to reduce the quantity of *denarii* being struck was, for the time being, thought to be an appropriate (if imperfect) response to the problems at hand.

The mint under Commodus might just have found itself able to keep the balance so long as there were no major or sudden increases in expenditure. The limited information available to us does not create the impression of a reign marked by especially lavish expenditures (accounts of the emperor's extravagance must be read with caution), or of significant draws on the public purse, such as new wars.[47] The tipping point might finally

---

[47] Sources like Cassius Dio and the *SHA* claim that Pertinax inherited a treasury that contained no more than 1,000,000 *sestertii*, and that Commodus had squandered ruinous sums on luxuries like furniture, horses, and artworks, as well as promises of lavish cash handouts to the people and army: *SHA* Commodus 16.8-9; Pertinax 7.4-7.6 and 9.1; Cassius Dio 74.5. That the regime of Commodus likely had to deal with sustained financial pressures that resulted in a treasury that was nearly bare at the end of the reign is not being contended here (Herodian, 2.4.7, describes Pertinax's repeal of "customs tariffs which had been devised under the tyranny of Commodus as a ready source of money"). The clear shortage of silver, not to mention a possible fiscal hangover following the wars fought under Aurelius, probably had a more significant impact on the state of the imperial finances than profligacy of the emperor. Both Cassius Dio and the *SHA* tell us that Pertinax was forced to hold fire-sales of Commodus' possessions to balance the finances of the state. These sales, if they happened, have the feeling of events whose significance was more political and symbolic than financial. The collective cost of the six *congiaria* that took place during Commodus' sole reign were estimated by Duncan-Jones (1994, pp. 248-250, on the basis of figures from Cassius Dio) to have been the costliest to date, at 39,000,000 *sestertii* (around 14,000,000 *sestertii* more than was spent by his father over seven *congiaria*), but this hardly stands as proof of any claim that his regime was any more extravagant than those that came before it, not least because the general tendency since the first century appears to have been for a reign-on-reign increase in the estimated overall cost of *congiaria* (Duncan-Jones, *ibid.*). Verifiable information on other expenditures under Commodus is limited. To our knowledge, there were few wars to pay for: the long-running insurrection in Britain was put down by 184, and apart from two poorly documented disturbances in Upper Germany (the *Bellum Desertorum*) and Dacia, no other conflicts are known of. On the contrary, we are told of peace treaties with peoples along the Rhine and Danubian frontiers in 180:

have arrived only a short while later, at the beginning of the reign of Severus (*c.* 193/194): longer-term issues relating to the supply of silver bullion, as well as the pressure to produce more *denarii* in place of gradually declining *aes* volumes (which must have been a source of strain for a mint that was finding it hard to source sufficient silver), could have combined with newer financial demands to create a fiscal environment in which the mint's decision to protect the metallic integrity of the *denarius* by suppressing output was no longer considered sustainable.[48] These newer pressures will likely have included: a) the financial aftermath of the civil war following the death of Commodus; b) the customary burst of expenditure typical of the beginning of any new reign, *e.g.,* Severus' first two *congiaria* in 193 and 196; c) the recommencement of war with Parthia (194-198); and perhaps even d) the Severan army pay raise of 197, which, if it was to be successfully implemented, will have required a period of planning and preparation that might be reckoned in years.[49]

With no apparent solution to the evident shortfall in the silver supply having presented itself, and with a range of new fiscal pressures compounding the effect of longer-term issues, it could have been that the mint decided its only remaining strategy was to resort

---

Cassius Dio 73.2; Herodian 1.6; Alföldy 1971; Hekster 2002, pp. 40-42 and pp. 48-49. The size of the army is not known to have increased, military pay did not rise, and, beyond the construction of new *thermae* and the column-temple complex dedicated to his father, Commodus is not credited with major programmes of public works at Rome or elsewhere: Hekster 2002, pp. 203-206.

[48] *Aes* denominations had been on a gradual journey of decline over the second half of the second century: the *quadrans* and the *semis* had all but ceased under Hadrian and Antoninus. The *as* and the *dupondius* were still in production in the 190s, albeit in far smaller numbers. The *sestertius* was still in regular production, although this too appears to have become far less common outside of core areas like Italy, its place being taken by the *denarius.* See Hobley 1998, p. 128; Abdy 2012, pp. 503-504; Kemmers 2009c. In Britain, for instance, compare 5,166 single finds of *denarii* of Reece Period 10 (193-222) recorded on the PAS database with just 426 *aes* coins (most of which – 289 in number – are *sestertii*): a ratio of roughly 12:1. On the Severan supply of silver and questions concerning circulation in the third century arising from the near-wholesale switch to silver, see **Chapter 3**, **footnote 16**.

[49] Butcher and Ponting 2014, pp. 454-455, point out that Domitian's decision to return to Nero's revised standard of 90% in 85 (climbing down from his own revised standard of near-100% purity, implemented in 82) was perhaps motivated by the need to strike more silver in order to finance a rise in army pay. On the Severan pay raise, see Speidel (1992, esp. p. 106, Table 7), who uses documentary and epigraphic evidence to persuasively argue for a doubling across the board, with the basic annual rates of legionary and auxiliary pay rising to 600 and 500 *denarii* respectively. Alston 1997, pp. 114-115, is more cautious.

to an outright debasement of the *denarius* – precisely the measure that, under the scenario outlined here, that it had been holding off for most of the previous 15 years. The debasement itself (to a new low of about 45% fine in 194) might be interpreted in the same light as the Neronian debasement of 64: *i.e.*, as a move to break the deadlock by making the production of *denarii* profitable once more.[50]

The Julio-Claudian decline in silver output was accompanied by a corresponding rise in the production and importance of gold in state finance.[51] The same might well have been true of the relationship between gold and silver under the reigns of Aurelius and Commodus, under whom neither the purity nor the weight of the *aureus* appears to have been subject to change, although a comparison (**Table 5.8,** below) of the comparative numbers of second-century *aurei* from hoards and museum collections shows that Commodan *aurei* are the scarcest of all the second-century reigns in terms of absolute numbers (excepting the short tenures of Pertinax and Julianus). This mirrors what we see in the relative frequences of *denarii*, thereby raising the possibility the quantity of gold struck during his reign also experienced a decline. Even allowing for differing reign lengths, the size of the drop between Aurelius and Commodus is very steep, at 1,531 and 191 *aurei* respectively. That said, low numbers are not themselves an absolute guarantee, especially when we are speaking of gold, and despite the smaller sample size, the average weight of *aurei* struck under Commodus is only marginally lower than the averages for his second-century predecessors. This slightly lower average weight might, again, have been influenced by the size of the sample (just 57 specimens with weights provided across the CHRE, BM, and ANS). It is clear that questions pertaining to the role of gold will only be resolved with more research – not least a full die study of Aurelian and Commodan *aurei*.

[50] Gitler and Ponting 2003 (esp. pp. 55-57); Butcher and Ponting 2012, pp. 76-77 and 2022, p. 277.
[51] Butcher and Ponting 2014, p. 439, and Mayer (forthcoming).

Table 5.8: Comparing quantities and average weights of second-century *aurei* from the CHRE, BM, and ANS				
Reign	Qty	Qty specimens with weights	Avg weight	Standard deviation
Trajan	1,032	267	7.24	0.20
Hadrian	1,265	396	7.23	0.21
Antoninus	2,058	574	7.25	0.22
Aurelius	1,531	298	7.25	0.20
Commodus	191	57	7.18	0.21
Pertinax	40	16	7.28	0.16
Julianus	22	6	6.69	0.10
Septimius	348	167	7.27	0.18
Qty	**6,487**	**1,781**		

v. Summary

This chapter has been rather different from the four that came before it. Owing to a limited number of available *denarii*, it was only possible to perform broad, issue-level distributional analyses using χ^2. For what they are worth, these tests yielded fewer instances of over- and underrepresentations in the various issues under survey than in the previous four reigns. This, it has already been remarked, might be a consequence of having so few *denarii* at our disposal. Even in Britain – scene of the most significant conflict of the reign – there is no suggestion that the war caused the mint to ship significant numbers of new coins into the province, much as it had done at the time of Antoninus' northern campaigns of the late 130s and early 140s, or over the course of the prolonged war fought by Aurelius. It is only at the end of the reign, *c.* 190-192, that several regions started to return values signifying overrepresentations of new *denarii* (see **Table 5.1**). It is hard to understand what these results might mean or how to interpret them within the chronology of the reign, especially considering the evidence presented in subsequent sections which convincingly points to a smaller coinage.

Our inability to detect large shipments of newly struck *denarii* even in areas (*e.g.*, Britain) where we might have expected to see them is significant in itself, and directly relates to the main finding of this chapter: *i.e.*, the high incidence of die links among a random sample of 564 *denarii* taken from OCRE, which includes single finds and hoards from different ends of the empire (Britain, Spain, Jordan) that bear no obvious relationship to each other. The die links are not peculiar to the reign of Commodus, but extend into his father's coinage: a search for die links on the coinage of Aurelius yielded nothing until 175, from which time onward the number of die links rises. The only logical reaction to their existence has to be that the silver coinages of Aurelius (from *c.* 175) and Commodus were significantly smaller than has been reckoned to date, putting to bed any notion that the relative shortage of these coinages (reckoned against the plentiful issues pre-dating *c.* 175) can be laid at the door of withdrawal and recycling by private individuals and the state, or the conditions brought about by the Severan debasement of 194. No other explanation can take account of the fact that these *denarii* are virtually always – regardless of context, hoard, or date of hoard closure – the least common coinage of the second century.

The die links must be interpreted within the context of relatively new information regarding the silver standard to which the *denarius* was struck in the second century. Thanks to research carried out by Butcher and Ponting (2012, 2014), we can now say that after the last great reduction in purity under Antoninus in 156/157, the *denarius* remained at a relatively stable average purity of around 70% through the reign of Aurelius and into the reign of Commodus (marked by occasional reductions and attempts at restoration). The knowledge that the coinage was being struck to a virtually unchanged purity, but was indisputably smaller, must mean that production was suppressed and maintained at a low level from *c.* 175 until at least the end of Commodus' reign in 192, and possibly up to the debasement in 193/194. The theory advanced here is that the mint under Aurelius and Commodus, either because it was struggling to locate sufficient silver to maintain both pace of output and the silver standard arrived at in 156-157, or because a rise in the price of silver made the production of *denarii* unprofitable (or both), preferred to reduce output rather than debase, possibly increasing its reliance on gold as production of silver dwindled. Something similar had happened long before, *c.* 37-64, when output of Julio-Claudian *denarii* had been reduced until the mint under Nero decided to debase. Similarly, the period of suppressed production under Aurelius and Commodus was capped off by another, more drastic debasement – this time under Severus, in 194, from which onward time the production of silver coinage took off once again. The circumstances that led Severus to debase, rather than to continue his predecessors' policies, were probably connected to a range of financial commitments and pressures, both new and longer in the making, including a war in Parthia and (possibly) the looming prospect of the army pay increases that would be implemented in 197. A possible reliance on gold to facilitate state payments under Commodus might not have gone away: a comparison of relative quantities of *aurei* from CHRE, the BM, and the ANS (**Table 5.8**) suggests that gold output might have been greater under Severus than Commodus, but still smaller than the other reigns of the period 98-180 (although the degree to which this figure is a reliable indicator is open to question: how many Severan *aurei* ended up being recycled, compared to the number of earlier *aurei* that were securely deposited in hoards?).

The next steps from here are clear. First, more coins for die-studies should be sought from collections, hoards, assemblages, and databases of single finds. The current array of die links already spans hoards and single finds at opposite ends of the empire. The incorporation of more coins from sources other than OCRE would surely yield further die links, as well as improving the geographical scope of the dataset. The sample dataset of 564 coins assessed above contains plenty of specimens from German, Swiss, and Austrian collections (for instance), but virtually none of these have a secure provenance. Many of the hoards containing Commodan *denarii* from the Rhine and Danubian frontiers (listed in **Annexe 5**) would be welcome additions, in particular the large hoards from Cologne (Gertrudenstraße 1909: CHRE no. 5289), Obererbach (no. 2990), or Flonheim (no. 2944). The same can be said of hoards from the centre of the centre of the empire, *e.g.*, the large Severan hoard of 6,442 *denarii* (including 719 *denarii* of Aurelius and 196 of Commodus) from Via Braccianese, outside Rome (CHRE no. 13851). It will also be vital to bring in more coinage from earlier reigns (Antoninus, Aurelius) in order to compare and contrast with what is being observed in the coinage of Commodus.

This expanded dataset should then be subjected to the kinds of computer-assisted die recognition programmes mentioned in the discussion above. The results would surely shed further light on the number of dies used to strike the *denarii* of Commodus, thereby laying the ground for an attempt to calculate the possible size of the coinage by the same methods applied to other areas of the imperial coinage (*e.g.*, Beckmann 2012a on the *aurei* and *sestertii* of Diva Faustina I). They would also help us lay to rest certain questions that did not find an answer in the present study. The *denarii* of Crispina, for instance, were the only group of coins struck for a single member of the imperial family that failed to return a single die link. This is a real oddity, especially given the fact that far smaller groups of *denarii* struck for Commodus himself yielded die links of their own. Is the lack of die links for Crispina just the product of chance, or does their absence speak to a coinage that was, perhaps, much larger and struck over a longer period? An expanded dataset would also aid our understanding of when, and how suddenly, output declined under Aurelius (was it as clean-cut and as sudden as the results above suggest?), and of the true spread of die links over the reign of Commodus. At present, the die links extend all the way from 180 to 192, but there are years in which they appear to concentrate: do these truly reflect the intensity of mint output, or will they be ironed out once more coins are added to the dataset? A comparable investigation of the quantities in which *aurei* were struck would be equally advantageous. Gold, under the Julio-Claudians, at least, became a mainstay of imperial finance; a decline in the production and possible importance of silver under Aurelius and Commodus could well signal the same, but further research – including a major die study – is required before we can say anything more.

Chapter 6: Discussion

This study is the first broad distributional analysis of the *denarius* in the second century, and one of a just few distributional studies to have made use of χ^2 residuality tests instead (as opposed to *e.g.* comparative percentages) in order to expose regional concentrations among a large dataset of hoarded coins.

Other studies have addressed the distribution and supply of Severan *denarii* (see, *e.g.*, Hellings 2016; Howgego 1994, 1995a, 2002; Duncan-Jones 2001, 2002) but the number of investigations into the second-century silver are considerably fewer, barring a recent publication by Hellings (2025), who looked at the distribution of second-century silver as part of a wider investigation into the monetisation of Roman northwest Europe. Most other works have tended to take a rather narrower focus. Duncan-Jones's surveys of the silver, for instance, zoomed in on specific examples of regionality at the level of the design or the issue in order to support his theoretical position on a perceived lack of integration in the Roman coinage and economy. They were not broad in their outlook, and they provided few meaningful conclusions on the functioning of Roman imperial finance and coin supply on something approaching an empire-wide scale. This thesis aims to bridge – or at least, to begin bridging – this gap in the scholarship. In so doing, it joins a larger body of work on the distribution of the *aes* coinage, which has received considerably more attention in this regard than the silver. In particular, the work performed by scholars such as Kemmers (*e.g.* 2005, 2009a, and 2014) has opened our eyes to the extent of regionalised supply to the army and frontier provinces on lower denominations in the first century. Flavian garrisons in Britain, the Rhine Delta, and the Rhineland, for instance, were in receipt of typologically distinct batches of coins, some of which can be explained with reference to audience targeting in the wake of recent victories. Others involved with the second century include Hobley's survey of the *aes* across the western empire, which aimed to trace the annual ebb and flow of supply to different regions across the later first and second centuries, and Walker (1988), whose exploration of the Bath assemblage identified waves of *aes* supply from the centre, as well as the *BRITANNIA* issues of Hadrian and Antoninus: two irrefutable – though isolated – examples of audience-based distribution in the second century.

It was natural, therefore, to seek an understanding of the extent to which regionalised distribution and/or targeted distribution also occurred on the silver coinage, and, if so, how far into the second century these practices persisted. The fact that scholars such as Kemmers and Hobley focused on the *aes* rather than silver is partly because the quantity and availability of lower denominations (outside of hoards) was so much better. Until the recent advent of the CHRE, the assembly of a workable dataset of the silver would have required trawling many dozens or hundreds of hoard reports. The fact this research was able to take place at all is a confirmation of the research potential of the CHRE project database.

Since <u>regionalised</u> distribution and <u>targeted</u> distribution are slightly different things, they should be dealt with in turn. Regarding the former, it made sense – before even examining the data – that the state could have organised the distribution of newly struck *denarii* on a regional basis to a greater or lesser extent, much as it did with *aes* denominations. The evidence presented in previous chapters, which will be discussed below, substantiates this belief entirely: large quantities of particular issues, or *e.g.* selected designs from within an issue, are commonly found to be overrepresented (*i.e.* concentrated) in a particular region or regions. Their visibility in the hoard record is an interesting topic in itself, touching on the nature of circulation in the Roman Empire; it will also be addressed below. On the practice of targeted distribution, we were treading on much less firm ground. Howgego (2024) made the observation that most examples of audience targeting identified to date come from the Flavian, Nervan, and Trajanic periods, possibly on account of the fact that intensive recall and reminting in this period (including the issuing of coins for circulation in the east) led to a heightened awareness of the potential communicative potential of coin types at this point in time.[1] Whether this is true, or simply a consequence of the fact that comparatively little scholarly effort has been devoted to looking for instances of audience targeting further into the second century, was one of the questions that this study sought to answer.

i. Audience targeting

One of the first and earliest aims of this thesis was to examine the question of audience targeting insofar as it applies to the silver coinages of the second century. As with the Flavian coinage, the finding of this study is that audience-based distributions did occur, but not as a matter of course. Rather, they were sporadic and appear to have taken place in limited contexts. The handful of plausible examples to have emerged from the χ^2 tests range from the highly likely to the tenuous, and are so few in number that they can be recapped one-by-one.

Figure 6.1: *denarius* of Trajan struck January-February 98. *TR P COS II P P // PROVID*; Trajan, in armour, receiving globe from Senator (*RIC* II 28; *MIR* 10a)

1. Rhine: Trajan receiving globe from Senator, January-February 98 (Figure 6.1). Only three examples of this rare type emerged from the dataset extracted from the CHRE database: two from the area of Cologne (the Obererbach and Köln Gertrudenstraße hoards), and one from the enormous Reka Devnia hoard in Bulgaria. This excluded them from statistical testing, and so it goes without saying that anything said about the distribution of three coins remains

[1] Howgego 2024, pp. 90-91; Butcher and Woytek 2018, pp. 272-275.

speculative. Nevertheless, the circumstantial evidence is worth consideration. It is hardly surprising that an example of a rare coin should materialise in the Reka Devnia hoard, given its size and the related fact that it tends to contain at least one example of most designs in the dataset. What is curious, however, is that the two other provenanced examples should both originate from the area of Cologne, which was Trajan's base in the weeks immediately following his accession. It is possible, therefore, that these two German examples are what remains in the hoard record of a shipment sent from the mint at Rome to Trajan in the emperor Cologne. That they should have stayed in the area until after the turn of the third century (Obererbach and Köln Gertrudenstraße close in 222 and 238 respectively) is interesting on its own terms; either they were pulled from circulation and remained dormant for a long time until their burial, or they represent a rump of coins from that shipment that did not circulate out of the Rhineland following their release. Unless more coins come to light, we will probably never know. Matters of coin supply and circulation in light of the evidence presented in the preceding chapters will be considered at further length below.

The decision to ship fresh coins bearing the image of the new emperor, complete with a design that clearly references his accession, could well have been taken by officials at the Rome. We can only guess at how they were used and received upon arrival; perhaps they were used as part of some sort of accessional donative or special bonus payable to the soldiers stationed in the region, but, in this scenario, we cannot discount the possibility that they were also intended for the eyes of the emperor himself. Whether the striking and dispatch of such types was what might be called 'standard' mint practice upon the accession of a new emperor is questionable, not least because, apart from Trajan and Hadrian, all the rulers of the second century came to the throne while resident in Italy. Coins bearing the *ADOPTIO* reverse type (*RIC* II.3 2959-2960) from eastern mints in the vicinity of Hadrian's base in Syria were some of the very earliest emissions of his reign, as were *CONCORDIAE* types issued from Rome at the outset of the joint reign of Aurelius and Verus in 161-162, but there are no similar types for

Antoninus and Commodus – perhaps, in part, because it was felt that neither of them needed to justify their claims to power.[2]

Figure 6.2: British single find of a *denarius* of Hadrian struck 119-120. *P M TR P COS III*; Concordia seated left (RIC II.3 218)

2. Britain: Concordia seated left, 119-120 (Figure 6.2). In **Chapter 2**, it was seen that the χ^2 results for Britain delivered a strong overrepresentation for the issue of 119-120, with a corresponding overrepresentation at the level of the design for the Concordia type. In no other region were Concordia *denarii* found to be consistently overrepresented in all the tested hoard groups, nor indeed were coins of the 119-120 issue as a whole. This led to the suggestion that their selection was motivated by the fact that contemporary shipments of targeted *BRITANNIA aes* were being sent to Britain, and that the marriage of these two images – Britannia and Concordia together – was seen as an appropriate message for the province in the wake of a recently suppressed insurrection.

It is possible that a kind of image 'programme', in the form of a suite of types across denominations, could have been used to transmit messages to audiences in specific places, but this is perhaps too complex an interpretation of the evidence in this case; how would their release have been coordinated so that the Britannia-Concordia message was noticed? We do

[2] Trajan was the first adoptive emperor within living memory, the last being Nero; his adoption by Nerva had occurred barely six months before his accession. Hadrian's (questionable) adoption was not announced until after Trajan's death. Aurelius and Verus, though their accession was in no way disputed, were the first joint rulers.

not know for definite whether new *aes* and new *denarii* were shipped together. Among which audience(s) would this message have been expected to find a home? It has not even been agreed which people – if any in particular – the *BRITANNIA* types on the *aes* themselves were aimed at, let alone a more complex message across two metals. It is, perhaps, more likely that a typologically homogenous batch of *denarii*, all bearing the Concordia design, were sent to Britain without much thought being given to their subject matter. Shipments of this nature, and what they tell us about the nature of coin supply and state finance in the second century, are discussed in section *ii*, below.

Figures 6.3-6.4:
6.3: *denarius* of Marcus Aurelius as Caesar, struck 145-147. *COS III*; Spes left (*RIC* III 431)
6.4: *denarius* of Antoninus Pius struck 145-146 in honour of the emperor's third *congiarium* (early 145). *TR POT COS III LIB IIII*; Liberalitas left (*RIC* III 156)

3. Italy: *congiaria* of Antoninus Pius (Figures 6.3-6.4). Of the seven Italian overrepresentations at the level of the issue for the reign of Antoninus, six occur in the form of coins struck in years of known or postulated *congiaria* (see **Chapter 3**, **Table 3.6**). It is of note that in one instance it was found that a *denarius* type bearing the image of Liberalitas, struck for the fourth *congiarium* in 145, was itself overrepresented among the Italian hoards (**Figure 6.3**). Of greater interest, however, are the issue-level overrepresentations – in particular, those of *denarii* struck for Aurelius as Caesar *c.* 140-144 and *c.* 145-147. Both of these broad periods coincide with *congiaria* II (140), III (142), and IV (145).

Nowhere but Italy returned such a consistent and strong set of overrepresentations for the issues of Aurelius as Caesar under Antoninus – a finding that led to the suggestion that this was no coincidence. As heir, he was present at the capital and in Italy for much of the reign, and so it is plausible to suppose that the regime would have wished to use newly struck *denarii* to promote his image among a 'home' audience, including the various *congiaria* he may have attended alongside the emperor. This supposition gains further ground in the case of the *denarii* struck *c.* 145-147 (see again **Table 3.6**), which are broadly contemporary with the fourth *congiarium* of the reign, held in honour of both Aurelius himself and his new bride, Faustina II. Virtually all of these overrepresentations are accompanied by corresponding Italian bulges in the relative quantities of *aes* denominations struck for Aurelius, as noted by Hobley.[3] The likelihood is that the mint facilitated the *congiarium* payment in substantial quantities of new *denarii* bearing the image of the young Caesar. This is not audience targeting in the way that most people have traditionally thought of the concept (which usually focuses on reverse designs), but it is an act of targeting, nonetheless.

Figure 6.5: *denarius* of Lucius Verus struck 166-167. *TR P VI IMP IIII COS II*; Victoria right with shield inscribed *VIC PAR* (*RIC* III 566)

4. Italy: *congiaria* of Aurelius and Verus (Figure 6.5). The same tendencies noted in respect of *congiaria* during the reign of Antoninus were also seen in the *denarii* of Aurelius and Verus. Once again, overrepresentations at the level of the issue for *denarii* struck 161-162 occurred primarily in Italy (see **Chapter 4**, **Table 4.5**), which might be connected with the accessional

[3] Hobley 1998, tables 9.1, 9.7, and relevant sections of Table 9.4, pp. 74-*ff.*

congiarium held in early 161. Far more interesting is the set of Italian overrepresentations for the issue of 166-167, which again corresponds with a known *congiarium*: the third of the reign, in late 166, to honour Roman victories won by Verus in the east. As with the overrepresentations of *denarii* struck for Aurelius as Caesar in the last reign, those that occur here are at the level of the issue rather than the design. More importantly, further χ^2 testing showed that they are caused entirely by *denarii* struck in the name of Lucius Verus. Virtually all other overrepresentations at the level of the issue observed elsewhere in the empire were backed by the far more numerous *denarii* of Aurelius; that coins of Verus struck in the same year as his triumph and accompanying *congiarium* should be overrepresented in Italy is probably not a coincidence. Although the triumph and *congiarium* were a celebrated as a joint affair, it was Verus who was accorded more credit for the eastern victories than Aurelius (see **pp. 189-193**). It is likely, therefore, that large numbers of newly struck *denarii* bearing both the image of Verus and reverses celebrating his victories were produced and set aside for distribution at his *congiarium*. Again, Hobley's research into the *aes* shows a corresponding Italian spike in the frequency of coins in the name of Verus – more than in any other region he surveyed.[4]

Of all the *denarii* subjected to χ^2 testing over the course of this study, these are the only plausible examples of audience targeting that came to light. Setting aside the overrepresentation of Hadrianic Concordia *denarii* in Britain, which, on balance, are probably not an act of audience targeting, we are left with the following: 1. the statistically unproven concentration of Trajanic *denarii* in Germany; 2. the various Italian overrepresentations in the name of Aurelius Caesar, as well as the one instance of a Liberalitas type in the name of Antoninus, all of which are contemporary with *congiaria* at Rome; 3. an Italian

[4] Hobley 1998, pp. 84-85, 90-91.

overrepresentation of *denarii* struck for Aurelius and Verus over the years 161-162, coincident with their accessional *congiarium*, and 4. another Italian overrepresentation of *denarii* struck for Verus alone in 166-167, contemporary with the *congiarium* held in honour of his victories in the east in 166.

The theme is clear. If the examples presented here are representative, then we might provisionally conclude that the only plausible cases of audience targeting on the second-century silver are connected with the emperor, court, and associated distributions of cash, especially *congiaria*. The German 'concentration' of Trajanic *denarii*, which bear types referencing the accession of Trajan, might plausibly have been distributed by the emperor or on his behalf in the weeks immediately following his rise to power. The various types noted for the reigns of Antoninus and Aurelius were struck in years of known *congiaria* and are predominantly or solely overrepresented in Italy; in the cases of the *congiaria* of 145 (the marriage of Aurelius and Faustina II) and 166 (for Roman victory in the east), those overrepresentations occur in the form of coins struck for the very members of the imperial family being honoured (and the same people who were probably present to oversee their distribution).

It is possible, of course, that some examples of audience targeting on the silver were not detected by χ^2 because 1. there were insufficient data for the tests to properly expose concentrations in every region; and/or 2. circulation destroyed all trace of concentrations that once existed. The first of these possibilities cannot be discounted: it is undeniable that the quantity of coin-level *denarii* for provinces like Gaul was minimal at the time of data collection, resulting in the almost total exclusion of regions such as this from analysis. More data and more testing for all regions is imperative. Likewise, the quantity of coin-level data available for the second half of the reign of Aurelius, as well as the entirety of the reign of Commodus, is inadequate. The fact that this is probably down to a contemporary downturn in the output of silver coinage means the scope for gathering of sufficient data to further assess the extent of audience targeting on the silver in their reigns is limited.

Regarding point 2: yes, circulation undoubtedly had a role in dulling or destroying some regional concentrations, but it should be pointed out that χ^2 managed to uncover plenty of regional concentrations not connected to audience targeting (these are discussed below) in almost all regions, so it cannot be said that the tests failed to expose regional differences where they exist. Moreover, most of the regions under survey (except Italy) were frontier areas, and therefore the likeliest to produce evidence for audience targeting aimed at the army, who were arguably one of the key (if not the key) audiences in the eyes of the mint and its administrators. That they produced no such evidence raises the question of the extent to which targeted messaging not aimed at a metropolitan or Italian audience occurred on *aes* denominations instead of on the silver. It might well be the case that it was on these coins that the bulk of targeting occurred, as it did in the Flavian era. Kemmers' (2006, 2009a, 2014) work on the coinage of that period exposed the sporadic targeting of soldiers in different parts of the northwestern empire, *e.g.* units on the Rhine, who appear to have been sent types lauding their role in the suppression of the Batavian Revolt led by Civilis in 69/70. That the mint should have continued in this vein is not beyond the bounds of possibility given that the second-century emperors continued to strike substantial *aes* coinages (although the volumes of *asses* and *dupondii,* in particular, declined as the century wore on). The last wide-ranging exploration of the *aes* was that undertaken by Hobley, in 1998 – his is a generally reliable study (it has been noted how concentrations in the silver detected here are often mirrored by corresponding types on the lower denominations), but a fresh assessment, making use of CHRE, PAS, and other data, is sorely needed.

6: Discussion

ii. Coin supply

We can count the number of times the state appears to have used the *denarii* to practice audience targeting on one hand. Evidence that the coin supply was routinely organised on a regionalised basis, however, is plentiful. All of the issue-level χ^2 tests in the preceding five chapters returned overrepresentations showing that virtually every issue displays a bias toward one region or another. The same goes for tests conducted at the level of the design. The relationship between overrepresentations at the level of the issue and the level of the design was not a fixed one, however: on many occasions, it was observed that significant portions of a single issue appear to have been released into circulation in one part of the empire at the same time as a single design (or designs) from within that issue appear to concentrate in different regions entirely. This suggests a system of coin allocation and distribution that could be dynamic and adaptable – one in which it was possible for officials to allocate a significant portion of a production run (*e.g.*, of a particular design or designs) to meet a regional request for a comparatively smaller quantity of coins than would have been the case if the greater part of entire issue was sent.

The degree to which the regions here overlap with ancient administrative divisions of the empire – and, therefore, the officials that might have been responsible for acquiring coins from regional centres or from the capital – is mixed. In the second century, the empire was divided into financial districts overseen by procurators, who worked alongside (rather than beneath) governors, and whose responsibilities ran to the taxation and financial administration of a province and its garrison.[5] Some of these financial districts overlap directly with the regions under study here. Britain, for instance, was consistently under the jurisdiction of one procurator, as was the Rhine, where a single official administered the finances of all four provinces that constitute this region (Gallia Belgica, Germania Inferior, and

[5] Millar 1964 and 1965; Brunt 1966; Goodman 1997, pp. 108-109; Schäfer 1998.

Germania Superior).[6] In this sense, then, both Britain and the Rhine were unified fiscal entities, making it easy to conceive that a single official and his staff could liaised with the mint and treasury officials at Rome in order to receive – and then distribute – shipments of new *denarii* from the centre. Spain was different: being three provinces, there were three procurators, but it is easy to imagine that, of the three, the procurator for Tarraconensis was the informal superior, and certainly most important to this study, since the receipt and distribution of coinage for Spain's sole legion (based in the north-western corner of his province) fell within his jurisdiction. The provinces corresponding with the regions of the Western Danube (Raetia, Noricum, the two Pannonias, parts of Dalmatia, Dacia, and Moesia Superior) and the Eastern Danube (parts of Moesia Superior and Dacia, as well as Moesia Inferior, and Thrace) were each in possession of their own procurators, all of which (except Dalmatia) played host to at least one legion. The durability of these arrangements, which lasted for the entire period under study, as well as overrepresentations of *denarii* along the Danube, suggest that the distribution of new coinage along this part of the frontier could be effectively organised between the centre and individual procurators.

Before going any further, it is important to recall the point that was stressed in the Introduction: namely, that almost all the regions under survey – barring Italy – were militarised, supporting substantial garrisons, and largely at the frontiers. The system (such as it was) of supply and circulation mapped out in the preceding chapters should, therefore, be taken as a reconstruction of *denarius* supply and circulation at the frontiers rather than of the west as a whole, nor less the entire empire. The notable exception in this regard comes in the form of Italy, the coin profile of which was such that elements of the coin supply (*e.g.* the

[6] Britain: see Mattingly 2007, pp. 129, 256, 275, 295, 459, 496; Frere 1973, pp. 197-198. Gaul: the Gallic interior – comprising Gallia Aquitania and Gallia Lugdunensis, which are not examined here – came under the collective aegis of another procurator.

state's evident employment of *congiaria* as a means of putting new *denarii* into circulation), could be made out.

It should be stressed that no single issue or design concentrates entirely in one region alone. No example came forward that showed exclusive zones of circulation, rather, the evidence is favour of regional concentrations, the varying strengths of which might be contingent on the size of the original shipment, how quickly its coins were withdrawn and hoarded (rather than circulating away from their area of distribution), and the effects of circulation itself (or a combination of all three). The overrepresentation of Hadrianic Concordia *denarii* of 119-120 in Britain, for instance, is undeniable, but other *denarii* bearing the same type are present in hoards from every other region under survey.

A particular feature of the χ^2 results, especially at the level of the issue, was that each region's set of overrepresentations tended not to overlap, thereby creating the impression that the mint was directing the bulk of output toward particular regions at different points within each reign, much as Kemmers suggested in relation to Flavian *aes* coinage.[7] Wigg-Wolf neatly summarised the situation, saying: "it is still not clear exactly what mechanisms were behind this rotation. Did the mint or imperial treasury take a central decision about where a year's production was to be sent, or did the provincial treasuries put in a demand for new coin whenever their stock ran low?".[8] The array of overrepresentations we see in the χ^2 results, both at the level of the issue and the design, makes it difficult to understand who lay behind the decision to ship coins: the mint at Rome? Financial officials connected to the army and provincial administration around the empire? The answer probably lies in a middle ground. In the absence of an obvious connection to a known event (*e.g.*, a war or a *congiarium*), many of the overrepresentations described in the preceding chapters were thought likelier to evidence the movement of cash to satisfy some sort of need, official or not, but none of this

[7] Kemmers 2006, pp. 212-215.
[8] Wigg-Wolf 2014, p. 163.

gets us any closer to being able to distinguish shipments sent in response to administrative or military requests for cash from than pre-planned shipments from the centre. It might be averred that the smaller observed shipments, *e.g.*, of a lone type or design, are likelier to represent responses to requests for cash from provincial governors, procurators, and their staff (see the tables presenting the various regional overrepresentations at the level of the design in each chapter), whereas large, issue-level bulges of new *denarii* in one region or another might point to a degree of central planning, but none of this need be a hard-and-fast rule.

Looking to **Table 6.1** (below), it can be seen that there are times in each reign when one region or another seems to have received a greater slice of mint output than the others. In the reign of Trajan, for instance, British overrepresentations at the level of the issue suggest that it was in receipt of the most substantial quantities of coins (relative to the other provinces) in the period *c.* 103-108, after which time the two Danubian regions occupy prime position (*c.* 110-116). As for Hadrian, Britain and the Western Danube appear to receive supply, but at two different times at the beginning and end of the reign; overrepresentations from Italy suggest that it received large quantities of coins through much of the 120s; the Eastern Danube, meanwhile, only returned overrepresentations for the period c. 130-136/138. In the reign of Antoninus, British supply appears to dominate the beginning of the reign, *c.* 138-144/147, but the province continued to return overrepresentations until the end of the 140s; Italy mainly flares up in in the first half of the 140s, too, and then again in the early 150s; the Eastern Danube returned intermittent overrepresentations throughout the reign, but in the Western Danube overrepresentations occurred only in the period *c.* 153-156. The reigns of Aurelius and Commodus are slightly different: in Aurelius' case, the first four years are dominated by Italy and the Western Danube. After this time – concurrent with the beginning of the Marcomannic Wars – supply is dominated by the Eastern Danube, Britain (again, there is war in the province), and Spain (where this is a possibility there was a war, addressed in

Chapter 4: this is possibly an anomaly). As for Commodus: Spain predominates at the beginning of the reign, followed at intervals by Britain, the Rhine, and the Western Danube, but it is hard to detect any pattern owing to the generally low numbers of coins for this reign and it is questionable that these concentrations are reliable at all. Some regions do not register in these results at all: it should be stressed once again that a lack of data for large parts of the Near East and North Africa means we are almost blind to what was occurring there in terms of coin supply. Even with the addition of more data for the east, the politically and fiscally crucial province Egypt, operating a 'closed' currency system, will never show up at all.

The point of all this was not to define every last instance of regional overrepresentation at the level of the issue, but to stress that although the data presented here does appear to support the notion that the supply of new *denarii* to the provinces went through phases (*per* Kemmers and Wigg-Wolf), there is no evident system, or a clear rotation at play. Indeed, many of the periods just outlined correspond with times of wars, insurrections, or invasions in some regions, in which case the coin supply may have risen to levels exceeding those required of peacetime finance, necessitating (perhaps) the disruption of 'normal' or pre-planned supply to other regions. This might account for some of the erratic patterns seen in **Table 6.1.** It is possible that not all supply in times of war was unexpected, or disruptive to existing plans: the war Antoninus fought in Scotland in the early 140s, for instance, was probably a while in the planning (discussed on **pp. 126-130**), and so the bulge of new *denarii* we see in Britain at this time could be construed as the mint satisfying a need to supply Britain at the same time as financing an army at war. The several links between issue-level overrepresentations and *congiaria* described in previous chapters may also represent times at which the mint used an extraordinary – and extraordinarily expensive – event as reason to supply coins, as well as a means to practice targeted messaging when it was required to do so (*e.g.* the *congiaria* held for Aurelius Caesar and Lucius Verus).

6: Discussion

The bottom line is that the dataset of hoarded *denarii* assembled and tested here suggests that the supply of new *denarii* appears to have been routinely uneven, with large portions of annual production being dispatched for preferential release in one region (or regions) over others. War, of course, will have created the need for extra cash on top of what local or regional commanders or provincial administrators had to hand, and it was observed in several places that wars or insurrections manifest themselves in the form of overrepresentations, showing a bulge in the quantities of new *denarii* being sent there.

The finding that the state ramped up shipments of cash in the face of wars might feel like the obvious conclusion, but this is, nevertheless, the first time that any study has been able to show this in respect of the silver coinage. It is natural to wonder what, exactly, the state was intending when it sent extra cash to theatres of war, as in the case of *e.g.* northern Britain in the opening years of Antoninus' reign. A standing army composed of salaried soldiers will not have required more funds in order to cover pay at times of war, but it is possible that more money will have been required in a particular province if troops from outside were shipped in to support the permanent garrison, or if local provincial and military administrators wished to purchase foodstuffs or other goods in order to keep the army in the field (instead of resorting to requisition, say). The process of preparing regularly garrisoned soldiers for life and operations on the move is likely to have thrown up all sorts of problems that were not as pressing (or even obvious) when in regular quarters – *e.g.* the costs associated with the mending of tents, saddles, and other perishable field items, or even the doubling up of soldier's equipment, or horses and waggon-pulling animals (and their fodder) in anticipation of wastage and casualties while on campaign. All this gives only a flavour of the costs that the state might have been attempting to defray when it sent outsized quantities of new *denarii* to provinces at times of war.

Beyond times when we know, from literary and archaeological evidence, that a province and its garrison was embroiled in war or rebellion, it is hard to know whether an apparent

Table 6.1: Regional overrepresentations at the level of the issue									
Trajan		Hadrian		Antoninus		Aurelius and Verus		Commodus	
98	Sp & W M	117	W Dan	138, 138-139	Britain	161, 161-162	W Dan	180	E Dan
100	W Dan	119-120	Britain		Rhine		Italy & Ad	181-182	Sp & W M
	E Med		E Med	139	Britain	161-64 (Lucilla)	Britain	183-184	E Med
103, -104, -105	Britain	120-121	Italy & Ad		E Dan	161-175 (Faust II)	W Dan	186-187	Sp & W M
107-108	Britain	121-123	Italy & Ad	139-141 (Faust I)	Britain	162-163	Italy & Ad	187-188	Sp & W M
	Italy & Ad	124-125	Italy & Ad	140	Britain		W Dan	190	Britain
	E Med	124-130 (East)	Italy & Ad		E Dan	163, 163-164	Italy & Ad		Rhine
110	E Dan	126-127	Italy & Ad	140-143	Britain		W Dan		E Med
111	W Dan	128-129, 129-130, 130	Rhine		Rhine	164-165	Italy & Ad	190-191	W Dan
114-115	E Dan		W Dan		Italy & Ad		E Dan	191-192	Britain
114-116	W Dan	130-133	E Dan		E Med	164-180 (Lucilla)	Britain		Rhine
	E Dan	133-135	E Dan	140-144 (Aurelius Caesar)	Britain		Sp & W M		W Dan
116	Italy & Ad	136	E Dan		Rhine		E Dan	192	Britain
116-117	Rhine	137 (Aelius), 137-138, 138 (Antoninus)	Britain		Italy & Ad	165, 165-166	W Dan		Sp & W M
			Sp & W M		E Med	166, 166-167	Rhine		Rhine
			Rhine	145/146-147 (Aurelius Caesar)	Britain		Italy & Ad		
			E Dan		Italy & Ad	167-168	W Dan		
					E Dan	168, 168-169	Britain		
				145-161	Rhine		Sp & W M		
					E Dan	169 (Divus Verus), 169-170	Britain		
				147-148	Britain		Sp & W M		
				148-149	Britain	170-171	Sp & W M		
				149-150, 150-151	Sp & W M		E Dan		
					Italy & Ad	171-172	Sp & W M		
					E Dan		E Dan		
				151-152	Italy & Ad	172-173	E Med		
					E Dan	173-174	Sp & W M		
				152-153	W Dan	175, 175-176	Britain		
				153-154	W Dan		Sp & W M		
				154-155	W Dan		E Dan		
				155-156	Rhine	176, 176-177	Sp & W M		
				156-157	E Dan	176-180 (mostly Div Faust II)	Sp & W M		
							E Dan		
						177, 177-178	Sp & W M		
							E Med		
						178-79, 179-180	Spain & WM		

bulge in supply is the result of prior planning at Rome, a request for cash top-ups from state servants in the provinces, or an unforeseen event that demanded a relatively sudden redirection of coinage from the mint. Shipments might have been undertaken in order to maintain regular financing of the army and provincial administration, or to facilitate all kinds of likely payments as necessity demanded, including (but not limited to) construction projects in the provinces, loans, cross-frontier payments, deposits with *nummularii* in the provinces, or even relief schemes in the wake of floods or natural disasters. In these cases, the ends to which shipments of new *denarii* will have been put are fairly obvious and require little explanation.

We are, of course only speaking of new *denarii*; the picture of annual supply sketched out in **Table 6.1** would probably look very different if we had a means of visualising when the authorities at Rome or in the provinces employed shipments of re-cycled *denarii* to satisfy demand or facilitate payments. This might account, for example, for the fact that no overrepresentations were seen in either of the Danubian regions at the time of Trajan's two Dacian wars; the first war was probably not long in the planning, and the second was not initiated by Rome (**p. 48**), so it is perhaps little wonder that little no evidence for a large increase in the supply of new *denarii* presented itself. The data presented and analysed here also give little idea of the interior supply to large tracts of land away from the frontier zones, *e.g.*, Gaul or the Balkan and Southern European provinces, where the comparative lack of soldiers might have necessitated different supply mechanisms. This is where more data would be of clear benefit.

iii. Circulation

Discussing audience targeting and regionality in the coin supply is to talk – in an indirect way – about the nature of circulation in the Roman Empire. The picture that has emerged over the course of this study quite clearly runs counter to two of the classic models of the coinage laid out by both Hopkins and Duncan-Jones. In Hopkins' view, the flow of money in the form of taxes, trade, *etc.,* resulted in the homogenisation of the coinage over the first two centuries , and contributed to the integration of the economy as a whole.[7] Regional difference in the composition of the coinage, under these circumstances, would be unimaginable. The picture painted here strongly points to the possibility that the silver coinage never fully homogenised in this way. The view expounded by Duncan-Jones, on the other hand, was that the Roman coinage was fundamentally fragmented and disjointed, which he supported with his finding that certain issues and reverse types cluster in particular corners of the empire.[8] His entire purpose in pointing to coin designs that never appeared to have strayed far from their initial points of distribution was to serve this point.[9]

It has long been known that *aes* denominations commonly cluster in the regions where they were sent (*e.g.* the famous *BRITANNIA* issues of Hadrian and Antoninus), sometimes to the extent that they are almost never found anywhere else, so the finding that the silver appears to have behaved in something of the same way is not entirely surprising. The results of the χ^2 tests carried out here confirm that this assessment of the coinage bears some resemblance to the truth, but with the key qualification that there was also considerable mixing at both the level of the issue and the design, and that no silver types appear to have

[7] Hopkins (1980). His proposition, in brief, was that tax imposition was a stimulus to monetisation; people needed the money to pay taxes and money rents and so sold produce and other goods to acquire it. This acted as the stimulus to markets, bankers, long-distance trade and the commercialisation of towns and exchange; the money supply rose correspondingly. Coins existed in a cycle that saw tax revenues from more productive 'inner' provinces exported to 'consumer' regions, primarily the frontiers where they took the form of military pay; these coins were spent and re-entered the cycle, being reclaimed by the state in the form of tax and returned to the soldiers, *etc*.

[8] Duncan-Jones 1990, pp. 38-42 and 2002, p. 475. Most of Duncan-Jones's claimed concentrations were not confirmed in the results of the tests carried out here, largely because his sample sizes were too small.

[9] In other instances, Duncan-Jones is ready to concede that some designs display a widespread distribution – *e.g.*, Sabina, whom he cites (1990, p. 40; 1994 p. 175.) as appearing in roughly the same proportions in hoards from regions as far apart as Britain and Syria. For further, related debate on circulation in the Severan period, see Duncan-Jones (2001, 2002). It was his contention that the widespread lack of eastern-minted Severan *denarii* in the west is not to be explained by the time it took them to filter westward, but because coin users in the west slowly removed eastern *denarii* from circulation, therefore making it look like they were less of a presence than was originally the case. This was subject to countervailing replies from Howgego (2002) and Hellings (2016).

circulated exclusively in one area. This is true of even the most intense concentrations that emerged from the χ^2 tests, *e.g.* the Trajan and Jupiter *denarii* of 114-115, which concentrate strongly in the Eastern Danube (mainly the Reka Devnia hoard), also appear in hoards from England, France, Italy, Germany, Croatia, Hungary, and Romania. Ditto rare coins, *e.g.*, the Trajan and Senator design that we have in the form of just three examples, one of which turned up within a mid-third-century hoard (Reka Devnia again) in the Eastern Danube, hundreds of miles away from its probable point of release around Cologne in Lower Germany.

The striking degree of empire-wide uniformity at the level of the issue was visualized in each chapter in charts showing the relative frequences at which issues occur in the Reka Devnia hoard and in the rest of the CHRE hoards combined. Spoerri Butcher and Hellings (2017) demonstrated as much for Trajan; the results of the χ^2 tests in **Chapter 1** (Trajan) confirmed their findings not only in the case of the Trajanic silver coinage, but for every other reign under study here. A combined view for all five reigns, of the relative issue-level frequences between Reka Devnia and the CHRE dataset can be seen overleaf, in **Figures 6.6** and **6.7**.[10]

This is the first time that the close correspondence between Reka Devnia and the rest of the hoards available to us has been visualised for the second-century silver beyond the reign of Trajan. First and foremost, it shows that the frequencies observed in Reka Devnia are largely reliable indicators of their presence in general circulation, which is of great use to anyone with an interest in relative levels of output on a year-by-year basis. The few issue periods in which the two datasets significantly diverge from each other (*e.g.*, 114-115, 126-127, or 154-155) are exceptions that prove the rule, and were explained in the corresponding

[10] Two charts have been produced: one that includes the inordinately large spike for coins struck *c.* 141-161 (the broadly dated *denarii* of Diva Faustina I), and one without, so that 'true' peaks (*e.g.*, the large spikes of *denarii* struck 108-109 and 161-162) are afforded the correct level of prominence.

chapters as the result of certain issues (or occasionally designs) being significantly overrepresented in one region or another.

The position being endorsed here is closest to the one outlined by Howgego (1994), who stressed that to dispute whether the coinage mixed is to ask the wrong question, because it quite clearly did mix, even though it has been possible to expose clear regional differences remaining in the distribution of issues and designs. Rather, we should be asking how long it took for the coinage to mix once released into circulation, since this gives us a better chance of getting to grips with the nature of circulation and, beyond that, of debates concerning the overall economic integration of the Roman world.

In part to answer this question, and partly in the hope that it might be possible to trace concentrations of *denarii* back through time, the datasets for each reign were divided into four subsets and analysed according to hoard closing date, namely: hoards closing up to the years 161, 180, 192, and 211 (except the reign of Commodus, where sample sizes did not allow). The results of these tests were compared to the same tests carried out on the complete dataset, with no lower or upper limits placed on closing dates. The introductory chapter addressed questions regarding how certain we can be that the closing dates of these hoards actually reflect the times at which they were composed and/or closed (**pp. 25-27**), but in the absence of a more practical solution, and since other studies had made effective use of the same method, it was decided that it ought to be trialled here on the CHRE dataset. The results were positive, insofar as:

1. The χ^2 tests exposed regional overrepresentations (*i.e.,* concentrations) of *denarii* at both the level of the issue and the design in the earliest of the subsets (*e.g.* hoards closing by 161, 180). These overrepresentations commonly endured through the later subsets and into the complete dataset. In many cases, faith in the method was boosted when overrepresentations appeared in places, and at times, that we might have

expected: *e.g.* in Britain or along the Danube at times of war, or Italy in *denarii* contemporary with *congiaria*.

2. The same tests exposed overrepresentations that gradually weakened and/or disappeared through the later subsets and into the complete dataset, suggesting that the potency of these regional concentrations were reduced over time – possibly as a result of circulation.

It is hard to point to a moment in time over the course of each reign when overrepresentations begin to drop off *en masse* as circulation took effect. Each reign appears to have been slightly different. The largest single dataset – for the reign of Antoninus Pius – behaves in the way one might have predicted, *i.e.*, the overall number of overrepresentations diminishes as we move from the earliest of the subsets through to the latest (see **Chapter 3**, **Table 3.5**). It produced 22 overrepresentations in the subset of hoards closing by 180 (the earliest to be tested for that reign), 20 overrepresentations for the 192 subset, 19 for the 211 subset, and 16 for the complete and uncontrolled dataset of hoards closing up to *c.* 250. Was this because circulation was gradually eroding concentrations so that the number of overrepresentations diminished over time, or because external factors such as the Marcommanic War of the next reign caused people to withdraw a disproportionate number of *denarii* from circulation and deposit them in hoards closing by either 180 or 192, thereby accounting for the higher number of overrepresentations in the earlier subsets? It is hard to say for sure, but the fact that many overrepresentations tend to decrease in strength over time suggests that circulation was a factor. This is true not only of the dataset for Antoninus, but all the other reigns under survey.

As for the other reigns: it was remarked in **Chapter 1** (Trajan) that the earliest subset (hoards closing by 161) contained almost as many issue-level overrepresentations as in the complete dataset (eight and six respectively); had the process of mixing plateaued by 161? The

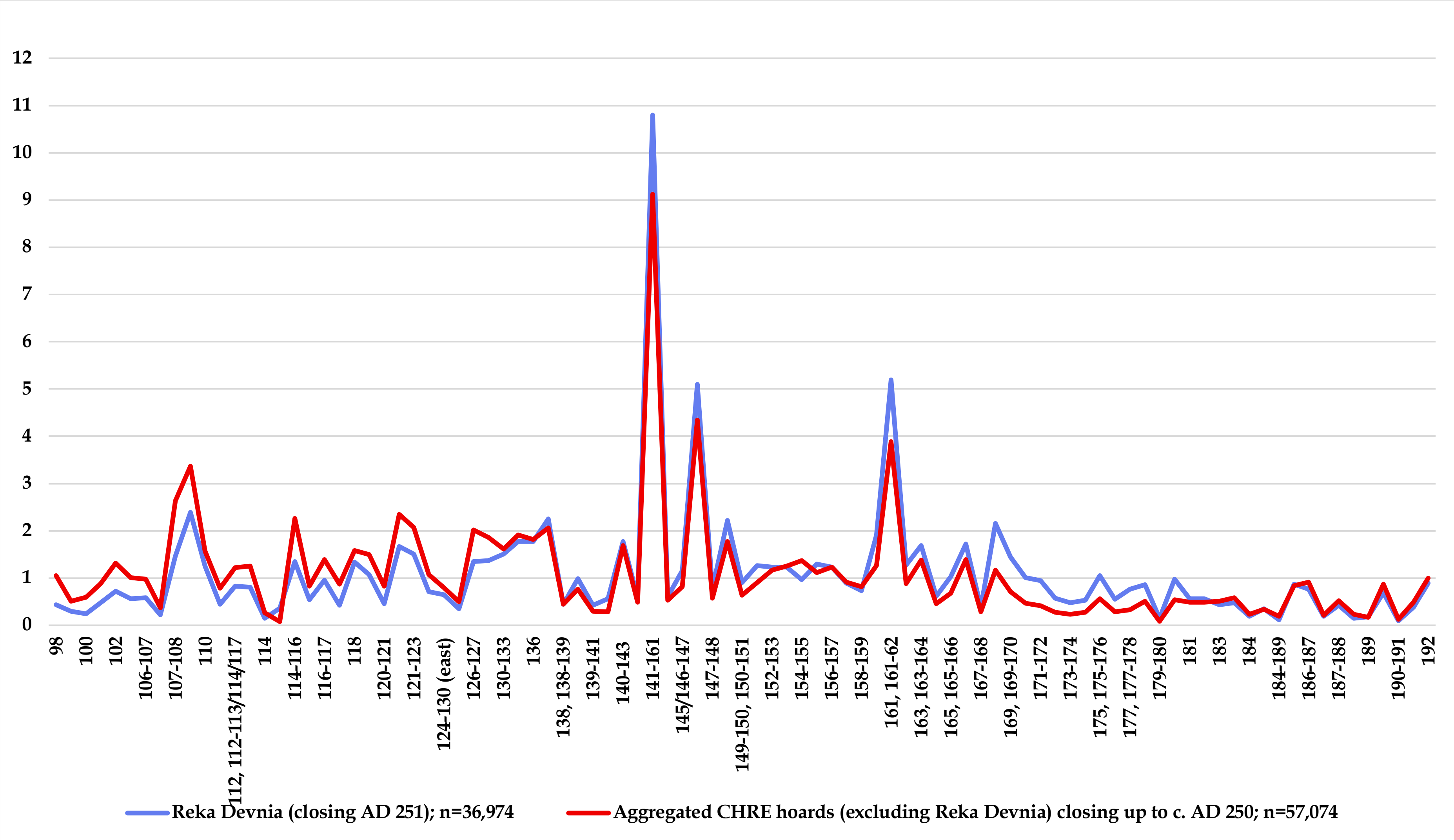

Figure 6.6: Relative frequencies of denarius issues c. 98-192, expressed as percentage of the total number of coins in each dataset (<u>with</u> denarii of 141-161)

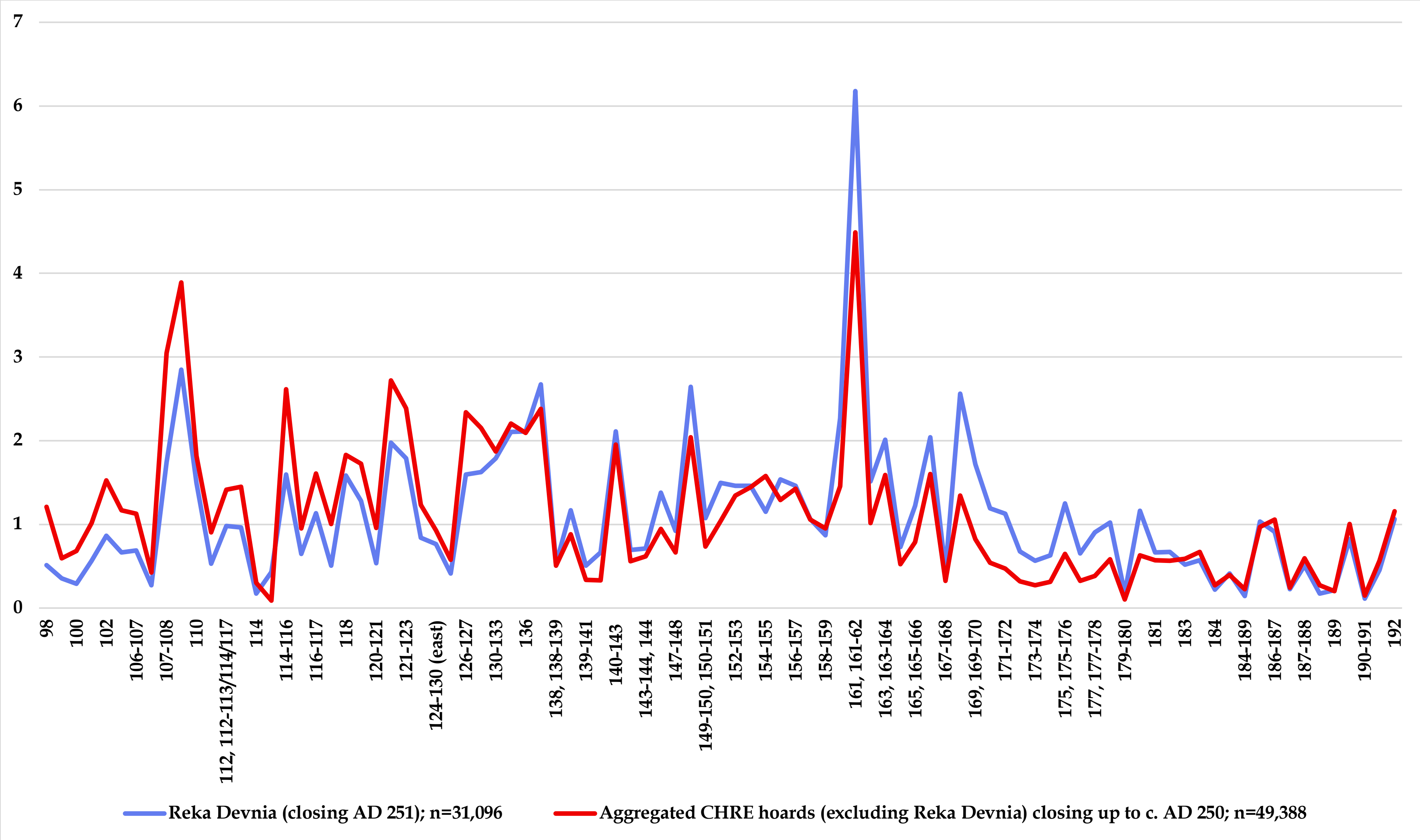

Figure 6.7: Relative frequencies of denarius issues c. 98-192, expressed as percentage of the total number of coins in each dataset (<u>without</u> denarii of 141-161)

Hadrianic dataset, like the *denarii* of Antoninus, produced more overrepresentations in the earliest testable subset (hoards closing by 161; nine overrepresentations) than it did in the succeeding subsets closing by 180 (six), 192 (seven), and 211 (seven) – but in the complete dataset the number of overrepresentations jumps to 13: see **Chapter 2**, **Table 2.6**. This jump is possibly because the final dataset was so much larger than the preceding subset (8,557 and 19,755 *denarii* respectively), thereby causing more overrepresentations to come to light.

The dataset for the reign of Marcus Aurelius presents its own problems (see **Chapter 4**, **Table 4.5**). Here, we are not in the best position to declare whether overrepresentations do or do not fade over time as a result of circulation. This is because the numbers of available coins, even at the level of the issue, were largely insufficient in the earliest hoard subsets (hoards closing by 180 and 192), with a particular lack of coins for the second half of the reign. This left only the results from the final subset (hoards closing by 211) and the complete dataset to go by, but the number of overrepresentations in their case were practically identical: 21 and 22 respectively.

A more useful measure of gradually declining interregional difference at the level of the issue might be found in the standard deviations for each reign, rather than the χ^2 results for each subset within each reign. Figures **1.2**, **2.5**, **3.7**, and **4.17** in the preceding chapters present the standard deviations of the χ^2 standardised residuals for each reign at the level of the issue. They quite clearly show that the standard deviations for the reigns of Trajan and Hadrian (**Figures 1.2** and **2.5**) are consistently nearer 0 than those of the following reigns. They are also more closely bunched together, exhibiting a smaller range (1.4274 and 1.4150 standard deviations respectively).

Both of these things tell us that the interregional distribution of their coinages display less overall variation than those of the next reign, Antoninus Pius (Figure **3.7**), where the standard deviations are slightly more dispersed and occupy a slightly wider range (1.5284) – *i.e.*, the *denarii* of Antoninus are still quite mixed, but not as much as those of his two predecessors. If we use as an indicator that 71%, 65%, and 54% of the datasets for Trajan, Hadrian, and Antoninus respectively come from hoards dating up to 200, then this significant degree of mixing could have been achieved by then.[11] In other words: in order to mix to the degree of the <u>most</u> integrated of these coinages (taking Trajan as our example), the *denarii* in question would require the better part of a century (between perhaps 80-100 years: the approximate time that the newest and oldest Trajanic *denarii* could theoretically have been in circulation) to reach a similar point. Even then, we know that this was not enough for them to have mixed so thoroughly that all trace of their original distribution had been eradicated.

The continued existence of regional difference at the level of both the issue and the design points towards a coinage that was never evenly supplied to begin with. The gradual reduction in interregional difference we see in the charts below also points toward a coinage that was simultaneously on a journey toward homogenisation (as coins moved about through taxes, trade, rents, *etc.*).

The situation changes with the coinages of Aurelius and Commodus (**Figure 4.17** and **Table 5.1**). In their cases, the ranges of their standard deviations are much larger (2.5901 and 3.3382 respectively) than those of the three reigns preceding them. The degree of difference between the ranges of Hadrian and Antoninus is barely equivalent to 0.1 standard deviations, whereas the difference between the ranges of Antoninus and Aurelius is equivalent to just over 1 standard deviation, and even more in the case of Commodus. These are large increases in relative terms, and are suggestive that the *denarii* of both Aurelius and Commodus were considerably less integrated by the time of their deposition than those of Antoninus.

Well over half (65%) of Aurelius' *denarii*, and exactly 50% of Commodus *denarii*, come from hoards closing by 211. Even if these hoards were actually assembled and deposited in

[11] These figures do not include the enormous numbers of *denarii* from the Reka Devnia hoard, the inclusion of which would unrealistically skew these percentages in favour of the mid-third century. Things become even more impressive if we push the closing date of the hoards up to 211: in which case 79%, 77%, and 69% of each dataset had been withdrawn from circulation and hoarded.

the 230s or 240s, then the time that the Aurelian and Commodan *denarii* spent in circulation was still a little shorter when reckoned against *denarii* of Trajan, Hadrian, and Antoninus. This was possibly on account of the Severan debasement of 194, or the even earlier decline in mint output from *c.* 170 (see discussion in **Chapters 4** and **5**), both of which might have encouraged hoarders to withdraw coins at an increased rate. All this could account for the comparative lack of mixing we see in the coinages of Aurelius and Commodus, and could show just how much (or how little) mixing could occur between two points in time, one fairly definite and the other less so. The first is their release into circulation, which can be fairly well dated; the second is the date at which they were hoarded – either by 211 (the time after which the majority of both the Aurelian and Commodan datasets had been hoarded, if not actually deposited), or as late as the 230s, 240s, or 250s – a period of up to 89 years in the case of the oldest of Aurelius' issues; 70 for Commodus. Again, even this amount of time was far from sufficient to eradicate regional differences: the number of overrepresentations from Aurelius' reign, for instance, was considerable, revealing the supply of coins to trouble spots in Britain and along the Danube, as well as ceremonial releases of *denarii* in Italy itself.

It is possible, of course, that the relationship between mixing and length of time spent in circulation might not be as direct as all this. A competing possibility is that mixing decreased as the second century wore on, presaging the more regionalised patterns of circulation seen in the debased radiate coinage of the third century (which has itself been viewed as symptomatic of wider economic fragmentation). This argument was put forward in **Chapter 4** as one possible explanation for a perceived lack of integration in the *denarii* of Aurelius and Commodus, but there are problems with the directness of this comparison. These range, most obviously, from the problems associated with viewing the (lack of) integration in the coinage as a barometer of economic integration, to the fact that the third-century radiate coinage was phased out at the turn of the fourth century, meaning it was never given the opportunity to mix to the same degree as *denarii* (see above, **pp. 208-209**).

Just as interesting as the role of circulation in eroding regional concentrations is the finding that those regional concentrations (both at the level of the issue and the design) that never appeared to go away. Many of these appeared in the earliest of the hoard subsets and continued to return overrepresentations all the way through to the uncontrolled group of hoards closing as late as *c.* 250. We can only speculate on the reasons for this, but it is possible that the answer might partially be a matter of geography, and that the level of integration brought about by circulation might have varied according to the nature of the regions concerned. This requires more work and thought, but for now it is worth observing that some regions – notably Britain and Spain – show patterns of overrepresentation that may be partly explained by their (pen)insular geographies, which could have limited the outward movement of coins once they entered circulation. Britain, even more than Spain, repeatedly appears to retain shipments of *denarii*, much as it does lesser mobile *aes* denominations. Italy, too, often returned standardised residuals for each of the subsets and the main dataset that signalled persistent concentrations of coins at both the level of the design and the issue: see especially **Chapter 2**, **Table 2.6**, where Hadrianic overrepresentations (including of *denarii* brought back from the east) do not appear to fade. All of this is theoretical, and before earning acceptance would have to account for a) the fact that while we might reasonably claim Britain was capable of holding onto coinage, it is less easy to argue for Italy being some sort of fiscal island that prevented money from leaving; and b) the existence of equally persistent overrepresentations in areas of the empire like the Rhine and Danubian frontiers, which are geographically dissimilar to Britain, Spain, or Italy. In respect of point a), it might be remarked that the mint and treasury officials in Italy were perfectly capable of moving coin out of Rome and to the provinces, but this is a separate issue to the one of coinage that was actually circulating in Italy. The persistence of the concentrations noted here might suggest that the amount of silver coinage leaving Italy in purses, chests, or aboard ship (see above, **pp. 104-106**, in which the numbers of coins found aboard shipwrecks are discussed) could have been low enough that the private movement and circulation of *denarii* would never have been sufficient to bring about full integration.

*   *

There remains plenty of work to be done, or ways in which the research carried out here could be expanded upon. First, when speaking of circulation, we have only been drawing on second-century material. It is potentially important that the degree and speed of mixing appears to have slowed in the later part the first half of the century (see **Chapter 4** on Aurelius, esp. **Table 4.9**), but no comparisons were drawn between the degree of mixing seen in the coinages of *e.g.* Trajan and Hadrian compared with those of Nerva or the Flavians. An extension of this study into the first century would, therefore, be beneficial.

Second, a complementary (re)assessment of the distribution of second-century *aes* is now overdue. It was noted in the discussion on audience targeting that if the number of plausible examples on the silver is low, then it is likely that *aes* remained a key vehicle for audience-based messaging, as in the Flavian period. Hobley demonstrated some trends in the disposition of second-century issues and designs, but the advent of new ways of visualising these trends, as well as new or enhanced data for the various regions of the empire (*e.g.* CHRE, PAS, or PAN), has created the need for a fresh reappraisal that complements the silver.

Finally, there remains the question of the gold coinage, which has never been subjected to a wide-ranging distributional assessment. At various points in this study, *e.g.* in the matter of how Trajan financed his Dacian wars (**pp. 47-48**), and later, in the reign of Commodus (when the striking of silver appears to have entered a precipitous decline; see **Chapter 5**), it was speculated that, as under the Julio-Claudians prior to the reform of Nero, the importance of gold to imperial finance might have increased in tandem with the decline in silver output. It is possible that the growing number of gold hoards, not to mention finds of single *aurei*, being registered on the CHRE database will allow for such a study in the near future, complementing recent research undertaken on the metallurgy of Roman gold coinage by George Green (2020).

In order to facilitate further work, it is important that more data are located for regions that could not be included in this study. Addressing the lack of *denarius* hoards from central Italy and Rome with available design-level information, *e.g.* the largely inaccessible Via Braccianese hoard (6,442 *denarii* to 235; CHRE 13851) from the outskirts of Rome, would be particularly beneficial given evidence for repeated (and sometimes targeted) distributions that emerged from the χ^2 tests. An expansion of coverage for all of the empire would, of course, be ideal, since it is still to say whether the conclusions arrived at here are applicable to the wider empire, or apply only to the regions that were studied here – most of which, with the exception of Italy, could be called 'frontier' areas, characterised by the presence of Roman military units (and their pay).

Chapter 5, on the coinage of Commodus, took a different tack. A limited number of issue-level χ^2 tests were possible, but the main feature of this chapter was an exploration of the reasons behind the lack of available Commodan *denarii* which, until now, has not been explored in any great depth. A preliminary survey of the Commodan *denarii* listed on OCRE revealed a high number of die links between hoarded and singly found specimens from unrelated contexts in parts of the empire as distant as Spain, Jordan, and Britain. A similar survey of *denarii* struck under Marcus Aurelius revealed that die links begin to become apparent on that coinage from *c.* 175 onward, which tallies with a decline in apparent output seen in the frequency of issues within the Reka Devnia hoard. This decline in output probably came about as the result of falling bullion supplies from the mines, exacerbated by the effects of the Antonine Plague (*e.g.,* depopulations, failure of mine workings, a reduced tax base), and a corresponding rise in the cost of striking silver at Rome. Moving forward, it is vital to confirm or deny the theory that the coinages of Aurelius and Commodus were indeed smaller, which necessitates the addition of many hundreds more coins from as many provenanced contexts as possible. This will in turn clear the ground for automated die studies much in the manner of similar, groundbreaking work undertaken on the size of the Julio-Claudian coinage (Emmanuel Mayer, forthcoming)

This study has made ground on questions of audience targeting (a sporadic practice on the silver, for which there was little evidence outside of very particular contexts), the highly uneven and regionalised organisation of coin supply, and the nature of circulation in the second century before key changes to currency in the early Severan period. None of this is the final word, but is intended merely as the starting point of a longer enquiry into the supply and distribution of the second-century silver coinage.

Bibliography

Reference works

BMC III Mattingly, H., 1936. *Coins of the Roman Empire in the British Museum, vol. 3: Nerva to Hadrian*. British Museum Press.

Cohen Cohen, H. *Description historique des monnaies frappées sous l 'Empire Romain*. 8 Volumes.

FMRD *Die Fundmünzen der römischen Zeit in Deutschland.* 10 volumes.

MIR 14 Woytek, B. 2010. *Die Reichsprägung des Kaisers Traianus (98 – 117). Moneta Imperii Romani (MIR)* Band 14. Austrian Academy of Sciences.

RIC II Mattingly, H., and Sydenham, E. A. 1926. *The Roman Imperial Coinage Vol. II. Vespasian to Hadrian*. Spink.

RIC II.2 Carradice, I. A., and Buttrey, T. V. 2007 (2nd ed.). *The Roman Imperial Coinage Vol. II – Part 1. Vespasian to Domitian*. Spink.

RIC II.3 Abdy, R. and Mittag, F. 2019. *Roman Imperial Coinage II.3. From AD 117 to AD 138.* Spink.

RIC III Mattingly, H., and Sydenham, E. A. 1930. *The Roman Imperial Coinage Vol. III. Antoninus Pius to Commodus.* Spink.

RIC IV.1 Mattingly, H., and Sydenham, E. A. 1936. *The Roman Imperial Coinage Vol. IV Part I. Pertinax to Geta.* Spink.

RPC III Amandry, M. and Burnett, A. 2015. *Roman Provincial Coinage Vol 3. Nerva, Trajan and Hadrian (AD 96-138)*. British Museum Press.

RPC IV.4 Howgego, C. 2024. *Roman Provincial Coinage IV.4: Antoninus Pius to Commodus (Ad 138-192): Egypt.* British Museum Press.

Primary literature

Arrian *Periplus Ponti Euxini*. Translated by A. Liddle. Bristol Classical Press, 2003.

Cassius Dio *Roman History, Volume IX: Books 71-80.* Translated by E. Cary and H. B. Foster. Loeb Classical Library 177. Harvard University Press, 1927.

Fronto *Correspondence, Volume I*. Translated by C. R. Haines. Loeb Classical Library 112. Harvard University Press, 1919.

Herodian *History of the Empire, Volume I: Books 1-4*. Translated by C. R. Whittaker. Loeb Classical Library 454. Harvard University Press, 1969.

Martial *Epigrams, Volume II: Books 6-10.* Translated by D. R. Shackleton Bailey. Loeb Classical Library 95. Harvard University Press, 1993.

Pausanias *Description of Greece, Volume I: Books 1-2 (Attica and Corinth)*. Translated by W. H. S. Jones. Loeb Classical Library 93. Harvard University Press, 1918.

Pliny the Younger *Letters, Volume II: Books 8-10. Panegyricus.* Translated by B. Radice. Loeb Classical Library 59. Harvard University Press, 1969.

Bibliography

SHA	*Historia Augusta, Volume I.* Translated by D. Magie. Revised by David Rohrbacher. Loeb Classical Library 139. Harvard University Press, 2022.
Suetonius	*Lives of the Caesars, Volume II: Claudius. Nero. Galba, Otho, and Vitellius. Vespasian. Titus, Domitian.* Translated by J. C. Rolfe. Loeb Classical Library 38. Harvard University Press, 1914.

Secondary literature

Abdy, R.	2012	'The Severans' in W. Metcalf (ed.) *The Oxford Handbook of Greek and Roman Coinage.* Oxford University Press, pp. 499-513.
Abudanah, F., Tarawneh, M. B., Twaissi, S., Wenner, S. and Al-Salameen, A.	2016	'The *Via Nova Traiana* between Petra and Ayn Al-Qana in Arabia Petraea', *Oxford Journal of Archaeology* 35, pp. 389-412.
Agresti, A.	2007	*An Introduction to Categorical Data Analysis.* Wiley.
Allen, J.	2007	'The gold coinage of Trajan dated COS V', *American Journal of Numismatics* 19, pp. 33-76.
Alston, R.	1994	'Roman Military Pay from Caesar to Diocletian', *Journal of Roman Studies* 84, pp. 113-123.
Alföldy, G.	1971	'Der Friedensschluss des Kaisers Commodus mit den Germanen', *Historia: Zeitschrift für Alte Geschichte* 20, pp. 84-109.
Allason-Jones, L. and McKay, B.	1985	*Coventina's Well. A Shrine on Hadrian's Wall.* Trustees of the Clayton Collection.
Ameling, W.	1992	'Die Kinder des Marc Aurel und die Bildnistypen der Faustina Minor', *Zeitschrift für Papryologie und Epigraphik* 90, pp. 147-166.
Barbato, M.	2014	'Flavian Typology: The Evidence from the '*sottosuolo urbano*' of Rome' in N. T. Elkins and S. Krmnicek (eds.) *'Art in the Round': New Approaches to Ancient Coin Iconography.* Tübinger Archäologische Forschungen 16. Marie Leidorf, pp. 173-180.
Bastien, P.	1988	*Monnaie et donativa au Bas-Empire*. Éditions Numismatique romaine.
Beckmann, M.	2007	'Trajan's gold coinage, AD 112-117', *American Journal of Numismatics* 19, pp. 77-129.
–	2009a	'The Significance of Roman Imperial coin types', *Klio* 91, pp. 144-161.
–	2009b	'The coinage of Diva Faustina' in N. Holmes (ed.) *Proceedings of the XIVth International Numismatic Congress Glasgow 2009 Volume I.* Spink.
–	2012a	*Diva Faustina: Coinage and Cult in Rome and the Provinces.* Numismatic Studies No. 26. American Numismatic Society
–	2012b	'Trajan and Hadrian' in W. Metcalf (ed.) *The Oxford Handbook of Greek and Roman Coinage.* Oxford University Press, pp. 405-422.
–	2015	'The Function of the Attribute of Liberalitas and its use in the Congiarium', *American Journal of Numismatics* 27, pp. 189-198.

–	2017	‘The Restoration of Mark Antony’s Legionary Denarii by Marcus Aurelius and Lucius Verus’, *Numismatic Chronicle* 177, pp. 135-147.
–	2021	*Faustina the Younger: Coinage, Portraits, and Public Image*. Numismatic Studies 43. New American Numismatic Society.
Bennett, J.	1997	*Trajan: Optimus Princeps.* Routledge.
Birley, A.	1981	*The fasti of Roman Britain.* Oxford University Press.
–	1997	*Hadrian: The Restless Emperor.* Routledge.
–	2000a	‘Hadrian to the Antonines’ in A. K. Bowman, P. Garnsey, and D. Rathbone (eds.) *The Cambridge Ancient History Volume XI: The High Empire, A.D. 70-192.* Second edition. Cambridge University Press, pp. 132-194.
–	2000b	*Marcus Aurelius: A Biography.* Routledge.
Blamberg. J. E.	1976	*The Public Image Projected by the Roman Emperors (A.D. 69-117) As Reflected in Contemporary Imperial Coinage.* Indiana University Press.
Bland, R.	1993	‘The coinage of Jotapian’ in A. Burnett and R. Bland (eds.) *Essays in Honour of Robert Carson and Kenneth Jenkins.* Spink, pp. 191-206.
–	2018	*Coin Hoards and Hoarding in Roman Britain AD 43-c. 498.* Spink.
–	2020	‘Coin hoards in the Roman Empire: A long-range perspective. Some preliminary observations’, *Journal of Ancient History and Archaeology* 7.1: *Group and Individual Tragedies in Roman Europe*, pp. 119-132.
Bland, R., Chadwick, D., Ghey, E., Haselgrove, C., Mattingly, D. J., Rogers, A., and Taylor, J.	2020	*Iron Age and Roman Coin Hoards in Britain.* Oxbow.
Börner, S.	2012	*Marc Aurel im Spiegel seiner Münzen und Medaillons. Eine vergleichende Analyse der stadtrömischen Prägungen zwischen 138 und 180 n. Chr.* Habelt.
Breeze, D., and Ferris, I.	2016	‘They think it’s all over. The face of victory on the British frontier’, *Journal of Conflict Archaeology* 11, pp. 19-39.
Brickstock, R.	2024	‘Counterfeit Coin Moulds from Britannia Inferior’ in A. Dymowski and K. Myzgi (eds.) *Counterfeits, Imitations, and Copies of Roman Imperial Denarii: Making and Faking Coins on Both Sides of the Limes*. Brepols, pp. 15-21.
Brown, L.	2008	‘Charon’s Obols? A Case Study in the Role of Coins in Roman Burial Ritual Space’, *Theoretical Roman Archaeology Journal* 2007, pp. 121-130.
Brunt, P. A.	1966	’Procuratorial Jurisdiction’, *Latomus* 25.3, pp. 461-489.
Bruun, C.	2003	‘The Antonine Plague in Rome and Ostia’, *Journal of Roman Archaeology* 16, pp. 426-434.
Butcher, K.	2024	‘Determining Weight Standards of Debased Ancient Silver-Copper Alloy Coinages’, *Numismatic Chronicle* 184, pp. 25-38.

Bibliography

Butcher, K. and Ponting, M 2005 ‘The Roman *denarius* under the Julio-Claudian Emperors: mints, metallurgy and technology’, *Oxford Journal of Archaeology* 24, pp. 163-197.

– 2009 ‘Roman Silver Coinage: Mints, Metallurgy, and Production’ in A. K. Bowman and A. Wilson (eds.) *Quantifying the Roman Economy: Methods and Problems.* Oxford University Press, pp. 269-280.

– 2012 ‘The Beginning of the End? The *Denarius* in the Second Century’, *Numismatic Chronicle* 172, pp. 63-83.

– 2014 *The Metallurgy of Roman Silver Coinage: From the Reform of Nero to the Reform of Trajan*. Cambridge University Press.

– 2022 ‘Hoarding of *Denarii* and the Reforms of Nero and Septimius Severus’ in J. Mairat, A. Wilson, and C. Howgego (eds.) *Coin Hoards and Hoarding in the Roman World.* Oxford University Press, pp. 273-281.

Buttrey, T. V. 1993 ‘Calculating Ancient Coin Production: Facts and Fantasies’, *Numismatic Chronicle* 153, pp. 335-351.

Campbell, B. 1994 *The Roman Army, 31 BC–AD 337: A Sourcebook.* Routledge.

Carradice, I. 1983 *Coinage and Finance in the Reign of Domitian AD 81-96*. Oxford University Press.

Clay, C. L. 1989 ‘The Supply of Bronze Coins to Britain in the Second Century AD’, *Numismatic Chronicle* 149, pp. 209-244.

Collis, J. 1988 ‘Data for dating’ in J. Casey and R. Reece (eds.) *Coins and the Archaeologist,* Second Edition. Seaby, pp. 189-199.

Crawford, M. 1983 ‘Roman imperial coin types and the formation of public opinion’ in C. N. L. Brooke (ed.) *Studies in Numismatic Method Presented to Philip Grierson.* Cambridge University Press, pp. 47-64.

Creighton, J. 2002 *The Circulation of Money in Roman Britain from the First to Third century by John Creighton*. PhD thesis, Durham University.

– 2014 ‘The supply and movement of denarii in Roman Britain', *Britannia* 45, pp. 121-163.

Davis, G., Blichert-Toft, J., Gentelli, L., Gore, D. B., Sheedy, K. A., and Albarède, F. 2025 ‘Identifying silver ore sources for the earliest coins of Athens’, *Archaeological and Anthropological Sciences* 17, Article 45. Online resource: https://doi.org/10.1007/s12520-024-02120-3.

de la Bédoyère, G. 1999 *Companion to Roman Britain.* Tempus.

Delegido Morant, C. 2014 *Aprovisionamiento, circulación y uso de la moneda de plata en Hispania (siglos I-III d.C.): El Tesoro de Llíria*. PhD thesis, University of Valencia: http://hdl.handle.net/10550/39268.

Deligio, C., Tolle, K., and Wigg-Wolf, D. 2022 ‘Supporting the analysis of a large coin hoard with AI-based methods.’ Online resource: 10.5281/zenodo.11187474.

Depeyrot, G. 2004 *La propaganda monétaire (64-235) et le trésor de Marcianopolis (251).* Moneta.

Bibliography

Depeyrot, G., and Moisil, D. 2004 *Le trésor de Frâncești (Roumanie). Les débuts de la crise du denier (98-235)*. Moneta.

Duncan-Jones, R. 1964 'The purpose and organisation of the Alimenta', *Papers of the British School at Rome* 32, pp. 123-146.

– 1974 *The Economy of the Roman Empire.* Cambridge University Press.

– 1990 *Structure and Scale in the Roman Economy*. Cambridge University Press.

– 1994 *Money and Government in the Roman Empire*. Cambridge University Press.

– 1996 'The impact of the Antonine Plague', *Journal of Roman Archaeology* 9, pp. 108-136.

– 1999 'The Monetization of the Roman Empire: Regional Variations in the Supply of Coin Types' in G. M. Paul and M. Ierardi (eds.) *Roman Coins and Public Life under the Empire. E Togo Salmon Papers II*. Michigan, pp. 61-82.

– 2001 'The Denarii of Septimius Severus and the Mobility of Roman Coin', *Numismatic Chronicle* 161, pp. 75-89.

– 2002 'The Denarii of Septimius Severus and the Mobility of Roman Coin: Further Comment', *Numismatic Chronicle* 162, pp. 342-345.

– 2005 'Implications of Roman Coinage: debates and differences', *Klio* 87 pp. 459-487.

– 2006 'Crispina and the Coinage of the Empresses', *Numismatic Chronicle* 166, pp. 223-228.

Eck, W. Holder, P., and Pangerl, A. 2016 'Eine Konstitution aus dem Jahr 152 oder 153 für niedermösische und britannische Truppen, abgeordnet nach Mauretania Tingitana', *Zeitschrift für Papyrologie und Epigraphik* 199, pp. 187-201.

Edmund, T. 2020 *Monumentality and the Roman Empire: Architecture in the Antonine age.* Oxford University Press.

Elkins, N. 2011 'Monuments on the Move: Architectural Coin Types and Audience Targeting in the Flavian and Trajanic Periods' in N. Holmes (ed.) *Proceedings of the XIVth International Numismatic Congress.* Spink.

– 2015 *Monuments in Miniature: Architecture on Roman Coinage.* Numismatic Studies 29. American Numismatic Society.

– 2017a *The Image of Political Power in the Reign of Nerva, A. D. 96-98*. Oxford University Press.

– 2017b 'Aequitas and Iustitia on the coinage of Nerva: a case of visual panegyric', *Numismatic Chronicle* 177, pp. 93-106.

– 2018 'Coinage programs and panegyric in the reign of Trajan', *Memoirs of the American Academy in Rome* 63, pp. 169-201.

– 2019 'Publicizing Victory: The Frequency and Audience of Flavian 'Judaea Capta' Coins from the Imperial Mints', *Israel Numismatic Research* 14, pp. 117-130.

Bibliography

Ellithorpe, C. 2017a *Circulating Imperial Ideology: Coins as Propaganda in the Roman World*. PhD thesis, University of North Carolina at Chapel Hill.

– 2017b 'Striking a dissonant chord: The geographical targeting of Trajan's Debellator coinage in Dacia' in M. C. Caltabiano (ed.) *XV International Numismatic Congress Taormina 2015, Proceedings I.* Arbor Sapientiae Editore, pp. 742-748.

Etsy, W. 2006 'How to estimate the original number of dies and the coverage of a sample', *Numismatic Chronicle* 166, pp. 359-364.

Etienne, R. and Rachet, R. 1984 *Le trésor de Garonne. Essai sur la circulation monétaire en Aquitaine à la fin du règne d'Antonin le Pieux, 159-161.* Fédération Historique du Sud-Ouest.

Evans, J. 2006 *The Joint Expedition to Caesarea Maritima Excavation Reports: The Coins and the Hellenistic, Roman, and Byzantine Economy of Palestine.* American Schools of Oriental Research.

Fittschen, K. 1982 *Die Bildnistypen der Faustina Minor und die Fecunditas Augustae*. Vandenhoek & Ruprecht.

Frere, S. 1973 *Britannia. A History of Roman Britain.* Third Edition. Book Club Associates.

Fulford, M. 2000 'Britain' in A. K. Bowman, P. Garnsey, and D. Rathbone (eds.) *The Cambridge Ancient History Volume XI: The High Empire, A.D. 70-192.* Second edition. Cambridge University Press, pp. 559-576.

Găzdac, C. 2005 'Monetary circulation in Pannonia Superior – The territories of Carnuntum and Vindobona – From Trajan to Constantine (AD 98-337)', in F. Beutler and W. Hamster (eds.) *"Eine Ganz Normale Inschrift" … und Ähnliches zum Geburtstag von Ekkehard Weber. Festschrift zum 30. April 2005.* Austrian Academy of Archaeology, pp. 489-506.

– 2010 *Monetary circulation in Dacia and the provinces from the Middle and Lower Danube from Trajan to Constantine I (AD 106–337).* Second edition. Mega Publishing House.

– 2022 'Coin Hoards from Roman Dacia' in C. Howgego, J. Mairat, and A. Wilson (eds.) *Coin Hoards and Hoarding in the Roman World*. Oxford University Press, pp. 130-196.

Gitler, H., and Ponting, M. 2003 *The Silver Coinage of Septimius Severus and His Family (193–211 AD): A Study of the Chemical Composition of the Roman and Eastern Issues.* Ennere.

Goodman, M. 1997 *The Roman World: 44 BC-AD 180.* Routledge.

Graf, D. 1995 'The *Via Nova Traiana* in Arabia Petraea' in J. H. Humphrey (ed.) *The Roman and Byzantine Near East: Some Recent Archaeological Research.* Journal of Roman Archaeology Supplementary Series. 14, pp. 241-268.

Grant, M. 1996 *The Antonines. The Roman Empire in Transition.* Routledge.

Bibliography

Green, G. 2020 *Gold Coinage in the Roman World: Function and Production*. PhD thesis, University of Warwick.

Greenberg, J. 2003 'Plagued by doubt: Reconsidering the impact of a mortality crisis in the 2nd c. A.D.', *Journal of Roman Archaeology* 16, pp. 413-425.

Heinecke, A., Mayer, E., Natarajan, A., and Jung, Y. 2021 *Unsupervised Statistical Learning for Die Analysis in Ancient Numismatics*. Computer Vision and Pattern Recognition. Online resource: https://doi.org/10.48550/arXiv.2112.00290

Heinrichs, J. 2007 'Münzverbote in der römischen Kaiserzeit?' in R. Haensch and J. Heinrichs (eds.) *Herrschen und Verwalten: Der Alltag der römischen Administration in der Hohen Kaiserzeit*. Böhlau, pp. 80-116.

Hekster, O. 2002 *Commodus. An Emperor at the Crossroads*. Brill.

2014 'Son of two fathers? Trajan and the adoption of emperorship in the Roman Empire', *The History of the Family* 19, pp. 380-392.

Hellings, B. 2016 'The Denarii of Septimius Severus and the Mobility of Roman Coin: the case of Roman Germany', *Numismatic Chronicle* 176, pp. 171-181.

– 2022 'Coin Supply and Longevity of Circulation: Three Case Studies from Hoards in North-West Europe' in C. Howgego, J. Mairat, and A. Wilson (eds.) *Coin Hoards and Hoarding in the Roman World*. Oxford University Press, pp. 282-293.

– 2025 *Coin Finds and Monetization in the Roman Northwest*. American Numismatic Society.

Hill, P. V. 1966 'The aurei and denarii of Hadrian from eastern mints', *Numismatic Chronicle* 6, pp. 135-143.

Hobley, A. S. 1998 *An Examination of Roman Coin Distribution in the Western Empire, A.D. 81-192*. BAR International Series 688. Archaeopress.

Hopkins, K. 1980 'Taxes and Trade in the Roman Empire (200 B.C.-A.D. 400), *Journal of Roman Studies* 70, pp. 101-125.

Howgego, C. 1985 *Greek Imperial Countermarks. Studies in the Provincial Coinage of the Roman Empire*. Royal Numismatic Society Special Publication No. 17. Spink.

– 1992 'The Supply and Use of Money in the Roman World 200 B.C. to A.D. 300', *Journal of Roman Studies* 82, pp. 1-31.

– 1994 'Coin circulation and the integration of the Roman economy', *Journal of Roman Archaeology* 7, pp. 5-21.

– 1995a 'The circulation of silver coins, models of the Roman economy, and crisis in the third century A.D.: some numismatic evidence', in C.E. King and D. Wigg (eds.) *Coin Finds and Coin Use in the Roman World: 13th Symposium on Coinage and Monetary History (Studien zu Fundmünzen der Antike 10). A NATO advanced research workshop*. Mann, pp. 219-236.

– 1995b *Ancient History from Coins*. Routledge.

–	2002	‘The denarii of Septimius Severus and the mobility of Roman coin: a reply’, *Numismatic Chronicle* 162, pp. 339-342.
–	2024	‘Archaeologies of Coinage’ in J. Tanner and A. Gardner (eds.) *Materialising Empire in Ancient Rome and Han China*. UCL Press, pp. 77-98.
Howgego, C., and Wilson, A.	2022	‘Introduction’ in J. Mairat, A. Wilson, and C. Howgego (eds.) *Coin Hoards and Hoarding in the Roman World*. Oxford University Press, pp. 3-22.
Hoyer, D.	2013	‘Calculating the use-wear rates of Roman coins using regression analysis: a case study of bronze sestertii from Imperial Gaul’, *American Journal of Numismatics* 25, pp. 259-282.
Jarzęcki, K.	2021	‘Some reflections on Faustina the Younger’s coins’ (review of M. Beckmann *Faustina the Younger: Coinage, Portraits, and Public Image.* Numismatic Studies 43. New York), *Acta Archaeologica Lodziensia* 67, pp. 149-154.
Jones, A. H. M.	1960	*Studies in Roman Government and Law.* Oxford University Press.
Kaiser-Raiss, M. R.	1980	*Die stadtrömische Münzprägung während der Alleinherrschaft des Commodus: Untersuchungen zur Selbstdarstellung eines römisches Kaisers*. Schulten.
Kampel, M. and Zaharieva, M.	2008	’Recognizing Ancient Coins Based on Local Features’ in G. Bebis, R. Boyle, and B. Parvin (eds.) *Advances in Visual Computing*. ISVC 2008. Lecture Notes in Computer Science, vol 5358. Berlin/Heidelberg, pp. 11-22.
Keltanen, M.	2002	‘The public image of the Four Empresses: Ideal wives, mothers and regents?’ in P. Setälä (ed.) *Women, Wealth and Power in the Roman Empire*. Institutum Romanum Finlandiae, pp. 133-140.
Kennedy, D.	2004	*The Roman Army in Jordan*. Council for British Research in the Levant.
Kemmers, F.	2003	‘Quadrantes from Nijmegen: Small change in a frontier province’, *Schweizerische Numismatische Rundschau* 82, pp. 17-35.
–	2005	‘Not at random: Evidence for a regionalized coin supply? In J. Bruhn *et al* (eds.) *TRAC 2004: Proceedings of the Fourteenth Annual Theoretical Roman Archaeology Conference Durham 2004*. Oxbow, pp. 39-49.
–	2006	*Coins for a Legion: An Analysis of the Coin Finds from Augustan Legionary Fortress and Flavian canabae legionis at Nijmegen*. Studien zu Fundmünzen der Antike 23. Philipp von Zabern.
–	2009a	‘Bought loyalty? Cash distribution in times of large scale troop movements’ in A. Morillo, N. Hanel, and E. Martin (eds.) *Limes XX: Roman frontier studies. Anejos de Gladius 13*. Consejo Superior de Investigaciones Científicas, pp. 847-854.

–	2009b	'Sender or receiver? Contexts of coin supply and coin use', in H.-M. Von Kaenel and F. Kemmers (eds.) *Coins in Context I: New perspectives for the interpretation of coin finds.* Philipp von Zabern, pp. 137-156.
–	2009c	'From bronze to silver. Coin circulation in the third century AD', *Revue Belge de Numismatique* 155, pp. 143-158.
–	2014	'Buying loyalty: targeted iconography and the distributions of cash to the legions' in M. Reddé (ed.) *De l'or pour les braves! Soldes, armèes et circulation monétaire dans le monde romain.* Ausonius, pp. 229-241.
Kienast, D., Eck, W., and Heil, M.	2017	*Römische Kaisertabelle. Grundzüge einer römischen Kaiserchronologie*. Wissenschaftliche Buchgesellschaft.
Komnick, H.	2001	*Die Restitutionsmünzen der frühen Kaiserzeit: Aspekte der Kaiserlegitimation*. de Gruyter.
Lazarenko, I.	2014	'1929 Девненската крупна монетна находка' ('Devnia's great 1929 coin hoard'), *Известия на Регионален исторически музей-Разград (Bulletin of the Regional History Museum-Razgrad)* 1, pp. 265-331.
-	2025	*Монетното съкровище "Река Девня, 1929 г." Документи, хипотези и интерпретаци* (*'The Devnia River, 1929' Coin Treasure. Documents, Hypotheses and Interpretation*. Art Tracer.
Levick, B.	1982	'Propaganda and the Imperial Coinage', *Antichthon* 16, pp. 104-116.
–	1999	'Messages on the Roman Coinage: Types and Inscriptions' in G. M. Paul and M. Ierardi (eds.) *Roman Coins and Public Life under the Empire: E. Togo Salmon Papers II.* University of Michigan Press, pp. 41-60.
–	2014	*Faustina I and II: Imperial Women oft he Golden Age.* Oxford University Press.
Lockyear, K.	2007	*Patterns and Process in Late Roman Republican Coin Hoards, 157-2 BC.* BAR International Series 1733. Archaeopress
–	2012	'Dating coins, dating with coins', *Oxford Journal of Archaeology* 31, pp. 191-211.
–	2018	'Mind the Gap! Roman Republican Coin Hoards from Italy and Iberia at the End of the Second Century BC', *Numismatic Chronicle* 178, pp. 123-164.
MacDonald, P. L., and Gardner, R. C.	2000	'Type 1 error rate comparisons of post hoc procedures for I J chi-square tables', *Educational and Psychological Measurement* 60, pp. 735-754. doi.org/10.1177/00131640021970871
Mairat, J.	2022	'Coin hoards of the Gallic Empire' in C. Howgego, A. Wilson, and J. Mairat (eds.) *Coin Hoards and Hoarding in the Roman World*. Oxford University Press, pp. 89-110.
Martínez Chico, D.	2025	*Los tesoros imperiales de Hispania. Moneda, metal y riqueza*. Serie de Trabajos Varios num. 132. Diputación de Valencia.

Bibliography

Marzano, A.	2009	'Trajanic building projects on base-metal denominations and audience targeting', *Papers of the British School at Rome* 77, pp. 125-158.
Mattingly, D.	2007	*An Imperial Possession: Britain in the Roman Empire*. Penguin.
Mayer, E.	Prep.	*Coinage, Political Economy and Commerce in the Early Roman Empire (AD* 14-68*)*. Oxford University Press.
McConnell, J. A. ,Wilson, A., Stohl, A., Arienzo, M., Chellman, N., Eckhardt, S., Thompson, E., Pollard, M., and Steffensen, J.	2018	'Lead pollution recorded in Greenland ice indicates European emissions tracked plagues, wars, and imperial expansion during antiquity', *Proceedings of the National Academy of Sciences of the United States of America* 115, pp. 5726-5731.
Metcalf, W. E.	1975	'The Tell Kalak Hoard and Trajan's Arabian Mint', *American Numismatic Society Museum Notes* 20, pp. 39-108.
–	1993	'Whose liberalitas? Propaganda and audience in the early Roman Empire', *Rivista Italiana di Numismatica* 95, pp. 337–346.
–	2002	'The Reka Devnia hoard re-examined' in *Ritrovamenti monetali nel mondo antico: problemi e metodi: atti del congresso internazionale, Padova 31 marzo-2 aprile 2000*. Esedra, pp. 145-150.
–	2004	*La propagande monétaire (64-235) et le trésor de Marcianopolis (251)*. Moneta.
Millar, F.	1964	'Some Evidence on the Meaning of Tacitus *Annals* XII. 60', *Historia: Zeitschrift für Alte Geschichte* 13.2, pp. 180-187.
–	1965	'The Development of Jurisdiction by imperial Procurators; Further Evidence', *Historia: Zeitschrift für Alte Geschichte* 14.3, pp. 362-367.
Mladenović, D.	2025	'Roman Gold and Silver Mining in the Central Balkans and its Significance for the Roman State', *Jahrbuch des Deutschen Archäologischen Instituts* 140, pp. 1-92.
Moorhead, S.	2013	*A History of Roman Coinage in Britain*. Greenlight.
–	2015	'Coins of British Association. Sam Moorhead (after D. R. Walker with *addenda* and coin of Nerva noted by David Shotter)'. Online resource: https://www.academia.edu/12608461/Coins_of_British_Association_after_David_Walker_and_David_Shotter_with_additions_by_Sam_Moorhead?source=swp_share
Morillo, A., and García-Marcos, V.	2003	'Legio VII Gemina and its Flavian fortress at León', *Journal of Roman Archaeology* 16, pp. 275-286.
Morley, N.	2008	'The early Roman Empire: Distribution' in W. Scheidel, I. Morris, and R. P. Saller (eds.) *The Cambridge Economy History of the Greco-Roman World.* Cambridge University Press, pp. 570-591.
Moushmov, N. A.	1930	'Une trouvaille de monnaies antiques près du village de Reka-Devnia (Marcianopolis)', *Aréthuse* 27, pp. 49-50.

– 1934 *Le trésor numismatique de Réka-Devnia (Marcianopolis).* Imprimerie de l'état.

Murphy, N. 2020 'The Severan reforms of the late second century: a case of monetary déjà vu?' in K. Butcher (ed.) *Debasement: Manipulation of Coin Standards in Pre-modern Monetary Systems*. Oxbow.

Naioti, E., and Mudrak, E. 2022 'Using Adjusted Standardized Residuals for Interpreting Contingency Tables.' Online resource: https://cscu.cornell.edu/wp-content/uploads/conttableresid.pdf

Natarajan, A., de Iorio, M., Heinecke, A., Mayer, E., and Glenn, S. 2021 'Cohesion and Repulsion in Bayesian Distance Clustering', *Journal of the American Statistical Association* 119, pp. 1374-1384.

Niederhuber, C. 2022 *Roman Imperial Portrait Practice in the Second Century AD: Marcus Aurelius and Faustina the Younger*. Oxford University Press.

Noreña, C. 2001 'The communication of the emperor's virtues', *The Journal of Roman Studies* 91, pp. 146-168.

– 2011 *Imperial Ideals in the Roman West: Representation, Circulation, Power*. Cambridge University Press.

Parker, A. J. 1992 *Ancient Shipwrecks of the Mediterranean and the Roman Provinces*, BAR Int. Ser. 580, Oxford.

Peter, M. 1996 'Bemerkungen zur Kleingeldversorgung der westlichen Provinzen im 2. Jahrhundert' in C. E. King and D. G. Wigg (eds.) *Coin Finds and Coin Use in the Roman World: 13th Symposium on Coinage and Monetary History (Studien zu Fundmünzen der Antike 10). A NATO advanced research workshop*. Mann. pp. 309-320.

Pöschl, F. 1941 'Die Congiarien (Liberalitates) des Kaisers Antoninus Pius', *Hermes* 76, pp. 423-476.

Rathbone, D. 2007 'Roman Egypt' in W. Scheidel, I. Morris, and R. Saller (eds.) *The Cambridge Economic History of the Greco-Roman World.* Cambridge University Press, pp. 698-719.

Reece, R. 1991 *Roman Coins from 140 Sites in Britain.* Archetype.

Reynolds, P. 2017 'The supply networks of the Roman east and west: Interaction, fragmentation, and the origins of the Byzantine economy' in A. Wilson and A. Bowman (eds.) *Trade, Commerce, and the State in the Roman World.* Oxford University Press, pp. 353-396.

Romano, F. P., Garraffo, S., Pappalardo, L., and Rizzo, F. 2012 'In situ investigation of the surface silvering of late Roman coins by combined use of high energy broad-beam and low energy micro-beam X-ray fluorescence techniques', *Spectrochimica Acta Part B* 73, pp. 13-19.

Rowan, C. 2011 'Communicating a *Consecratio*: The Deification Coinage of Faustina I' in N. Holmes (ed.) *Proceedings of the XIV International Numismatic Congress Glasgow* (vol. 1). Spink, pp. 991-998.

– 2012 *Under Divine Auspices. Divine Ideology and the Visualisation of Imperial Power in the Severan Period.* Cambridge University Press.

Bibliography

–	2013	'Imaging the Golden Age: the coinage of Antoninus Pius', *Papers of the British School at Rome* 81, pp. 211-246.
Schachinger, U.	1997	'Die Reisen des Kaisers Hadrian nach Aussagen der Munzbilder', *Numismatische Zeitschrift* 104/105, pp. 83-108.
Schäfer, C.	1998	*Spitzenmanagement in Republik und Kaiserzeit. Die Prokuratoren von Privatpersonen im Imperium Romanum vom 2. Jahrhundert v. Chr. bis zum 3. Jahrhundert n. Chr.* Scripta Mercaturae.
Scheidel, W.	2002	'A model of demographic and economic change in Roman Egypt after the Antonine Plague', *Journal of Roman Archaeology* 15, pp. 97-114.
Scheller, D. S.	2025	*Elementary Statistics for Public Administration. An Applied Perspective.* Cambridge University Press.
Schultz, H.-D.	1982	'Zur Chronologie des Lucilla-Portraits auf Münzen', *Wissenschaftliche Zeitschrift der Humboldt-Universität* 31, pp. 283-286.
Sharpe, D.	2015	'Your Chi-Square Test is Statistically Significant: Now What?' *Practical Assessment, Research, and Evaluation* 20, Article 8. Online resource: https://doi.org/10.7275/tbfa-x148.
Shotter, D.	2013	'A Rare Find: a Neptune As of the Roman Emperor Nerva', *Numismatic Chronicle* 173, pp. 85-97.
Smith, R. R. R., and Niederhuber, C.	2023	*Commodus: The Public Image of a Roman Emperor.* Reichert.
Speidel, M. A.	1992	'Roman Army Pay Scales', *Journal of Roman Studies* 82, pp. 87-106.
Spoerri Butcher, M.	2019	'Reka Devnia (Bulgaria): The Challenges of Creating a Digital Dataset of 80,000 Coins' in B. Callegher (ed.) *Too Big to Study? Troppo grandi da studiare?* EUT Edizioni Università di Trieste, pp. 161-171
Spoerri Butcher, M. and Hellings, B.	2017	'Quantifying relative coin production during the reigns of Nerva and Trajan (AD 96-117): Reka Devnia reconsidered in light of regional coin finds from Romania and the Northwest', *Revue Belge de Numismatique* 163, pp. 53-86.
Strack, P. L.	1931	*Untersuchungen zur Römischen Reichsprägung des zweiten Jahrhunderts. Teil I. Die Reichsprägung zur Zeit des Traian.* Kohlhammer.
–	1933	*Untersuchungen zur römischen Reichsprägung des zweiten Jahrhunderts. Teil II: Die Reichsprägung zur Zeit des Hadrian.* Kohlhammer.
–	1937	*Untersuchungen zur römischen Reichsprägung des zweiten Jahrhunderts. Teil III: Die Reichsprägung zur Zeit des Antoninus Pius.* Kohlhammer.
Strauss, J.	2017	Shipwrecks Database. Version 2.1. Accessed (29.6.2026): https://oxrep.web.ox.ac.uk/shipwrecks-database
Sutherland, C. H. V.	1951	*Coinage in Roman Imperial Policy, 31 B. C.-A. D. 68.* Meuthen.

– 1983 'The Purpose of Roman Imperial Coin Types', *Rivista Numismatica* 25, pp. 73-82.

– 1986 'Compliment or Complement? Dr Levick on Imperial Coin Types', *Numismatic Chronicle* 146, pp. 85-93.

Szaivert, W. 1980 'Zur Chronologie der Lucillaprägungen', *Jahrbuch für Numismatik und Geldgeschichte* 30, pp. 7-14.

– 1986 *Die Münzprägung der Kaiser Marcus Aurelius, Lucius Verus und Commodus (161-192)*. Austrian Academy of Sciences.

Taylor, Z. M. 2020 *The Computer-Aided Die Study (CADS): A tool for conducting numismatic die studies with computer vision and hierarchical clustering.* Thesis, Trinity University: https://digitalcommons.trinity.edu/compsci_honors/54.

Temin, P. 2012 *The Roman Market Economy*. Princeton University Press.

Thill, E. R. 2014 'The Emperor in Action: Group Scenes in Trajanic Coins and Monumental Reliefs', *American Journal of Numismatics* 26, pp. 89-142.

Todd, N. 1966 'Roman-British Mintages of Antoninus Pius', *Numismatic Chronicle* 6, pp. 147-153.

Toynbee, J. 1924 'Britannia on Roman Coins of the Second Century', *Journal of Roman Studies* 14, pp. 142-157.

– 1925 'Some 'programme' coin-types of Antoninus Pius', *The Classical Review* 39, pp. 170-173.

Tselekas, P. 2016 'Treasures from the Deep: Coins from Hellenistic and Roman Republican Shipwrecks' in F. Duyrat and C. Grandjean (eds.) *Les monnaies de fouille du monde grec (VIer-Ier s. a.C.) Apports, approches, et méthodes.* Bordeaux, pp. 147-156.

van Alfen, P. 2017 'The Computer Aided Die Studies Program.' Online resource: https://numismatics.org/pocketchange/cads/

van Heesch, J. 2014 'Paying Roman soldiers in the east (1st-2nd century AD)' in M. Reddé (ed.) *De l'or pour les braves! Soldes, armèes et circulation monétaire dans le monde romain.* Ausonius, pp. 139-159.

von Kaenel, H. 1986 *Münzprägung und Münzbildnis des Claudius.* de Gruyter.

Walker, D. R. 1977 *The Metrology of the Roman Silver Coinage, Volume II. From Nerva to Commodus*. BAR Supplementary Series 22. Archaeopress

– 1978 *The Metrology of the Roman Silver Coinage, Volume III. From Pertinax to Uranius Antoninus*. BAR Supplementary Series 40. Archaeopress.

– 1988 *Roman Coins from the Sacred Spring at Bath.* Oxford University Committee for Archaeology Fascicule 2 of Monograph 16. Oxford University Committee for Archaeology.

Wallace-Hadrill, A. 1986 'Image and Authority in the Coinage of Augustus', *Journal of Roman Studies* 76, pp. 66-87.

Bibliography

Warne, T.	2021	*Statistics for the Social Sciences. A General Linear Model Approach* (Second Edition). Cambridge University Press.
Wegner, M.	1939	*Die Herrscherbildnisse in antoninischer Zeit.* Deutsches Archäologisches Institut.
Whincop, M.	2010	'The complexity of ceramic regions in the Iron Age Northern Levant: the application of Correspondence Analysis to Near Eastern ceramic data', *Levant* 42, pp. 30-47.
Wigg-Wolf, D.	2009	'Sites as context' in H. Von Kaenel and F. Kemmers (eds.) *Coins in Context I: New Perspectives for the Interpretation of Coin Finds. Colloquium Frankfurt a. M., October 25–27, 2007*. Philipp von Zabern, pp. 109-126.
–	2014	'Coin supply and the Roman army revisited: coin finds and military finance in the late-first and second centuries AD' in M. Reddé (ed.) *De l'or pour les braves! Soldes, armèes et circulation monétaire dans le monde romain.* Ausonius, pp. 161-179.
Wilson, A.	2007	'The Metal Supply of the Roman Empire' in E. Papi and M. Bonifay (eds.), *Supplying Rome and the Empire,* Journal of Roman Archaeology Supplementary Series. 69, pp. 109–126.
–	2009a	'Indicators for Roman economic growth: a response to Walter Scheidel', *Journal of Roman Archaeology* 22, pp. 71-82.
–	2009b	'Approaches to quantifying Roman trade' in A. Bowman and A. Wilson (eds.) *Quantifying the Roman Economy: Methods and Problems.* Oxford University Press, pp. 213-249.
–	2026	'The Economic Impact of the Antonine Plague' in R. Raja and A. Wilson (eds.) *Catastrophes in Context: Disaster and Response in the Roman and Early Byzantine World*. Brepols, pp. 103-129.
Wood, J. R., Ponting, M., and Butcher, K.	2023	'Mints not Mines: a macroscale investigation of Roman silver coinage', *Internet Archaeology* 61: https://doi.org/10.11141/ia.61.10.
Woods, D.	2019	'Commodus and Fortuna Manens', *Numismatic Chronicle* 179, pp. 173-178.
Woytek, B.	2012	'System and product in Roman mints from the Late Republic to the High Principate: Some current problems', *Revue belge de numismatique et de sigillographie* 158, pp. 85-122.
–	2022	'The Imperial Afterlife of Roman Republican Coins and the Phenomenon of the Restored *Denarii'* in C. Howgego, A. Wilson, and J. Mairat (eds.) *Coin Hoards and Hoarding in the Roman World*. Oxford University Press, pp. 237-272.
Woytek, B., and Blet-Lemarquand, M.	2017	'The C. L. CAESARES denarii RIC I2 Augustus 208. A pseudo-Augustan unsigned restoration issue. Corpus, die study, metallurgical analyses', *Revue Numismatique* 174, pp. 183-248.

Bibliography

Woytek, B. and Butcher, K.	2015	'The Camel Drachms of Trajan in Context: Old Problems and a New Overstrike', *Numismatic Chronicle* 175, pp. 117-136.
–	2018	'The Grand Scheme of Things. Modelling Coin Production and Coin Distribution in the Roman Empire in the First and Second Centuries AD' in B. Woytek (ed.) *Infrastructure and Distribution in Ancient Economies: Proceedings of a conference held at the Austrian Academy of Sciences, 28-31 October 2014.* Austrian Academy of Sciences, pp. 253-281.
Yarrow, L. M.	2012	'Antonine Coinage' in W. E. Metcalf (ed.) *The Oxford Handbook of Greek and Roman Coinage*. Oxford University Press, pp. 423-452.

Appendix: Hoards used by this study

Hoards are listed chronologically by their closing dates, and according to the names by which they are known on the Coin Hoards of the Roman Empire project database. Links are provided to the CHRE records, which contain full typological breakdowns of the contents of each hoard, along with information pertaining to circumstances of their discovery, findspots, and associated literature.

CHRE no.	Hoard	Region	Country	*tpq*	CHRE record
2671	**Gigen 9**	Eastern Danube	Bulgaria	102	https://chre.ashmus.ox.ac.uk/hoard/2671
6935	**Idna**	Eastern Mediterranean	Israel	108	https://chre.ashmus.ox.ac.uk/hoard/6935
17563	**Fuente de Piedra**	Spain & Western Med	Spain	110	https://chre.ashmus.ox.ac.uk/hoard/17563
2025	**Lavenham 1874**	Britain	England	111	https://chre.ashmus.ox.ac.uk/hoard/2025
12874	**Alaquàs**	Spain & Western Med	Spain	112	https://chre.ashmus.ox.ac.uk/hoard/12874
2586	**Medveș**	Western Danube	Romania	112	https://chre.ashmus.ox.ac.uk/hoard/2586
955	**Verulamium (Insula XIV)**	Britain	England	112-113	https://chre.ashmus.ox.ac.uk/hoard/955
12877	**Monteseiro**	Spain & Western Med	Spain	113-114	https://chre.ashmus.ox.ac.uk/hoard/12877
6947	**Gauting 1951**	Western Danube	Germany	114-116	https://chre.ashmus.ox.ac.uk/hoard/6947
17404	**Sarmizegetusa 2006**	Western Danube	Romania	114-116	https://chre.ashmus.ox.ac.uk/hoard/17404
5226	**Sakha**	Eastern Mediterranean	Egypt	116-117	https://chre.ashmus.ox.ac.uk/hoard/5226
7690	**Wadi Murabba'at**	Eastern Mediterranean	Israel	118	https://chre.ashmus.ox.ac.uk/hoard/7690
403	**Birdoswald 1949**	Britain	England	119-120	https://chre.ashmus.ox.ac.uk/hoard/403
13134	**Klagenfurt 1880**	Western Danube	Austria	121	https://chre.ashmus.ox.ac.uk/hoard/13134
16266	**Dersca**	Eastern Danube	Romania	121-123	https://chre.ashmus.ox.ac.uk/hoard/16266
5391	**Garešnica**	Western Danube	Croatia	121-123	https://chre.ashmus.ox.ac.uk/hoard/5391
5230	**Hastings II**	Britain	England	121-123	https://chre.ashmus.ox.ac.uk/hoard/5230
1165	**Ormskirk**	Britain	England	121-123	https://chre.ashmus.ox.ac.uk/hoard/1165
5228	**Volubilis 1930**	Spain & Western Med	Morocco	121-123	https://chre.ashmus.ox.ac.uk/hoard/5228
5386	**Khirbet Wadi Ḥamam**	Eastern Mediterranean	Israel	124-125	https://chre.ashmus.ox.ac.uk/hoard/5386
8173	**Khirbet Badd 'Isa 1995-1997 B**	Eastern Mediterranean	Israel	126-127	https://chre.ashmus.ox.ac.uk/hoard/8173
16272	**Urecheni**	Eastern Danube	Romania	126-127	https://chre.ashmus.ox.ac.uk/hoard/16272
212	**Middlewich**	Britain	England	125-128	https://chre.ashmus.ox.ac.uk/hoard/212

Appendix: Hoards used by this study

CHRE no.	Hoard	Region	Country	*tpq*	CHRE record
7702	**Ḥorbat Ẓalit 1983-1984**	Eastern Mediterranean	Israel	128-129	https://chre.ashmus.ox.ac.uk/hoard/7702
5231	**Castagnaro**	Italy & Adriatic	Italy	129-130	https://chre.ashmus.ox.ac.uk/hoard/5231
5433	**Wien Rennweg 1989**	Western Danube	Austria	130-133	https://chre.ashmus.ox.ac.uk/hoard/5433
5235	**Erla 1966**	Western Danube	Austria	133-135	https://chre.ashmus.ox.ac.uk/hoard/5235
5233	**Tiszanagyrév**	Western Danube	Hungary	133-135	https://chre.ashmus.ox.ac.uk/hoard/5233
1179	**Waddington 1989**	Britain	England	136	https://chre.ashmus.ox.ac.uk/hoard/1179
13144	**Dornhof**	Western Danube	Austria	137-138	https://chre.ashmus.ox.ac.uk/hoard/13144
5234	**Eleutheropolis**	Eastern Mediterranean	Israel	132-138	https://chre.ashmus.ox.ac.uk/hoard/5234
2845	**Györ**	Western Danube	Hungary	137-138	https://chre.ashmus.ox.ac.uk/hoard/2845
390	**Mallerstang**	Britain	England	137-138	https://chre.ashmus.ox.ac.uk/hoard/390
8111	**Ptuj 6 - Vičava**	Western Danube	Slovenia	137-138	https://chre.ashmus.ox.ac.uk/hoard/8111
1280	**Swaby**	Britain	England	137-138	https://chre.ashmus.ox.ac.uk/hoard/1280
10038	**Vechten 1996 2**	Rhine	Netherlands	138	https://chre.ashmus.ox.ac.uk/hoard/10038
17039	**Nida 1850**	Rhine	Germany	139	https://chre.ashmus.ox.ac.uk/hoard/17039
6124	**Dealul Perjului**	Eastern Danube	Romania	140	https://chre.ashmus.ox.ac.uk/hoard/6124
16280	**Homiceni 1980-1987**	Eastern Danube	Romania	139-141	https://chre.ashmus.ox.ac.uk/hoard/16280
809	**Bryn Gwydion**	Britain	Wales	140-143	https://chre.ashmus.ox.ac.uk/hoard/809
17565	**Cortalago**	Spain & Western Med	Spain	140-143	https://chre.ashmus.ox.ac.uk/hoard/17565
16276	**Covasinț**	Western Danube	Romania	141-161	https://chre.ashmus.ox.ac.uk/hoard/16276
1464	**Itteringham**	Britain	England	141-161	https://chre.ashmus.ox.ac.uk/hoard/1464
2595	**Tibru**	Western Danube	Romania	141-161	https://chre.ashmus.ox.ac.uk/hoard/2595
2596	**Dîmbău**	Western Danube	Romania	142-143	https://chre.ashmus.ox.ac.uk/hoard/2596
12889	**La Polonia**	Spain & Western Med	Spain	140-144	https://chre.ashmus.ox.ac.uk/hoard/12889
5239	**Middels Osterloog**	Rhine	Germany	140-144	https://chre.ashmus.ox.ac.uk/hoard/5239
2192	**Monknash**	Britain	Wales	143-144	https://chre.ashmus.ox.ac.uk/hoard/2192
6134	**Mont**	Rhine	France	143-144	https://chre.ashmus.ox.ac.uk/hoard/6134
2471	**Norton 1963**	Britain	England	143-144	https://chre.ashmus.ox.ac.uk/hoard/2471
4942	**Tipasa 1948-1950**	Spain & Western Med	Algeria	143-144	https://chre.ashmus.ox.ac.uk/hoard/4942
16538	**Samenheim**	Western Danube	Germany	145-147	https://chre.ashmus.ox.ac.uk/hoard/16538
12885	**Aloria B**	Spain & Western Med	Spain	147-148	https://chre.ashmus.ox.ac.uk/hoard/12885

Appendix: Hoards used by this study

CHRE no.	Hoard	Region	Country	*tpq*	CHRE record
2678	**Medgidia 1978**	Eastern Danube	Romania	150-151	https://chre.ashmus.ox.ac.uk/hoard/2678
5241	**Vyškovce nad Ipľom**	Western Danube	Slovakia	152-153	https://chre.ashmus.ox.ac.uk/hoard/5241
2599	**Vişea**	Western Danube	Romania	155-156	https://chre.ashmus.ox.ac.uk/hoard/2599
5474	**Manyas**	Eastern Mediterranean	Turkey	140-160	https://chre.ashmus.ox.ac.uk/hoard/5474
514	**East Stoke**	Britain	England	145-160	https://chre.ashmus.ox.ac.uk/hoard/514
18912	**Sângeru de Pădure**	Western Danube	Romania	151-160	https://chre.ashmus.ox.ac.uk/hoard/18912
9886	**Eenum**	Rhine	Netherlands	159-160	https://chre.ashmus.ox.ac.uk/hoard/9886
244	**Little Chester 1987 A**	Britain	England	145-161	https://chre.ashmus.ox.ac.uk/hoard/244
12778	**Bonyhád**	Western Danube	Hungary	145-161	https://chre.ashmus.ox.ac.uk/hoard/12778
54	**Chalfont St Giles**	Britain	England	145-161	https://chre.ashmus.ox.ac.uk/hoard/54
8869	**Stari Trg**	Western Danube	Slovenia	145-161	https://chre.ashmus.ox.ac.uk/hoard/8869
12632	**Venlo 1899**	Rhine	Netherlands	145-161	https://chre.ashmus.ox.ac.uk/hoard/12632
2848	**Wallern im Burgenland**	Western Danube	Austria	145-161	https://chre.ashmus.ox.ac.uk/hoard/2848
1773	**Llanymynech 1965**	Britain	Wales	148-161	https://chre.ashmus.ox.ac.uk/hoard/1773
1264	**Londonthorpe**	Britain	England	153-161	https://chre.ashmus.ox.ac.uk/hoard/1264
230	**Lawrence Weston**	Britain	England	156-161	https://chre.ashmus.ox.ac.uk/hoard/230
1383	**Llanvaches**	Britain	Wales	156-161	https://chre.ashmus.ox.ac.uk/hoard/1383
2779	**Misača**	Western Danube	Serbia	156-161	https://chre.ashmus.ox.ac.uk/hoard/2779
2601	**Sălaşuri**	Western Danube	Romania	158-161	https://chre.ashmus.ox.ac.uk/hoard/2601
2089	**Pyrford**	Britain	England	159-161	https://chre.ashmus.ox.ac.uk/hoard/2089
1950	**Stoke on Trent Area 2012**	Britain	England	159-161	https://chre.ashmus.ox.ac.uk/hoard/1950
2849	**Illmitz**	Western Danube	Austria	162-163	https://chre.ashmus.ox.ac.uk/hoard/2849
9771	**Kičevo**	Italy & Adriatic	N Maced	162-163	https://chre.ashmus.ox.ac.uk/hoard/9771
1272	**Osgodby**	Britain	England	162-163	https://chre.ashmus.ox.ac.uk/hoard/1272
1212	**Long Whatton**	Britain	England	163-164	https://chre.ashmus.ox.ac.uk/hoard/1212
5248	**Mocsolád**	Western Danube	Hungary	164	https://chre.ashmus.ox.ac.uk/hoard/5248
2609	**Barbura**	Western Danube	Romania	165	https://chre.ashmus.ox.ac.uk/hoard/2609
16998	**Marköbel 1899(?)**	Rhine	Germany	165-166	https://chre.ashmus.ox.ac.uk/hoard/16998
16473	**Gârcina**	Eastern Danube	Romania	166	https://chre.ashmus.ox.ac.uk/hoard/16473
5479	**Liberchies 1969-1970**	Rhine	Belgium	166	https://chre.ashmus.ox.ac.uk/hoard/5479

Appendix: Hoards used by this study

CHRE no.	Hoard	Region	Country	*tpq*	CHRE record
1785	**Presteigne**	Britain	Wales	166	https://chre.ashmus.ox.ac.uk/hoard/1785
5252	**Sotin**	Western Danube	Croatia	166	https://chre.ashmus.ox.ac.uk/hoard/5252
13875	**Verona 1887 – Palazzo Chiodo**	Italy & Adriatic	Italy	166	https://chre.ashmus.ox.ac.uk/hoard/13875
2603	**Gostavățu 1969**	Eastern Danube	Romania	166-167	https://chre.ashmus.ox.ac.uk/hoard/2603
16299	**Muncelul de Sus 1963**	Eastern Danube	Romania	166-167	https://chre.ashmus.ox.ac.uk/hoard/16299
6172	**Spital am Pyhrn**	Western Danube	Austria	167	https://chre.ashmus.ox.ac.uk/hoard/6172
8141	**Ušće 2**	Western Danube	Serbia	167	https://chre.ashmus.ox.ac.uk/hoard/8141
9326	**Scorțeni**	Eastern Danube	Romania	167-168	https://chre.ashmus.ox.ac.uk/hoard/9326
6168	**Ostriach**	Western Danube	Austria	169	https://chre.ashmus.ox.ac.uk/hoard/6168
16545	**Stockstadt 1951**	Rhine	Germany	161-169	https://chre.ashmus.ox.ac.uk/hoard/16545
16294	**Davideni**	Eastern Danube	Romania	169-170	https://chre.ashmus.ox.ac.uk/hoard/16294
119	**Melbourn**	Britain	England	169-170	https://chre.ashmus.ox.ac.uk/hoard/119
5250	**Osijek 3**	Western Danube	Croatia	167-170	https://chre.ashmus.ox.ac.uk/hoard/5250
926	**Braughing**	Britain	England	170-171	https://chre.ashmus.ox.ac.uk/hoard/926
1981	**Brundish**	Britain	England	170-171	https://chre.ashmus.ox.ac.uk/hoard/1981
5467	**Grădiştea de Munte**	Western Danube	Romania	170-171	https://chre.ashmus.ox.ac.uk/hoard/5467
2453	**Hebden**	Britain	England	171-172	https://chre.ashmus.ox.ac.uk/hoard/2453
16292	**Caporal Alexa**	Western Danube	Romania	161-175	https://chre.ashmus.ox.ac.uk/hoard/16292
2853	**Carnuntum 1888**	Western Danube	Austria	161-175	https://chre.ashmus.ox.ac.uk/hoard/2853
5489	**Cislău**	Eastern Danube	Romania	161-175	https://chre.ashmus.ox.ac.uk/hoard/5489
16474	**Dragomirești**	Eastern Danube	Romania	175	https://chre.ashmus.ox.ac.uk/hoard/16474
9351	**Durrës 1941**	Italy & Adriatic	Albania	170-175	https://chre.ashmus.ox.ac.uk/hoard/9351
5256	**Carnuntum 1901**	Western Danube	Austria	161-175	https://chre.ashmus.ox.ac.uk/hoard/5256
5249	**Kurd-Gyuliaji**	Western Danube	Hungary	161-175	https://chre.ashmus.ox.ac.uk/hoard/5249
376	**Maryport, near**	Britain	England	161-175	https://chre.ashmus.ox.ac.uk/hoard/376
1194	**Cadeby 2004**	Britain	England	164-176	https://chre.ashmus.ox.ac.uk/hoard/1194
5254	**Apetlon 1961**	Western Danube	Austria	166-176	https://chre.ashmus.ox.ac.uk/hoard/5254
1813	**Chetwynd, Aston and Woodcote 2007**	Britain	England	165-176	https://chre.ashmus.ox.ac.uk/hoard/1813
2239	**Hamstead Marshall**	Britain	England	168-176	https://chre.ashmus.ox.ac.uk/hoard/2239
1468	**Marlingford**	Britain	England	171-176	https://chre.ashmus.ox.ac.uk/hoard/1468

Appendix: Hoards used by this study

CHRE no.	Hoard	Region	Country	*tpq*	CHRE record
939	**Potters Bar**	Britain	England	175-176	https://chre.ashmus.ox.ac.uk/hoard/939
17495	**Kiszombor**	Western Danube	Hungary	176	https://chre.ashmus.ox.ac.uk/hoard/17495
5255	**Stockstadt III**	Rhine	Germany	176	https://chre.ashmus.ox.ac.uk/hoard/5255
9889	**Emmer-Erfscheidenveen 1915**	Rhine	Netherlands	176-177	https://chre.ashmus.ox.ac.uk/hoard/9889
2230	**Aldworth 1984**	Britain	England	176-177	https://chre.ashmus.ox.ac.uk/hoard/2230
2594	**Belcinu**	Eastern Danube	Romania	176-177	https://chre.ashmus.ox.ac.uk/hoard/2594
16297	**Măgirești**	Eastern Danube	Romania	176-177	https://chre.ashmus.ox.ac.uk/hoard/16297
486	**Poughill**	Britain	England	176-177	https://chre.ashmus.ox.ac.uk/hoard/486
2606	**Râmnicu Vâlcea 1971**	Eastern Danube	Romania	176-177	https://chre.ashmus.ox.ac.uk/hoard/2606
12817	**Mertert**	Rhine	Luxembourg	177	https://chre.ashmus.ox.ac.uk/hoard/12817
1376	**Caerleon (Prysg Barrack 7)**	Britain	Wales	177	https://chre.ashmus.ox.ac.uk/hoard/1376
5257	**Szombathely I**	Western Danube	Hungary	177	https://chre.ashmus.ox.ac.uk/hoard/5257
6156	**Hertioana de Jos**	Eastern Danube	Romania	179	https://chre.ashmus.ox.ac.uk/hoard/6156
2856	**Neunkirchen**	Western Danube	Austria	161-180	https://chre.ashmus.ox.ac.uk/hoard/2856
12539	**Oderzo 1957**	Italy & Adriatic	Italy	161-180	https://chre.ashmus.ox.ac.uk/hoard/12539
1182	**Allerton Bywater**	Britain	England	164-180	https://chre.ashmus.ox.ac.uk/hoard/1182
2782	**Nemenikuće**	Western Danube	Serbia	164-180	https://chre.ashmus.ox.ac.uk/hoard/2782
5258	**Simioneşti**	Eastern Danube	Romania	164-180	https://chre.ashmus.ox.ac.uk/hoard/5258
13325	**Holler**	Rhine	Luxembourg	175-180	https://chre.ashmus.ox.ac.uk/hoard/13325
2780	**Mrčevac**	Western Danube	Serbia	176-180	https://chre.ashmus.ox.ac.uk/hoard/2780
1425	**Caistor by Norwich 1895**	Britain	England	177-180	https://chre.ashmus.ox.ac.uk/hoard/1425
2248	**Castle Bromwich**	Britain	England	177-180	https://chre.ashmus.ox.ac.uk/hoard/2248
5259	**Bîrgăoani**	Eastern Danube	Romania	179-180	https://chre.ashmus.ox.ac.uk/hoard/5259
9850	**Balloo 1839**	Rhine	Netherlands	180	https://chre.ashmus.ox.ac.uk/hoard/9850
1662	**Ollerton**	Britain	England	180	https://chre.ashmus.ox.ac.uk/hoard/1662
2612	**Gîrla mare**	Eastern Danube	Romania	180	https://chre.ashmus.ox.ac.uk/hoard/2612
2781	**Grocka**	Western Danube	Serbia	180	https://chre.ashmus.ox.ac.uk/hoard/2781
8038	**Gura Ialomiței 1**	Eastern Danube	Romania	180	https://chre.ashmus.ox.ac.uk/hoard/8038
16323	**Pocreaca**	Eastern Danube	Romania	180	https://chre.ashmus.ox.ac.uk/hoard/16323
16312	**Bălănești 1958**	Eastern Danube	Romania	181	https://chre.ashmus.ox.ac.uk/hoard/16312

Appendix: Hoards used by this study

CHRE no.	Hoard	Region	Country	*tpq*	CHRE record
13318	**Feulen**	Rhine	Luxembourg	181-182	https://chre.ashmus.ox.ac.uk/hoard/13318
2610	**Dumbrăvioara**	Western Danube	Romania	180-183	https://chre.ashmus.ox.ac.uk/hoard/2610
5263	**Larnaka**	Eastern Mediterranean	Cyprus	183-184	https://chre.ashmus.ox.ac.uk/hoard/5263
16255	**Parava 1937**	Eastern Danube	Romania	183-184	https://chre.ashmus.ox.ac.uk/hoard/16255
15473	**Unterammergau 1908**	Western Danube	Germany	184	https://chre.ashmus.ox.ac.uk/hoard/15473
2613	**Alba Iulia 1867**	Western Danube	Romania	184-185	https://chre.ashmus.ox.ac.uk/hoard/2613
16318	**Gherăieștii Noi**	Eastern Danube	Romania	184-185	https://chre.ashmus.ox.ac.uk/hoard/16318
2614	**Desa 1988**	Eastern Danube	Romania	185	https://chre.ashmus.ox.ac.uk/hoard/2614
16319	**Lunguleţu**	Eastern Danube	Romania	185	https://chre.ashmus.ox.ac.uk/hoard/16319
5265	**Briglands**	Britain	Scotland	186-187	https://chre.ashmus.ox.ac.uk/hoard/5265
5268	**Barger Compascuum**	Rhine	Netherlands	178-191	https://chre.ashmus.ox.ac.uk/hoard/5268
126	**Barway**	Britain	England	178-191	https://chre.ashmus.ox.ac.uk/hoard/126
2806	**Bela Reka**	Western Danube	Serbia	178-191	https://chre.ashmus.ox.ac.uk/hoard/2806
49	**Bletchley 1987**	Britain	England	178-191	https://chre.ashmus.ox.ac.uk/hoard/49
16146	**Bugojno**	Italy & Adriatic	Bos-Herz	178-191	https://chre.ashmus.ox.ac.uk/hoard/16146
5260	**Butoiești**	Eastern Danube	Romania	178-191	https://chre.ashmus.ox.ac.uk/hoard/5260
5491	**Parava 1956**	Eastern Danube	Romania	178-191	https://chre.ashmus.ox.ac.uk/hoard/5491
5264	**Prelasko**	Western Danube	Slovenia	178-191	https://chre.ashmus.ox.ac.uk/hoard/5264
16736	**Radalj**	Western Danube	Serbia	178-191	https://chre.ashmus.ox.ac.uk/hoard/16736
5267	**Sascut**	Eastern Danube	Romania	178-191	https://chre.ashmus.ox.ac.uk/hoard/5267
17266	**Ostfriesland I**	Rhine	Germany	190-191	https://chre.ashmus.ox.ac.uk/hoard/17266
16320	**Peștera Igliţa**	Western Danube	Romania	190-191	https://chre.ashmus.ox.ac.uk/hoard/16320
213	**Knutsford Area**	Britain	England	190-191	https://chre.ashmus.ox.ac.uk/hoard/213
9826	**Dura Europos 21**	Eastern Mediterranean	Syria	177-192	https://chre.ashmus.ox.ac.uk/hoard/9826
13869	**Gualdo Tadino**	Italy & Adriatic	Italy	180-192	https://chre.ashmus.ox.ac.uk/hoard/13869
12460	**Mirosaljci**	Western Danube	Serbia	187-192	https://chre.ashmus.ox.ac.uk/hoard/12460
1487	**Postwick**	Britain	England	191-192	https://chre.ashmus.ox.ac.uk/hoard/1487
16325	**Săhăteni 1900**	Eastern Danube	Romania	191-192	https://chre.ashmus.ox.ac.uk/hoard/16325
2165	**South Shields 1878**	Britain	England	191-192	https://chre.ashmus.ox.ac.uk/hoard/2165
2489	**Ugthorpe 1998**	Britain	England	192	https://chre.ashmus.ox.ac.uk/hoard/2489

Appendix: Hoards used by this study

CHRE no.	Hoard	Region	Country	*tpq*	CHRE record
16342	**Ghindăuani**	Eastern Danube	Romania	193	https://chre.ashmus.ox.ac.uk/hoard/16342
1322	**Littleborough 1994**	Britain	England	193	https://chre.ashmus.ox.ac.uk/hoard/1322
2941	**Făurei**	Eastern Danube	Romania	193-194	https://chre.ashmus.ox.ac.uk/hoard/2941
2954	**Itești**	Eastern Danube	Romania	193-194	https://chre.ashmus.ox.ac.uk/hoard/2954
16346	**Mircești**	Eastern Danube	Romania	193-194	https://chre.ashmus.ox.ac.uk/hoard/16346
9379	**Prăjești**	Eastern Danube	Romania	193-194	https://chre.ashmus.ox.ac.uk/hoard/9379
9893	**Finkum**	Rhine	Netherlands	194	https://chre.ashmus.ox.ac.uk/hoard/9893
3037	**Villach**	Western Danube	Austria	193-195	https://chre.ashmus.ox.ac.uk/hoard/3037
17475	**Gnotzheim**	Western Danube	Germany	194-195	https://chre.ashmus.ox.ac.uk/hoard/17475
2615	**Lujerdiu**	Western Danube	Romania	194-195	https://chre.ashmus.ox.ac.uk/hoard/2615
16347	**Oboroceni**	Eastern Danube	Romania	195	https://chre.ashmus.ox.ac.uk/hoard/16347
16348	**Racova-Chetriș**	Eastern Danube	Romania	195	https://chre.ashmus.ox.ac.uk/hoard/16348
1305	**Owston Ferry**	Britain	England	196	https://chre.ashmus.ox.ac.uk/hoard/1305
13139	**Kristendorf 1 1908**	Western Danube	Austria	196-197	https://chre.ashmus.ox.ac.uk/hoard/13139
5275	**Măgura**	Eastern Danube	Romania	196-197	https://chre.ashmus.ox.ac.uk/hoard/5275
2944	**Flonheim**	Rhine	Germany	193-200	https://chre.ashmus.ox.ac.uk/hoard/2944
5490	**Diepenveen**	Rhine	Netherlands	201	https://chre.ashmus.ox.ac.uk/hoard/5490
8010	**Mastacăn**	Eastern Danube	Romania	202	https://chre.ashmus.ox.ac.uk/hoard/8010
2808	**Mór-Felsődobos**	Western Danube	Hungary	203	https://chre.ashmus.ox.ac.uk/hoard/2808
9991	**Passewaaij 2000**	Rhine	Netherlands	205	https://chre.ashmus.ox.ac.uk/hoard/9991
17391	**Solin**	Italy & Adriatic	Croatia	205	https://chre.ashmus.ox.ac.uk/hoard/17391
3019	**Sveti Petar Mrežnički**	Italy & Adriatic	Croatia	205	https://chre.ashmus.ox.ac.uk/hoard/3019
2911	**Abergele 1842 B**	Britain	Wales	201-206	https://chre.ashmus.ox.ac.uk/hoard/2911
2616	**Sarmizegetusa 1993**	Western Danube	Romania	201-206	https://chre.ashmus.ox.ac.uk/hoard/2616
13315	**Thamusida - Northern Hoard**	Spain & Western Med	Morocco	201-206	https://chre.ashmus.ox.ac.uk/hoard/13315
2918	**Arborfield**	Britain	England	203-206	https://chre.ashmus.ox.ac.uk/hoard/2918
5277	**Vidin**	Eastern Danube	Bulgaria	201-207	https://chre.ashmus.ox.ac.uk/hoard/5277
2209	**Kenilworth I**	Britain	England	207	https://chre.ashmus.ox.ac.uk/hoard/2209
238	**Bristol (Rochester Road)**	Britain	England	208	https://chre.ashmus.ox.ac.uk/hoard/238
12824	**Llíria 1999**	Spain & Western Med	Spain	209	https://chre.ashmus.ox.ac.uk/hoard/12824

Appendix: Hoards used by this study

CHRE no.	Hoard	Region	Country	*tpq*	CHRE record
16337	**Ardeoani**	Eastern Danube	Romania	201-210	https://chre.ashmus.ox.ac.uk/hoard/16337
13314	**Thamusida - Southern Hoard**	Spain & Western Med	Morocco	206-210	https://chre.ashmus.ox.ac.uk/hoard/13314
17038	**Seligenstadt**	Rhine	Germany	208-210	https://chre.ashmus.ox.ac.uk/hoard/17038
9911	**Hargen**	Rhine	Netherlands	210	https://chre.ashmus.ox.ac.uk/hoard/9911
5272	**Puriceni**	Eastern Danube	Romania	193-211	https://chre.ashmus.ox.ac.uk/hoard/5272
2807	**Mendé**	Western Danube	Hungary	193-211	https://chre.ashmus.ox.ac.uk/hoard/2807
533	**Mandley**	Britain	England	194-211	https://chre.ashmus.ox.ac.uk/hoard/533
2965	**Lashorst 1899**	Rhine	Germany	197-211	https://chre.ashmus.ox.ac.uk/hoard/2965
17403	**Požarevac (surroundings) 1982**	Western Danube	Serbia	197-211	https://chre.ashmus.ox.ac.uk/hoard/17403
16999	**Marköbel 1983**	Rhine	Germany	209-211	https://chre.ashmus.ox.ac.uk/hoard/16999
755	**Muswell hill**	Britain	England	209-211	https://chre.ashmus.ox.ac.uk/hoard/755
16532	**Čortanovci**	Western Danube	Serbia	210-213	https://chre.ashmus.ox.ac.uk/hoard/16532
2522	**Darfield 1948**	Britain	England	213	https://chre.ashmus.ox.ac.uk/hoard/2522
5281	**Kecel I**	Western Danube	Hungary	214	https://chre.ashmus.ox.ac.uk/hoard/5281
15419	**Libya 1923 - Unknown Findspot**	Eastern Mediterranean	Libya	214	https://chre.ashmus.ox.ac.uk/hoard/15419
13116	**Carnuntum 2012**	Western Danube	Austria	215	https://chre.ashmus.ox.ac.uk/hoard/13116
3045	**Zadar**	Italy & Adriatic	Croatia	215	https://chre.ashmus.ox.ac.uk/hoard/3045
12902	**Castrillo de Cabrera**	Spain & Western Med	Spain	211-217	https://chre.ashmus.ox.ac.uk/hoard/12902
566	**Chadwell St Mary**	Britain	England	213-217	https://chre.ashmus.ox.ac.uk/hoard/566
9800	**Dura Europos 3 and 4**	Eastern Mediterranean	Syria	217-218	https://chre.ashmus.ox.ac.uk/hoard/9800
2976	**Mainz 1952**	Rhine	Germany	217-218	https://chre.ashmus.ox.ac.uk/hoard/2976
2617	**Frânceşti**	Eastern Danube	Romania	219	https://chre.ashmus.ox.ac.uk/hoard/2617
5436	**Kiziltepe**	Eastern Mediterranean	Turkey	219	https://chre.ashmus.ox.ac.uk/hoard/5436
58	**Prestwood A**	Britain	England	220	https://chre.ashmus.ox.ac.uk/hoard/58
9846	**Anloo 2008-2009**	Rhine	Netherlands	218-222	https://chre.ashmus.ox.ac.uk/hoard/9846
9824	**Dura Europos 19**	Eastern Mediterranean	Syria	218-222	https://chre.ashmus.ox.ac.uk/hoard/9824
2990	**Obererbach**	Rhine	Germany	218-222	https://chre.ashmus.ox.ac.uk/hoard/2990
12493	**Trichiana 1967**	Italy & Adriatic	Italy	218-222	https://chre.ashmus.ox.ac.uk/hoard/12493
1975	**Akenham**	Britain	England	220-222	https://chre.ashmus.ox.ac.uk/hoard/1975
2924	**Blăgeşti**	Eastern Danube	Romania	222	https://chre.ashmus.ox.ac.uk/hoard/2924

Appendix: Hoards used by this study

CHRE no.	Hoard	Region	Country	*tpq*	CHRE record
8878	**Denarius Hoard (Erimtan Collection)**	Eastern Mediterranean	Turkey	222	https://chre.ashmus.ox.ac.uk/hoard/8878
3058	**Câmpulung-Muscel**	Eastern Danube	Romania	223	https://chre.ashmus.ox.ac.uk/hoard/3058
5282	**Tell Kalak**	Eastern Mediterranean	Jordan	222-225	https://chre.ashmus.ox.ac.uk/hoard/5282
5503	**Bäretswil ZH 1993**	Western Danube	Switzerland	226	https://chre.ashmus.ox.ac.uk/hoard/5503
8039	**Nireș**	Western Danube	Romania	227	https://chre.ashmus.ox.ac.uk/hoard/8039
2620	**Dănești**	Eastern Danube	Romania	228	https://chre.ashmus.ox.ac.uk/hoard/2620
5247	**Jever**	Rhine	Germany	222-228	https://chre.ashmus.ox.ac.uk/hoard/5247
3083	**Lempten-Lindenberg 1958**	Western Danube	Germany	222-228	https://chre.ashmus.ox.ac.uk/hoard/3083
3093	**Mainz 1950**	Rhine	Germany	222-228	https://chre.ashmus.ox.ac.uk/hoard/3093
16633	**Sigmaringen**	Western Danube	Germany	222-228	https://chre.ashmus.ox.ac.uk/hoard/16633
16360	**Muntenești**	Eastern Danube	Romania	228	https://chre.ashmus.ox.ac.uk/hoard/16360
2869	**Spodnja Hajdina**	Western Danube	Slovenia	229	https://chre.ashmus.ox.ac.uk/hoard/2869
13267	**Mauer bei Amstetten**	Western Danube	Austria	230	https://chre.ashmus.ox.ac.uk/hoard/13267
3085	**Kirchmatting**	Western Danube	Germany	222-231	https://chre.ashmus.ox.ac.uk/hoard/3085
3082	**Kempten/Spinnerei**	Western Danube	Germany	226-231	https://chre.ashmus.ox.ac.uk/hoard/3082
16258	**Moigrad-Porolissum 2004**	Western Danube	Romania	228-231	https://chre.ashmus.ox.ac.uk/hoard/16258
16362	**Târpești**	Eastern Danube	Romania	228-231	https://chre.ashmus.ox.ac.uk/hoard/16362
3121	**Tîrpești**	Eastern Danube	Romania	228-231	https://chre.ashmus.ox.ac.uk/hoard/3121
2622	**Turda 1981-1982**	Western Danube	Romania	228-231	https://chre.ashmus.ox.ac.uk/hoard/2622
580	**East of England**	Britain	England	231	https://chre.ashmus.ox.ac.uk/hoard/580
5285	**Ercsi**	Western Danube	Hungary	231	https://chre.ashmus.ox.ac.uk/hoard/5285
3132	**Wiggensbach**	Western Danube	Germany	233	https://chre.ashmus.ox.ac.uk/hoard/3132
7713	**Carmel Coast 1990 A**	Eastern Mediterranean	Israel	222-235	https://chre.ashmus.ox.ac.uk/hoard/7713
3072	**Falkirk**	Britain	Scotland	222-235	https://chre.ashmus.ox.ac.uk/hoard/3072
16479	**Iezer**	Eastern Danube	Romania	222-235	https://chre.ashmus.ox.ac.uk/hoard/16479
12486	**Vicenza 1908 – Surroundings**	Italy & Adriatic	Italy	222-235	https://chre.ashmus.ox.ac.uk/hoard/12486
3130	**Welzheim**	Rhine	Germany	222-235	https://chre.ashmus.ox.ac.uk/hoard/3130
3050	**Baden-Baden 1824**	Rhine	Germany	225-235	https://chre.ashmus.ox.ac.uk/hoard/3050
3095	**Marnbach**	Western Danube	Germany	228-235	https://chre.ashmus.ox.ac.uk/hoard/3095
792	**Standish 1926**	Britain	England	228-235	https://chre.ashmus.ox.ac.uk/hoard/792

Appendix: Hoards used by this study

CHRE no.	Hoard	Region	Country	*tpq*	CHRE record
16650	**Rembrechts**	Western Danube	Germany	230-235	https://chre.ashmus.ox.ac.uk/hoard/16650
7483	**Börgönd**	Western Danube	Hungary	231-235	https://chre.ashmus.ox.ac.uk/hoard/7483
16370	**Kučevo**	Western Danube	Serbia	231-235	https://chre.ashmus.ox.ac.uk/hoard/16370
13270	**Pottenbrunn 1985**	Western Danube	Austria	233-235	https://chre.ashmus.ox.ac.uk/hoard/13270
3091	**Leskovec**	Western Danube	Slovenia	235	https://chre.ashmus.ox.ac.uk/hoard/3091
13265	**Linsberg**	Western Danube	Austria	235	https://chre.ashmus.ox.ac.uk/hoard/13265
3120	**Sulakyurt**	Eastern Mediterranean	Turkey	235-237	https://chre.ashmus.ox.ac.uk/hoard/3120
2520	**Cadeby 1912**	Britain	England	235-238	https://chre.ashmus.ox.ac.uk/hoard/2520
2523	**Darfield 1947**	Britain	England	235-238	https://chre.ashmus.ox.ac.uk/hoard/2523
612	**Kamenica**	Western Danube	Serbia	235-238	https://chre.ashmus.ox.ac.uk/hoard/16612
5288	**Niederaschau**	Western Danube	Germany	235-238	https://chre.ashmus.ox.ac.uk/hoard/5288
2784	**Ravna**	Western Danube	Serbia	235-238	https://chre.ashmus.ox.ac.uk/hoard/2784
5289	**Köln Gertrudenstraße 1909**	Rhine	Germany	236-238	https://chre.ashmus.ox.ac.uk/hoard/5289
3096	**Mehovine**	Western Danube	Serbia	236-238	https://chre.ashmus.ox.ac.uk/hoard/3096
8848	**Postojna**	Italy & Adriatic	Slovenia	236-238	https://chre.ashmus.ox.ac.uk/hoard/8848
16530	**Supska 1995**	Western Danube	Serbia	236-238	https://chre.ashmus.ox.ac.uk/hoard/16530
2627	**Ţaga**	Western Danube	Romania	239	https://chre.ashmus.ox.ac.uk/hoard/2627
16197	**Verona 1891 - Ponte Postumio**	Italy & Adriatic	Italy	240	https://chre.ashmus.ox.ac.uk/hoard/16197
1435	**Dereham, Near**	Britain	England	241	https://chre.ashmus.ox.ac.uk/hoard/1435
17396	**Vis**	Italy & Adriatic	Croatia	241-243	https://chre.ashmus.ox.ac.uk/hoard/17396
3517	**Yatağan**	Eastern Mediterranean	Turkey	243	https://chre.ashmus.ox.ac.uk/hoard/3517
3446	**Stellata**	Italy & Adriatic	Italy	238-244	https://chre.ashmus.ox.ac.uk/hoard/3446
2633	**Cristeşti 1963**	Western Danube	Romania	243-244	https://chre.ashmus.ox.ac.uk/hoard/2633
3280	**Jeledinţi**	Western Danube	Romania	244	https://chre.ashmus.ox.ac.uk/hoard/3280
9304	**Timişoara 1958**	Western Danube	Romania	244-247	https://chre.ashmus.ox.ac.uk/hoard/9304
2639	**Galicea Mare**	Eastern Danube	Romania	246-247	https://chre.ashmus.ox.ac.uk/hoard/2639
24	**Timsbury 2011**	Britain	England	247	https://chre.ashmus.ox.ac.uk/hoard/24
5507	**Köngen**	Rhine	Germany	246-248	https://chre.ashmus.ox.ac.uk/hoard/5507
16541	**Mezul 1966 2**	Western Danube	Serbia	247-248	https://chre.ashmus.ox.ac.uk/hoard/16541
7744	**Bârca 1962**	Eastern Danube	Romania	244-249	https://chre.ashmus.ox.ac.uk/hoard/7744

Appendix: Hoards used by this study

CHRE no.	Hoard	Region	Country	*tpq*	CHRE record
7502	**Bakonyszombathely-Páskum**	Western Danube	Hungary	247-249	https://chre.ashmus.ox.ac.uk/hoard/7502
2785	**Sikirica 1952**	Western Danube	Serbia	247-249	https://chre.ashmus.ox.ac.uk/hoard/2785
4788	**Skopje**	Italy & Adriatic	N Maced	248-249	https://chre.ashmus.ox.ac.uk/hoard/4788
2799	**Jablanica**	Western Danube	Serbia	249	https://chre.ashmus.ox.ac.uk/hoard/279
3406	**Reka Devnia 1929**	Eastern Danube	Bulgaria	243-251	https://chre.ashmus.ox.ac.uk/hoard/3406
4843	**Eastern Turkey**	Eastern Mediterranean	Turkey	249-251	https://chre.ashmus.ox.ac.uk/hoard/4843
3305	**Ladenburg 1877/82**	Rhine	Germany	249-251	https://chre.ashmus.ox.ac.uk/hoard/3305
4846	**Bârca 1937**	Eastern Danube	Romania	249-251	https://chre.ashmus.ox.ac.uk/hoard/4846
5292	**Russe 1916**	Eastern Danube	Bulgaria	249-251	https://chre.ashmus.ox.ac.uk/hoard/5292
2656	**Bârca 1963**	Eastern Danube	Romania	250-251	https://chre.ashmus.ox.ac.uk/hoard/2656
2657	**Bocşa Română**	Western Danube	Romania	251	https://chre.ashmus.ox.ac.uk/hoard/2657
3133	**Abrud**	Eastern Danube	Romania	251-252	https://chre.ashmus.ox.ac.uk/hoard/3133
13037	**Courcelles-sur-Nied 2005**	Rhine	France	251-253	https://chre.ashmus.ox.ac.uk/hoard/13037
6113	**Le Sablon**	Rhine	France	251-253	https://chre.ashmus.ox.ac.uk/hoard/6113
7501	**Péliföldszentkereszt II**	Western Danube	Hungary	251-253	https://chre.ashmus.ox.ac.uk/hoard/7501
5299	**Wiesbach Mangelhausen**	Rhine	Germany	251-253	https://chre.ashmus.ox.ac.uk/hoard/5299
5300	**Gračič**	Western Danube	Slovenia	253	https://chre.ashmus.ox.ac.uk/hoard/5300
3198	**Clavier III**	Rhine	Belgium	254	https://chre.ashmus.ox.ac.uk/hoard/3198
2663	**Stăneşti**	Eastern Danube	Romania	254-255	https://chre.ashmus.ox.ac.uk/hoard/2663
2875	**Balozsameggyes**	Western Danube	Hungary	255	https://chre.ashmus.ox.ac.uk/hoard/2875
2876	**Bušetina**	Western Danube	Croatia	257	https://chre.ashmus.ox.ac.uk/hoard/2876
9746	**Slatina 1**	Eastern Danube	Bulgaria	257	https://chre.ashmus.ox.ac.uk/hoard/9746
7431	**Xanten**	Rhine	Germany	257	https://chre.ashmus.ox.ac.uk/hoard/7431
13260	**Gösseling**	Western Danube	Austria	257-258	https://chre.ashmus.ox.ac.uk/hoard/13260
8090	**Krog**	Western Danube	Slovenia	259	https://chre.ashmus.ox.ac.uk/hoard/8090
9792	**Dura Europos 5**	Eastern Mediterranean	Syria	253-260	https://chre.ashmus.ox.ac.uk/hoard/9792
5418	**Banasa - House of Fonteius**	Spain & Western Med	Morocco	257-260	https://chre.ashmus.ox.ac.uk/hoard/5418
6543	**Baden**	Western Danube	Switzerland	258-260	https://chre.ashmus.ox.ac.uk/hoard/6543
16558	**Vlajića Brdo**	Western Danube	Serbia	260	https://chre.ashmus.ox.ac.uk/hoard/16558
1469	**Mattishall 1968**	Britain	England	260-261	https://chre.ashmus.ox.ac.uk/hoard/1469

Appendix: Hoards used by this study

CHRE no.	Hoard	Region	Country	*tpq*	CHRE record
3711	**Haydere**	Eastern Mediterranean	Turkey	264	https://chre.ashmus.ox.ac.uk/hoard/3711
1424	**Caister by Yarmouth 1946**	Britain	England	266-267	https://chre.ashmus.ox.ac.uk/hoard/1424
5336	**Mainz 1886**	Rhine	Germany	259-268	https://chre.ashmus.ox.ac.uk/hoard/5336
3713	**Heidelberg-Neuenheim 1897 A**	Rhine	Germany	259-268	https://chre.ashmus.ox.ac.uk/hoard/3713
3694	**Garčin 1**	Western Danube	Croatia	260-268	https://chre.ashmus.ox.ac.uk/hoard/3694
7433	**Xanten 1964**	Rhine	Germany	260-268	https://chre.ashmus.ox.ac.uk/hoard/7433
3190	**Almenara**	Spain & Western Med	Spain	260-269	https://chre.ashmus.ox.ac.uk/hoard/3190
9919	**Helmond 1917**	Rhine	Netherlands	260-269	https://chre.ashmus.ox.ac.uk/hoard/9919
2898	**Nagyberki I**	Western Danube	Hungary	268-270	https://chre.ashmus.ox.ac.uk/hoard/2898
538	**Wareham I**	Britain	England	271	https://chre.ashmus.ox.ac.uk/hoard/538
9252	**Mollis GL 1765**	Western Danube	Switzerland	270-275	https://chre.ashmus.ox.ac.uk/hoard/9252
4337	**Medgidia 1968**	Eastern Danube	Romania	383	https://chre.ashmus.ox.ac.uk/hoard/4337
16144	**Majdaniste**	Italy & Adriatic	Bos-Herz	392	https://chre.ashmus.ox.ac.uk/hoard/16144
2349	**Stanchester**	Britain	England	402-406	https://chre.ashmus.ox.ac.uk/hoard/2349
10002	**Rossum 1895**	Rhine	Netherlands	388-408	https://chre.ashmus.ox.ac.uk/hoard/10002

Annexe 1: Trajan

Results of design-level χ^2 tests on *denarii* from hoards closing up to *c.* 250

Table 1: Reverse designs of 98 and 98-99 from *denarii* in hoards closing up to *c.* 250 (n=1,160)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Abundantia	30	13	10	17	44	116	16	**246**
Concordia	37	7	10	20	55	85	19	**233**
Traj and Sen	0	0	2	0	0	1	0	**3**
Pax	40	9	16	25	71	105	14	**280**
Vesta	22	9	14	17	43	75	15	**195**
Victoria	29	7	12	20	43	81	11	**203**
Qty	**158**	**45**	**64**	**99**	**256**	**463**	**75**	**1160**

χ^2 standardised residuals
χ^2 = 19.258, df = 24, **p-value = 0.7381**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Abundantia	-0.6200	1.1096	-0.8765	-0.8826	-1.4138	1.7929	0.0134
Concordia	0.9186	-0.6850	-0.7035	0.0141	0.4799	-0.8334	1.0026
Pax	0.2851	-0.5728	0.2570	0.2128	1.1494	-0.6437	-0.9742
Vesta	-0.8971	0.5141	1.0984	0.0770	-0.0222	-0.3247	0.6637
Victoria	0.2428	-0.3187	0.3401	0.6311	-0.2859	-0.0066	-0.5952

Table 2: Reverse designs of 100 and 101-102 from *denarii* in hoards closing up to *c.* 250 (n=1,106)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Abundantia	12	2	7	7	35	25	7	**95**
Concordia	7	1	5	8	17	35	8	**81**
Hercules	33	7	25	37	67	129	22	**320**
Mars	22	5	11	18	52	93	15	**216**
Pax	19	1	11	11	32	45	14	**133**
Vesta	16	1	6	5	24	66	4	**122**
Victoria	17	0	5	13	40	54	10	**139**
Qty	**126**	**17**	**70**	**99**	**267**	**447**	**80**	**1106**

χ^2 standardised residuals
χ^2 = 41.438, df = 30, **p-value = 0.07988**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Abundantia	0.3779	-	0.4180	-0.5002	2.5546	-2.1322	0.0643
Concordia	-0.7416	-	-0.0628	0.2697	-0.5903	0.3774	0.8758
Hercules	-0.5342	-	1.0881	1.6020	-1.1120	0.0462	-0.2072
Mars	-0.4884	-	-0.6959	-0.2698	0.0372	0.6868	-0.1271
Pax	0.9537	-	0.8635	-0.2887	-0.0639	-1.2474	1.3818
Vesta	0.5345	-	-0.6375	-1.8091	-1.0404	2.3176	-1.6398
Victoria	0.2287	-	-1.3164	0.1023	1.0141	-0.4045	-0.0661

Table 3: Reverse designs of 102 from *denarii* in hoards closing up to *c.* 250 (n=1,022)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Vict and altar	6	0	3	2	7	19	10	**47**
Victora adv	60	12	22	32	88	236	27	**477**

Table 3: Reverse designs of 102 from *denarii* in hoards closing up to *c.* 250 (n=1,022)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Victoria stg	37	7	25	22	67	132	16	**306**
Vict on prow	28	8	19	15	54	55	9	**188**
Traj in quadriga	0	0	0	0	0	4	0	**4**
Qty	**131**	**27**	**69**	**71**	**216**	**446**	**62**	**1022**

χ² standardised residuals
χ² = 29.693, df = 12, **p-value = 0.003105**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Victora adv	-0.1794	-0.3470	-1.8304	-0.3257	-1.4478	1.9565	0.2879
Victoria stg	-0.3812	-0.5172	0.9211	0.0548	0.1400	-0.1129	-0.0957
Vict on prow	0.7721	1.2126	1.7404	0.4489	2.1276	-2.9723	-0.3366

Table 4: Reverse designs of 103, 103-104, and 103-105 from *denarii* in hoards closing up to *c.* 250 (n=783)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Dacian	53	5	23	21	67	137	22	**328**
Fortuna	9	0	4	6	12	36	3	**70**
Hercules	1	0	0	0	2	3	0	**6**
Mars	15	1	1	2	13	8	5	**45**
Pax and Dacian	18	2	4	14	18	33	9	**98**
Traj and Vict	12	1	8	7	9	30	4	**71**
Vict	2	0	0	1	3	6	0	**12**
Virtus	23	3	5	10	32	71	9	**153**
Qty	**133**	**12**	**45**	**61**	**156**	**324**	**52**	**783**

χ² standardised residuals
χ² = 21.456, df = 20, **p-value = 0.3707**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Dacian	0.0842	-	0.6600	-1.0550	0.5210	-0.2419	0.1271
Fortuna	-0.6986	-	-0.1651	0.1143	-0.4402	1.0335	-0.7615
Pax and Dacian	0.6155	-	-0.8021	2.1934	-0.1586	-1.3290	1.0450
Traj and Vict	0.1917	-	1.7540	0.5322	-1.2529	-0.0564	-0.2973
Virtus	-0.2696	-	-1.4123	-0.6483	0.5189	0.7506	-0.2992

Table 5: Reverse designs of 106-107 from *denarii* in hoards closing up to *c.* 250 (n=771)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Abundantia	11	7	11	11	29	59	6	**134**
Felicitas	19	4	9	14	40	74	10	**170**
Fides	2	0	2	2	4	12	3	**25**
Genius	27	4	2	14	39	57	8	**151**
Mars	19	5	11	8	29	57	9	**138**
Pax and Dacian	25	1	6	10	26	80	5	**153**
Qty	**103**	**21**	**41**	**59**	**167**	**339**	**41**	**771**

χ² standardised residuals
χ² = 25.878, df = 20, **p-value = 0.1699**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Abundantia	-1.5911	-	1.5947	0.3213	0.0836	0.2271	-0.2545
Felicitas	-0.8579	-	0.0235	0.2627	0.4385	-0.1007	0.4405
Genius	1.4411	-	-2.1008	0.7185	1.0350	-1.1424	0.1063
Mars	0.1096	-	1.4377	-0.7597	-0.1650	-0.3857	0.7685

Annexe 1: Trajan

Table 5: Reverse designs of 106-107 from *denarii* in hoards closing up to *c.* 250 (n=771)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Pax and Dacian	0.8312	-	-0.7612	-0.5642	-1.3982	1.3820	-1.0511	

Table 6: Reverse designs of 107 and 107-108 from *denarii* in hoards closing up to *c.* 250 (n=2,341)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Aequitas	5	1	4	6	14	29	3	**62**
Ceres	4	0	0	1	9	11	3	**28**
Dacian	12	3	7	9	16	22	11	**80**
Danube	8	2	8	3	16	26	6	**69**
Fortuna	39	5	15	26	50	124	14	**273**
Mars	8	2	12	10	22	56	3	**113**
Spes	69	8	22	43	73	156	17	**388**
Traj in quadriga	2	0	0	1	3	8	0	**14**
Trophy	60	15	27	37	79	176	22	**416**
Victoria	124	32	51	81	165	387	58	**898**
Qty	**331**	**68**	**146**	**217**	**447**	**995**	**137**	**2341**

χ^2 **standardised residuals** χ^2 = 19.656, df = 20, **p-value = 0.4797**							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**
Fortuna	-0.1086	-	-0.4391	-0.0116	-0.2031	0.4658	-0.2781
Mars	-2.0809	-	1.9114	-0.2414	0.1489	0.9612	-1.2988
Spes	1.6973	-	-0.3730	0.9953	0.0045	-0.9717	-0.9477
Trophy	0.0807	-	0.3716	-0.3189	0.2287	-0.1452	-0.1187
Victoria	-0.3738	-	-0.4459	-0.3494	-0.0989	0.1392	1.3282

Table 7: Reverse designs of 108-109 from *denarii* in hoards closing up to *c.* 250 (n=2,806)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Aequitas	184	29	74	99	273	619	74	**1352**
Dacian	30	8	10	16	59	131	11	**265**
Felicitas	47	8	18	30	60	190	25	**378**
Roma	63	8	28	34	75	180	20	**408**
Victoria	47	18	19	31	88	179	21	**403**
Qty	**371**	**71**	**149**	**210**	**555**	**1299**	**151**	**2806**

χ^2 **standardised residuals** χ^2 = 25.398, df = 24, **p-value = 0.3844**							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**
Aequitas	0.3922	-0.7965	0.2606	-0.2170	0.3417	-0.2754	0.0854
Dacian	-0.8510	0.4603	-1.0854	-0.8606	0.9096	0.7513	-0.8412
Felicitas	-0.4212	-0.5456	-0.4625	0.3216	-1.7076	1.1347	1.0663
Roma	1.2329	-0.7631	1.3610	0.6271	-0.6343	-0.6460	-0.3877
Victoria	-0.8608	2.3818	-0.5187	0.1529	0.9286	-0.5537	-0.1170

Table 8: Reverse designs of 110 from *denarii* in hoards closing up to *c.* 250 (n=1,364)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Arabia	43	13	25	37	76	196	18	**408**
Dacian	15	2	4	5	22	67	3	**118**
Felicitas	43	13	29	33	83	225	16	**442**

Annexe 1: Trajan

Table 8: Reverse designs of 110 from *denarii* in hoards closing up to *c.* 250 (n=1,364)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Roma	66	11	17	21	74	193	14	**396**
Qty	**167**	**39**	**75**	**96**	**255**	**681**	**51**	**1364**

χ^2 standardised residuals
χ^2 = 21.656, df = 18, **p-value = 0.2476**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Arabia	-0.9838	0.3907	0.5418	1.5460	-0.0316	-0.5396	0.7028
Dacian	0.1454	-0.7480	-0.9769	-1.1468	-0.0128	1.0535	-0.6722
Felicitas	-1.5111	0.1019	0.9527	0.3391	0.0405	0.2911	-0.1295
Roma	2.5156	-0.0959	-1.0231	-1.3015	-0.0037	-0.3349	-0.2096

Table 9: Reverse designs of 111 from *denarii* in hoards closing up to *c.* 250 (n=612)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aeternitas	17	5	9	7	26	57	2	**123**
Pax	13	2	6	15	29	49	10	**124**
Pietas	14	2	5	11	27	49	7	**115**
Vesta	19	3	9	5	28	72	8	**144**
Victoria	6	3	8	8	25	46	10	**106**
Qty	**69**	**15**	**37**	**46**	**135**	**273**	**37**	**612**

χ^2 standardised residuals
χ^2 = 23.215, df = 20, **p-value = 0.2783**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Aeternitas	0.9103	-	0.6237	-0.6938	-0.1323	0.4139	-1.9647
Pax	-0.2931	-	-0.5677	1.8264	0.2688	-0.9089	0.8869
Pietas	0.2600	-	-0.7570	0.7771	0.2863	-0.3719	-0.0013
Vesta	0.6697	-	0.0884	-1.7792	-0.6879	0.9368	-0.2499
Victoria	-1.7113	-	0.6398	0.0226	0.3540	-0.1604	1.4314

Table 10: Reverse designs of 112, 112-113, 112-114, and 112-117 from *denarii* in hoards closing up to *c.* 250 (n=1003)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aeternitas	3	1	1	0	0	9	0	**14**
Marcia and Matid	1	0	0	0	0	0	0	**1**
Pax	1	0	2	4	5	5	1	**18**
Pietas	2	1	0	1	2	10	1	**17**
Vesta	0	0	3	2	5	7	3	**20**
Victoria	1	1	0	2	3	5	1	**13**
Aeneas and Anch	0	0	0	0	0	1	0	**1**
ALIM ITAL	17	8	12	16	29	99	11	**192**
Arabia	22	1	14	20	31	95	9	**192**
Trajan on horse	12	11	11	8	35	73	11	**161**
DIVVS PAT TRAIAN	29	6	12	8	40	73	5	**173**
VIA TRAIANA	22	6	13	9	33	72	12	**167**
Plotina	2	0	1	3	2	6	0	**14**
Matid and Div Marcia	1	1	2	2	2	9	3	**20**
Qty	**113**	**36**	**71**	**75**	**187**	**464**	**57**	**1003**

χ^2 standardised residuals
χ^2 = 35.934, df = 24, **p-value = 0.0557**

Annexe 1: Trajan

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
ALIM ITAL	-1.0903	0.4014	-0.3956	0.7604	-1.2336	1.0172	0.1817
Arabia	-0.0274	-2.2553	0.1497	1.8599	-0.9023	0.5941	-0.4380
Trajan on horse	-1.5219	2.1463	-0.0831	-0.9297	0.8026	-0.2254	0.7674
DIVVS PAT TRAIAN	2.0292	-0.1021	-0.0344	-1.1364	1.2493	-0.8399	-1.4309
VIA TRAIANA	0.6274	-0.0156	0.3802	-0.7400	0.2306	-0.6515	0.9777

Table 11: Reverse designs of 113-114 and 114 from *denarii* in hoards closing up to *c.* 250 (n=1,217)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aquila	28	3	10	10	40	85	10	**186**
Bonus Event	21	7	11	21	42	108	12	**222**
Felicitas	23	4	12	18	40	100	12	**209**
Fortuna	10	0	7	6	16	37	2	**78**
Traj and Jup	4	1	6	0	5	15	1	**32**
Mars	32	10	10	22	55	99	10	**238**
Spes	2	0	0	2	4	5	0	**13**
Traj Column	32	3	11	15	43	97	13	**214**
Vict	1	0	2	1	1	5	1	**11**
Virtus	0	0	1	0	7	4	2	**14**
Qty	**153**	**28**	**70**	**95**	**253**	**555**	**63**	**1217**

χ^2 standardised residuals
$\chi^2 = 14.424$, df = 25, **p-value = 0.9538**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Aquila	0.8486	-	0.0105	-1.2979	0.2318	-0.1019	0.1159
Bon Event	-1.3273	-	-0.2074	0.7946	-0.4908	0.6993	0.2003
Felicitas	-0.7202	-	0.2498	0.2829	-0.4863	0.3795	0.3654
Fortuna	-0.0526	-	1.3351	-0.1608	-0.1075	0.0608	-1.0404
Mars	0.4180	-	-0.6861	0.7559	1.0037	-0.7807	-0.5802
Traj Column	0.8570	-	-0.1451	-0.5602	-0.2191	-0.2104	0.5653

Table 12: Reverse designs of 114 and 114-115 from *denarii* in hoards closing up to *c.* 250 (n=1,967)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Bonus Event	39	15	30	30	78	243	14	**449**
Felicitas	40	9	14	27	71	185	26	**372**
Fort Red	54	8	23	23	78	187	22	**395**
Mars	46	9	19	26	73	85	21	**279**
Providentia	1	0	0	0	2	7	1	**11**
Traj and Jup	1	0	0	1	0	117	0	**119**
Traj Column	7	2	4	1	17	25	3	**59**
Virtus	30	5	16	25	59	135	13	**283**
Qty	**218**	**48**	**106**	**133**	**378**	**984**	**100**	**1967**

χ^2 standardised residuals
$\chi^2 = 177.41$, df = 30, **p-value < 2.2e-16**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Bonus Event	-1.5184	1.2463	1.1922	-0.2224	-0.7563	1.1772	-1.8298
Felicitas	-0.1840	-0.0068	-1.3420	0.2191	0.0716	-0.1234	1.6536
Fort Red	1.5536	-0.5100	0.3822	-0.8556	0.3756	-0.7975	0.4497
Mars	2.7196	0.8591	1.0323	1.4948	2.7800	-4.6494	1.8312
Traj and Jup	-3.3540	-1.6987	-2.5295	-2.5301	-4.7456	7.4122	-2.4540
Virtus	-0.2373	-0.7109	0.2008	1.1961	0.7438	-0.5892	-0.3492

Table 13: Reverse designs of 116 and 116-117 from *denarii* in hoards closing up to *c.* 250 (n=1,816)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Bonus Event	18	4	4	11	12	38	2	**89**
Felicitas	27	5	32	18	67	142	17	**308**
Fort Red	30	5	28	17	65	115	10	**270**
Mars	36	8	20	25	57	144	11	**301**
Providentia	59	13	17	35	88	218	17	**447**
Salus	8	3	4	0	10	13	1	**39**
Sol	8	1	4	1	9	14	0	**37**
Virtus	42	4	21	32	63	146	17	**325**
Qty	**228**	**43**	**130**	**139**	**371**	**830**	**75**	**1816**

χ^2 standardised residuals
χ^2 = 33.661, df = 24, **p-value = 0.09087**

Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**
Bonus Event	-1.5278	-0.5985	2.1285	-1.1695	0.4485	-0.0597	0.9736
Felicitas	-0.3065	-0.3025	1.9811	-0.8271	1.2603	-0.9035	-0.5172
Fort Red	0.1061	0.6409	-0.3262	0.3837	-0.6334	0.3836	-0.5870
Mars	0.8935	1.1448	-2.6446	0.1049	-0.4225	0.7560	-0.5648
Traj and Jup	0.6167	-1.1009	-0.4624	1.4000	-0.4803	-0.3741	0.7509
Virtus	-1.5278	-0.5985	2.1285	-1.1695	0.4485	-0.0597	0.9736

Annexe 2: Hadrian

2.1: Results of design-level χ^2 tests on *denarii* from hoards closing up to 180

Table 1: reverse designs of 117 from *denarii* in hoards closing up to 180 (n=263)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Concordia	18	8	10	40	6	**82**
Fortuna	7	2	2	14	2	**27**
Justitia	8	4	13	23	4	**52**
Pax	8	1	10	16	5	**40**
Pietas	4	4	9	14	5	**36**
Traj and Had	4	1	2	16	3	**26**
Qty	**49**	**20**	**46**	**123**	**25**	**263**

χ^2 standardised residuals
χ^2 = 18.516, df = 20, **p-value = 0.5535**

	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Concordia	0.6965	0.7065	-1.1466	0.2665	-0.6428
Fortuna	0.8781	-0.0371	-1.2528	0.3863	-0.3536
Justitia	-0.5423	0.0229	1.2948	-0.2675	-0.4241
Pax	0.2005	-1.1707	1.1356	-0.6259	0.6142
Pietas	-1.0453	0.7629	1.0774	-0.6913	0.8530
Traj and Had	-0.3835	-0.6950	-1.1946	1.1013	0.3362

Table 2: reverse designs of 118 from *denarii* in hoards closing up to 180 (n=455)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Concordia	22	5	17	48	13	**105**
Felicitas	8	0	7	11	3	**29**
Fortuna	14	2	12	28	9	**65**
Justitia	7	4	10	32	7	**60**
Pax	16	4	19	25	10	**74**
Pietas	18	7	13	29	4	**71**
Salus	5	2	9	19	6	**41**
Qty	**92**	**25**	**89**	**196**	**53**	**455**

χ^2 standardised residuals
χ^2 = 19.822, df = 24, **p-value = 0.7068**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Concordia	0.1657	-0.2786	-0.7787	0.4006	0.2085
Felicitas	0.8815	-1.2506	0.5587	-0.4275	-0.2112
Fortuna	0.2355	-0.8041	-0.1986	-0.0085	0.5096
Justitia	-1.4740	0.4247	-0.5052	1.2013	-0.0042
Pax	0.2672	0.0045	1.1917	-1.2261	0.4600
Pietas	0.9606	1.6204	-0.2364	-0.2952	-1.4917
Salus	-1.1432	-0.1421	0.3477	0.3115	0.5523

Table 3: reverse designs of 119-120 from *denarii* in hoards closing up to 180 (n=404)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aeternitas	17	5	16	30	9	**76**
Concordia	12	1	2	8	1	**24**
Felicitas	14	3	12	30	11	**70**

Pax	17	4	10	31	6	**68**
Pietas	22	5	9	28	4	**68**
Salus	25	7	12	46	7	**97**
Qty	**107**	**25**	**61**	**173**	**38**	**404**

χ^2 standardised residuals
χ^2 = 8.68, df = 20, **p-value = 0.5427**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Aeternitas	-0.7515	0.1077	1.2827	-0.5177	0.6530
Concordia	2.2384	-0.3981	-0.8530	-0.7103	-0.8369
Felicitas	-1.0543	-0.6398	0.4401	0.0045	1.7209
Pax	-0.2380	-0.1014	-0.0834	0.3486	-0.1566
Pietas	0.9402	0.3861	-0.3955	-0.2073	-0.9474
Salus	-0.1362	0.4072	-0.6914	0.6925	-0.7031

Table 4: reverse designs of 120-121 from *denarii* in hoards closing up to 180 (n=219)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Felicitas	7	2	11	19	8	**47**
Congiarium	3	3	14	18	2	**40**
Hilaritas	7	2	7	16	5	**37**
Mars	20	8	23	34	10	**95**
Qty	**37**	**15**	**55**	**87**	**25**	**219**

χ^2 standardised residuals
χ^2 = 10.128, df = 12, **p-value = 0.6047**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Felicitas	-0.3338	-0.6795	-0.2339	0.0760	1.1374
Congiarium	-1.4456	0.1572	1.2476	0.5292	-1.2009
Hilaritas	0.2995	-0.3355	-0.7519	0.3394	0.3777
Mars	0.9859	0.5853	-0.1757	-0.6087	-0.2565

Table 5: reverse designs of 121 from *denarii* in hoards closing up to 180 (n=641)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aeq-Mon	47	16	41	86	25	**215**
Fortuna	14	5	18	46	8	**91**
Libertas	25	7	16	66	11	**125**
Salus	18	8	21	42	13	**102**
Victoria	24	10	10	51	13	**108**
Qty	**128**	**46**	**106**	**291**	**70**	**641**

χ^2 standardised residuals
χ^2 = 15.687, df = 16, **p-value = 0.475**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Aeq-Mon	0.6207	0.1454	0.9134	-1.1747	0.3139
Fortuna	-0.9786	-0.5989	0.7609	0.7294	-0.6146
Libertas	0.0078	-0.6579	-1.0273	1.2283	-0.7174
Salus	-0.5247	0.2514	1.0062	-0.6328	0.5577
Victoria	0.5241	0.8081	-1.8598	0.2814	0.3511

Table 6: reverse designs of 121-123 from *denarii* in hoards closing up to 180 (n=390)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty

Clementia	6	6	15	20	3	**50**
Concordia	15	3	9	23	4	**54**
Pax	1	4	13	22	6	**46**
Roma	48	11	63	91	27	**240**
Qty	**70**	**24**	**100**	**156**	**40**	**390**

χ^2 standardised residuals
χ^2 = 20.256, df = 12, **p-value = 0.0624**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Clementia	-0.9929	1.6664	0.6087	0.0000	-0.9398
Concordia	1.7049	-0.1772	-1.3024	0.3012	-0.6537
Pax	-2.5254	0.6949	0.3509	0.8393	0.5902
Roma	0.7501	-0.9808	0.1863	-0.5103	0.4806

Table 7: reverse designs of 124-125 from *denarii* in hoards closing up to 180 (n=284)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Diana	7	6	7	25	2	**47**
Genius	14	1	17	33	9	**74**
Hercules	8	1	6	9	3	**27**
Roma	9	4	22	21	10	**66**
Spes	15	8	20	20	7	**70**
Qty	**53**	**20**	**72**	**108**	**31**	**284**

χ^2 standardised residuals
χ^2 = 824.85, df = 16, **p-value = 0.07251**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Diana	-0.5980	1.4787	-1.4240	1.6857	-1.3820
Genius	0.0512	-1.8448	-0.4065	0.9160	0.3246
Hercules	1.3192	-0.6537	-0.3230	-0.3956	0.0308
Roma	-0.9451	-0.3005	1.2878	-0.8181	1.0416
Spes	0.5358	1.3829	0.5349	-1.2830	-0.2318

Table 8: reverse designs of 126-127 from *denarii* in hoards closing up to 180 (n=557)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Ann-Abund	25	5	24	36	15	**105**
Pudicitia	20	9	17	48	8	**102**
Star(s) in cres	16	8	22	27	14	**87**
Victoria	20	8	32	56	15	**131**
Virtus	23	16	34	46	13	**132**
Qty	**104**	**46**	**129**	**213**	**65**	**557**

χ^2 standardised residuals
χ^2 = 18.284, df = 16, **p-value = 0.3075**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Ann-Abund	1.2184	-1.2468	-0.0644	-0.6553	0.7847
Pudicitia	0.2189	0.1986	-1.3627	1.4402	-1.1313
Star(s) in cres	-0.0606	0.3041	0.4124	-1.0869	1.2075
Victoria	-0.9017	-0.8570	0.3015	0.8343	-0.0735
Virtus	-0.3316	1.5443	0.6202	-0.6302	-0.6125

Table 9: reverse designs of 128-129, 129-130, and 130 from *denarii* in hoards closing up to 180 (n=468)

Annexe 2: Hadrian

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Clement (128-29, 129-130)	8	5	3	8	10	**34**
Ann-Abund (128-129)	4	7	6	19	4	**40**
Tranquil (128-29, 129-130)	7	4	12	7	12	**42**
Virtus (128-29)	4	3	7	16	3	**33**
Fortuna Redux	8	4	7	2	33	**54**
Liberal (128-129, 129-130)	8	3	3	4	15	**33**
Roma (129-130, 130)	4	2	8	0	35	**49**
Eastern (128-30)	30	9	44	55	18	**156**
Romulus (130)	3	5	3	0	16	**27**
Qty	**76**	**42**	**93**	**111**	**146**	**468**

χ^2 standardised residuals
$\chi^2 = 168.75$, df = 32, **p-value < 2.2e-16**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Clement (128-29, 129-130)	1.0548	1.1156	-1.4452	-0.0226	-0.1863
Ann-Abund (128-129)	-0.9792	1.7999	-0.6912	3.0885	-2.4002
Tranquil (128-29, 129-130)	0.0687	0.1189	1.2648	-0.9383	-0.3046
Virtus (128-29)	-0.5870	0.0223	0.1727	2.9214	-2.2736
Fortuna Redux	-0.2598	-0.3844	-1.1389	-3.0199	3.9357
Liberal (128-129, 129-130)	1.1409	0.0223	-1.3893	-1.3679	1.4664
Roma (129-130, 130)	-1.4029	-1.1433	-0.5567	-3.4091	5.0422
Eastern (128-30)	0.9272	-1.3363	2.3349	2.9592	-4.3959
Romulus (130)	-0.6612	1.6555	-1.0212	-2.5306	2.6107

Table 10: reverse designs of 130-133 from *denarii* in hoards closing up to 180 (n=299)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Africa	13	1	9	28	6	**57**
Aegyptos	19	10	16	42	18	**105**
Conc (Sabina)	21	7	20	37	10	**95**
Hispania	6	7	6	18	5	**42**
Qty	**59**	**25**	**51**	**125**	**39**	**299**

χ^2 standardised residuals
$\chi^2 = 824.85$, df = 16, **p-value = 0.07251**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Africa	0.5226	-1.7250	-0.2317	0.8544	-0.5262
Aegyptos	-0.3777	0.4120	-0.4513	-0.2862	1.1631
Conc (Sabina)	0.5206	-0.3346	0.9430	-0.4309	-0.6793
Hispania	-0.7946	1.8615	-0.4348	0.1054	-0.2043

Table 11: reverse designs of 133-135 from *denarii* in hoards closing up to 180 (n=329)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Conc (Sabina)	7	0	5	13	1	**26**
Felicitas	16	6	18	27	7	**74**
Juno (Sabina)	8	1	7	28	8	**52**
Salus	16	7	23	54	18	**118**
Tellus	13	8	6	26	6	**59**
Qty	**60**	**22**	**59**	**148**	**40**	**329**

χ^2 standardised residuals
$\chi^2 = 21.511$, df = 16**, p-value = 0.1597**

Annexe 2: Hadrian

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Conc (Sabina)	0.8034	-1.2907	1.0170	-0.7491	0.1009
Felicitas	0.6658	0.5506	1.0794	-0.9004	-0.8360
Juno (Sabina)	-0.4930	-1.2907	-0.8983	1.1459	0.4862
Salus	-1.2060	-0.2333	0.1546	0.3929	0.6930
Tellus	0.6685	**2.1367**	-1.5389	0.0802	-0.5950

Table 12: reverse designs of 136 from *denarii* in hoards closing up to 180 (n=429)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Conc (Sabina)	12	1	13	19	7	**52**
Fides	30	11	11	53	21	**126**
Moneta	23	10	21	73	13	**140**
Victoria	15	13	20	49	14	**111**
Qty	**80**	**35**	**65**	**194**	**55**	**429**

χ^2 standardised residuals
χ^2 = 21.566, df = 12, **p-value = 0.04268**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Conc (Sabina)	0.7396	-1.5742	1.8245	-0.9311	0.1291
Fides	1.3417	0.2247	-1.8518	-0.5271	1.2058
Moneta	-0.6081	-0.4207	-0.0461	1.2178	-1.1681
Victoria	-1.2527	1.3106	0.7759	-0.1688	-0.0612

Table 13: reverse designs of 137, 137-138, and 138 (Ant Caes) from *denarii* in hoards closing up to 180 (n=409)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aelius (137)	16	13	8	23	9	**69**
Antoninus Caesar (138)	7	4	8	10	1	**30**
Fortuna (137-138)	6	0	11	11	7	**35**
Had *VOTA PVBLICA* (137-138)	6	5	13	36	5	**65**
Modius (137-138)	8	4	9	18	2	**41**
Providentia (137-138)	4	4	8	22	4	**42**
Salus (137-138)	14	10	9	30	9	**72**
Venus (Sabina) (137-138)	17	6	2	26	4	**55**
Qty	**78**	**46**	**68**	**176**	**41**	**409**

χ^2 standardised residuals
χ^2 = 48.814, df = 28, p-value = 0.008744

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Aelius (137)	0.7832	1.8809	-1.0251	-1.2281	0.7921
Antoninus Caesar (138)	0.5346	0.3408	1.3488	-0.8098	-1.1575
Fortuna (137-138)	-0.2612	-1.9840	2.1477	-1.0464	1.8640
Had *VOTA PVBLICA* (137-138)	-1.8167	-0.8545	0.6671	1.5182	-0.5939
Modius (137-138)	0.0647	-0.2846	0.8363	0.0850	-1.0408
Providentia (137-138)	-1.4168	-0.3330	0.3849	0.9236	-0.1025
Salus (137-138)	0.0726	0.6685	-0.8586	-0.1766	0.6634
Venus (Sabina) (137-138)	2.0104	-0.0747	-2.3626	0.4795	-0.6445

2.2. Results of design-level χ^2 tests on *denarii* from hoards closing up to 192

Table 14: reverse designs of 117 from *denarii* in hoards closing up to 192 (n=298)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Concordia	18	8	10	45	10	**91**
Fortuna	9	2	2	15	6	**34**
Justitia	10	4	13	24	7	**58**
Pax	9	1	10	19	7	**46**
Pietas	5	4	10	16	6	**41**
Traj & Had	5	1	2	16	4	**28**
Qty	**80**	**35**	**65**	**194**	**55**	**298**

χ^2 standardised residuals
χ^2 = 17.563, df = 20, **p-value = 0.6162**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Concordia	0.2175	0.7658	-1.1488	0.5880	-0.6337
Fortuna	1.0329	-0.1866	-1.4520	-0.1026	0.6723
Justitia	-0.2724	0.0544	1.2737	-0.4439	-0.2814
Pax	0.1210	-1.1879	1.0191	-0.4028	0.3322
Pietas	-0.9744	0.7525	1.3896	-0.5972	0.2117
Traj & Had	-0.1141	-0.6414	-1.1497	0.9309	0.1246

Table 15: reverse designs of 118 from *denarii* in hoards closing up to 192 (n=495)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Concordia	24	7	17	52	13	**113**
Felicitas	10	0	7	12	4	**33**
Fortuna	18	2	12	29	10	**71**
Justitia	9	5	10	36	11	**71**
Pax	18	4	19	31	13	**85**
Pietas	21	8	14	32	4	**79**
Salus	6	2	9	20	6	**43**
Qty	**108**	**30**	**90**	**217**	**62**	**495**

χ^2 standardised residuals
χ^2= 22.684, df = 24, **p-value = 0.5385**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Concordia	-0.0402	0.2405	-0.6892	0.5181	-0.2479
Felicitas	1.1035	-1.3663	0.4679	-0.5675	-0.0331
Fortuna	0.7171	-1.0061	-0.1751	-0.2553	0.4228
Justitia	-1.5911	0.4909	-0.7381	1.0141	0.7608
Pax	-0.0474	-0.3685	1.0004	-0.8957	0.7802
Pietas	0.9927	1.6705	-0.0119	-0.3154	-1.8382
Salus	-1.0572	-0.2772	0.4903	0.3691	0.3045

Table 16: reverse designs of 119-120 from *denarii* in hoards closing up to 192 (n=467)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aeternitas	19	5	16	34	13	**87**
Concordia	16	2	2	9	2	**31**
Felicitas	15	5	13	32	12	**77**
Pax	20	4	10	36	12	**82**
Pietas	23	6	9	37	7	**82**

Annexe 2: Hadrian

Table 16: reverse designs of 119-120 from *denarii* in hoards closing up to 192 (n=467)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Salus	30	7	12	49	10	**108**
Qty	**123**	**29**	**62**	**197**	**56**	**467**

χ^2 standardised residuals

χ^2 = 20.827, df = 20, **p-value = 0.4074**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Aeternitas	-0.8177	-0.1732	1.3093	-0.4457	0.7949
Concordia	2.7420	0.0540	-1.0428	-1.1274	-0.8907
Felicitas	-1.1726	0.0999	0.8686	-0.0845	0.9105
Pax	-0.3437	-0.4840	-0.2687	0.2396	0.6911
Pietas	0.3018	0.4023	-0.5718	0.4096	-0.9034
Salus	0.2915	0.1133	-0.6175	0.5098	-0.8199

Table 17: reverse designs of 120-121 from *denarii* hoards closing up to 192 (n=266)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Felicitas	12	4	11	21	12	**60**
Congiarium	4	4	15	20	5	**48**
Hilaritas	10	3	8	17	7	**45**
Mars	24	9	23	41	16	**113**
Qty	**50**	**20**	**57**	**99**	**40**	**266**

χ^2 standardised residuals

χ^2 = 8.5198, df = 12, **p-value = 0.7433**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Felicitas	0.2149	-0.2407	-0.5179	-0.2816	0.9912
Congiarium	-1.6721	0.2058	1.4699	0.5052	-0.8256
Hilaritas	0.5300	-0.2085	-0.5291	0.0615	0.0896
Mars	0.5987	0.1728	-0.2468	-0.1629	-0.2408

Table 18: reverse designs of 121 from *denarii* in hoards closing up to 192 (n=776)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aeq-Mon	61	17	41	93	36	9	**257**
Fortuna	17	5	18	50	14	7	**111**
Libertas	31	7	16	73	15	1	**143**
Salus	29	9	21	52	21	1	**133**
Victoria	33	12	10	55	16	6	**132**
Qty	**171**	**50**	**106**	**323**	**102**	**24**	**776**

χ^2 standardised residuals

χ^2 = 28.871, df = 20, **p-value = 0.09033**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Aeq-Mon	0.5803	0.1083	0.9948	-1.3510	0.3818	0.3730
Fortuna	-1.5084	-0.8047	0.7287	0.5587	-0.1545	1.9252
Libertas	-0.0911	-0.7294	-0.7995	1.7470	-0.8757	-1.6275
Salus	-0.0569	0.1470	0.6645	-0.4515	0.8414	-1.5351
Victoria	0.7254	1.1984	-1.8913	0.0076	-0.3242	0.9490

Table 19: reverse designs of 121-123 from *denarii* in hoards closing up to 192 (n=450)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Clementia	10	6	15	22	4	**57**
Concordia	18	3	9	29	10	**69**
Pax	4	4	13	24	6	**51**
Roma	58	12	63	106	34	**273**
Qty	90	25	100	181	54	**450**
χ^2 standardised residuals						
$\chi^2 = 20.256$, df = 12, **p-value = 0.0624**						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	
Clementia	-0.4146	1.5922	0.6556	-0.1935	-1.0859	
Concordia	1.1306	-0.4256	-1.6174	0.2366	0.5977	
Pax	-1.9413	0.6931	0.4951	0.7698	-0.0485	
Roma	0.4601	-0.8131	0.2996	-0.3633	0.2166	

Table 20: reverse designs of 124-125 from *denarii* in hoards closing up to 192 (n=355)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Diana	10	6	7	25	5	**53**
Genius	23	1	17	37	12	**90**
Hercules	9	1	6	10	6	**32**
Roma	12	6	22	27	10	**77**
Spes	20	8	20	26	9	**83**
Qty	**74**	**22**	**72**	**125**	**42**	**335**
χ^2 standardised residuals						
$\chi^2 = 19.472$, df = 16, **p-value = 0.2449**						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	
Diana	-0.4990	1.3504	-1.3010	1.1747	-0.6381	
Genius	0.6996	-2.0198	-0.5328	0.5898	0.2133	
Hercules	0.7264	-0.7598	-0.3346	-0.5615	0.9925	
Roma	-1.2145	0.4195	1.3399	-0.3230	0.1114	
Spes	0.3890	1.0919	0.5117	-0.8931	-0.4358	

Table 21: reverse designs of 126-127 from *denarii* in hoards closing up to 192 (n=671)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Ann-Abund	35	6	24	44	19	**128**
Pudicitia	26	9	18	55	13	**121**
Star(s) in cres	20	9	23	30	18	**100**
Victoria	25	11	32	67	32	**167**
Virtus	30	17	35	55	18	**155**
Qty	**136**	**52**	**132**	**251**	**100**	**671**
χ^2 standardised residuals						
$\chi^2 = 22.045$, df = 16, **p-value = 0.1417**						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	
Ann-Abund	1.7781	-1.2445	-0.2352	-0.5608	-0.0174	
Pudicitia	0.2979	-0.1231	-1.1895	1.4474	-1.1852	
Star(s) in cres	-0.0596	0.4492	0.7503	-1.2110	0.8022	
Victoria	-1.5208	-0.5398	-0.1487	0.5732	1.4255	
Virtus	-0.2526	1.4392	0.8164	-0.3914	-1.0611	

Table 22: reverse designs of 128-129, 129-130, and 130 from *denarii* in hoards closing up to 192 (n=595)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Clementia (128-129, 129-130)	10	5	3	19	3	**40**
Annona-Abundantia (128-129)	4	8	6	21	5	**44**
Tranquillitas (128-129, 129-130)	9	3	12	14	8	**46**
Virtus (128-129)	4	4	7	18	6	**39**
Fortuna Redux	9	4	7	34	12	**66**
Justitia (128-129, 129-130)	6	4	6	19	3	**38**
Liberalitas (128-129, 129-130)	11	3	3	17	9	**43**
Roma (129-13, 130)	5	2	8	32	8	**55**
Eastern (128-130)	40	10	46	69	24	**189**
Romulus (130)	5	6	3	14	7	**35**
Qty	**103**	**49**	**101**	**257**	**85**	**595**

χ^2 standardised residuals
χ^2 = 55.904, df = 36, **p-value = 0.01829**

Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**
Clementia (128-129, 129-130)	1.1688	0.9399	-1.4544	0.4144	-1.1355
Annona-Abundantia (128-129)	-1.3105	2.2991	-0.5375	0.4576	-0.5128
Tranquillitas (128-129, 129-130)	0.3675	-0.4050	1.5000	-1.3166	0.5573
Virtus (128-129)	-1.0589	0.4398	0.1476	0.2813	0.1816
Fortuna Redux	-0.7175	-0.6156	-1.2558	1.0287	0.8374
Justitia (128-129, 129-130)	-0.2254	0.4921	-0.1773	0.6384	-1.0423
Liberalitas (128-129, 129-130)	1.3035	-0.2876	-1.5913	-0.3650	1.1528
Roma (129-13, 130)	-1.4652	-1.1885	-0.4373	1.6913	0.0510
Eastern (128-130)	1.2732	-1.4105	2.4572	-1.3984	-0.5774
Romulus (130)	-0.4302	1.8363	-1.2067	-0.2875	0.8944

Table 23: reverse designs of 130-33 from *denarii* in hoards closing up to 192 (n=388)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Africa	14	1	9	34	14	**72**
Aegyptos	28	17	16	48	25	**134**
Conc (Sabina)	24	8	20	47	21	**120**
Hispania	9	7	6	23	17	**62**
Qty	**75**	**33**	**51**	**152**	**77**	**388**

χ^2 standardised residuals
χ^2 = 14.765, df = 12, **p-value = 0.2545**

Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**
Africa	0.0221	-2.0705	-0.1508	1.0909	-0.0764
Aegyptos	0.4122	1.6597	-0.3844	-0.6204	-0.3089
Conc (Sabina)	0.1670	-0.6906	1.0643	-0.0015	-0.5767
Hispania	-0.8621	0.7520	-0.7530	-0.2615	1.3387

Table 24: reverse designs of 133-135 from *denarii* in hoards closing up to 192 (n=411)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Conc (Sabina)	9	0	5	14	9	**37**
Felicitas	21	7	18	32	9	**87**
Juno (Sabina)	10	2	7	37	11	**67**
Salus	27	8	23	62	32	**152**
Tellus	15	11	6	26	10	**68**
Qty	**82**	**28**	**59**	**171**	**71**	**411**

Annexe 2: Hadrian

Table 24: reverse designs of 133-135 from *denarii* in hoards closing up to 192 (n=411)

χ^2 standardised residuals

χ^2 = 29.439, df = 16, **p-value = 0.02114**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Conc (Sabina)	0.5955	-1.5877	-0.1351	-0.3553	1.0317
Felicitas	0.8742	0.4407	1.5594	-0.6976	-1.5552
Juno (Sabina)	-0.9210	-1.2003	-0.8442	1.7281	-0.1688
Salus	-0.6040	-0.7319	0.2526	-0.1560	1.1206
Tellus	0.3891	2.9583	-1.2039	-0.4309	-0.5097

Table 25: reverse designs of 136 from *denarii* in hoards closing up to 192 (n=516)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Conc (Sabina)	15	1	13	22	14	**65**
Fides	34	11	11	57	25	**138**
Moneta	35	13	21	88	23	**180**
Victoria	27	13	20	53	20	**133**
Qty	**111**	**38**	**65**	**220**	**82**	**516**

χ^2 standardised residuals

χ^2 = 17.214, df = 12, **p-value = 0.1417**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Conc (Sabina)	0.2721	-1.7308	1.6817	-1.0853	1.1421
Fides	0.7918	0.2626	-1.5311	-0.2395	0.6555
Moneta	-0.5980	-0.0703	-0.3516	1.2849	-1.0479
Victoria	-0.3011	1.0242	0.7931	-0.4921	-0.2470

Table 26: reverse designs of 137, 137-138, and 138 (Ant Caes) from *denarii* in hoards closing up to 192 (n=515)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aelius (137)	18	15	10	31	17	**91**
Antoninus Caesar (138)	10	5	9	13	2	**39**
Fortuna (137-138)	11	1	11	13	13	**49**
Had *VOTA PVBLICA* (137-138)	12	5	13	40	9	**79**
Modius (137-138)	9	6	9	21	4	**49**
Providentia (137-138)	6	5	9	23	5	**48**
Salus (137-138)	18	10	10	34	13	**85**
Venus (Sabina) (137-138)	20	7	3	35	10	**75**
Qty	**104**	**54**	**74**	**210**	**73**	**515**

χ^2 standardised residuals

χ^2 = 43.81, df = 28, **p-value = 0.02901**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Aelius (137)	-0.0879	1.7670	-0.8506	-1.0025	1.1418
Antoninus Caesar (138)	0.7569	0.4503	1.4346	-0.7279	-1.5006
Fortuna (137-138)	0.3512	-1.8255	1.4921	-1.5617	**2.2973**
Had *VOTA PVBLICA* (137-138)	-0.9898	-1.1409	0.4893	1.3719	-0.6569
Modius (137-138)	-0.2846	0.3804	0.7384	0.2281	-1.1177
Providentia (137-138)	-1.1862	-0.0147	0.8007	0.7747	-0.6916
Salus (137-138)	0.2015	0.3642	-0.6334	-0.1121	0.2741
Venus (Sabina) (137-138)	1.2474	-0.3081	-2.3689	0.7988	-0.1935

2.3. Results of design-level x^2 tests on *denarii* from hoards closing up to 211

Table 27: reverse designs of 117 from *denarii* in hoards closing up to 211 (n=379)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Concordia	19	9	11	53	20	**112**
Fortuna	9	3	2	15	15	**44**
Justitia	11	5	13	24	23	**76**
Pax	11	1	10	23	16	**61**
Pietas	6	4	10	16	14	**50**
Traj & Had	6	2	2	18	8	**36**
Qty	**62**	**24**	**48**	**149**	**96**	**379**

χ^2 standardised residuals
χ^2 = 22.545, df = 20, **p-value = 0.3117**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Concordia	0.1584	0.7163	-0.8456	1.3515	-1.5713
Fortuna	0.6717	0.1280	-1.5134	-0.5526	1.1547
Justitia	-0.4063	0.0854	1.0877	-1.0755	0.8545
Pax	0.3232	-1.4566	0.8183	-0.2004	0.1396
Pietas	-0.7620	0.4686	1.4574	-0.8248	0.3752
Traj & Had	0.0457	-0.1852	-1.1986	1.0226	-0.3705

Table 28: reverse designs of 118 from *denarii* in hoards closing up to 211 (n=649)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Concordia	26	8	17	52	27	**130**
Felicitas	12	0	7	14	11	**44**
Fortuna	22	2	12	29	23	**88**
Justitia	15	6	10	40	25	**96**
Pax	21	5	19	32	23	**100**
Pietas	26	9	14	34	20	**103**
Salus	7	2	9	24	24	**66**
Qty	**131**	**34**	**90**	**234**	**160**	**649**

χ^2 standardised residuals
χ^2 = 26.013, df = 24, **p-value = 0.3525**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Concordia	-0.1443	0.5300	-0.2916	0.7832	-0.8385
Felicitas	0.9796	-1.4985	0.3318	-0.4503	0.0803
Fortuna	0.9153	-1.1755	-0.0998	-0.4589	0.3294
Justitia	-1.0691	0.4972	-0.9463	0.9456	0.3252
Pax	0.0939	-0.0459	1.3253	-0.6486	-0.2838
Pietas	1.0446	1.6326	-0.1200	-0.4872	-1.0241
Salus	-1.7853	-0.7456	-0.0865	0.0649	1.9672

Table 29: reverse designs of 119-120 from *denarii* in hoards closing up to 211 (n=594)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aeternitas	24	7	16	40	31	**118**
Concordia	21	3	2	15	8	**49**
Felicitas	15	7	13	38	20	**93**
Pax	22	7	11	36	35	**111**

Annexe 2: Hadrian

Table 29: reverse designs of 119-120 from *denarii* in hoards closing up to 211 (n=594)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Pietas	24	9	9	39	28	**109**
Salus	30	7	13	49	15	**114**
Qty	**136**	**40**	**64**	**217**	**137**	**594**

χ^2 standardised residuals

χ^2 = 30.239, df = 20, **p-value = 0.06608**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Aeternitas	-0.5804	-0.3356	0.9216	-0.4733	0.7254
Concordia	2.9202	-0.1650	-1.4273	-0.6856	-0.9820
Felicitas	-1.3638	0.2947	0.9413	0.6906	-0.3130
Pax	-0.6772	-0.1736	-0.2775	-0.7146	1.8576
Pietas	-0.1914	0.6127	-0.8007	-0.1299	0.5705
Salus	0.7632	-0.2443	0.2046	1.1395	-2.2024

Table 30: reverse designs of 120-121 from *denarii* in hoards closing up to 211 (n=327)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Felicitas	17	5	11	25	18	**76**
Congiarium	5	4	15	20	12	**56**
Hilaritas	13	3	8	19	15	**58**
Mars	26	9	23	48	31	**137**
Qty	**61**	**21**	**57**	**112**	**76**	**327**

χ^2 standardised residuals

χ^2 = 8.1255, df = 12, **p-value = 0.7752**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Felicitas	0.7496	0.0540	-0.6175	-0.2020	0.0800
Congiarium	-1.6851	0.2129	1.6767	0.1871	-0.2814
Hilaritas	0.6629	-0.3755	-0.6636	-0.1942	0.4140
Mars	0.0877	0.0680	-0.1802	0.1571	-0.1490

Table 31: reverse designs of 121 from *denarii* in hoards closing up to 211 (n=1,065)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aeq-Mon	65	21	41	108	36	70	**341**
Fortuna	21	5	18	54	14	27	**139**
Libertas	40	11	17	78	15	40	**201**
Salus	34	13	21	54	21	53	**196**
Victoria	45	15	10	57	16	45	**188**
Qty	**205**	**65**	**107**	**351**	**102**	**235**	**1065**

χ^2 standardised residuals

χ^2 = 25.195, df = 20, **p-value = 0.1941**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Aeq-Mon	-0.0788	0.0412	1.1515	-0.4137	0.5846	-0.6046
Fortuna	-1.1128	-1.1960	1.0797	1.2098	0.1884	-0.6629
Libertas	0.2106	-0.3619	-0.7108	1.4443	-0.9688	-0.6535
Salus	-0.6069	0.3000	0.2948	-1.3185	0.5143	1.4828
Victoria	1.4649	1.0409	-2.0451	-0.6302	-0.4727	0.5460

Annexe 2: Hadrian

Table 32: reverse designs of 121-123 from *denarii* in hoards closing up to 211 (n=765)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Clementia	12	6	15	26	17	**76**
Concordia	23	5	9	31	20	**88**
Had-Fort	10	5	9	11	7	**42**
Minerva	8	1	8	14	17	**48**
Pax	7	4	13	24	10	**58**
Providentia	9	1	5	12	11	**38**
Roma	66	13	64	120	84	**347**
Ship/Galley	8	1	13	9	7	**38**
Spes	3	3	7	10	7	**30**
Qty	**146**	**39**	**143**	**257**	**180**	**765**

χ^2 standardised residuals
$\chi^2 = 35.56$, df = 32, **p-value = 0.3043**

Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**
Clementia	-0.6576	1.0798	0.2105	0.0926	-0.2087
Concordia	1.5142	0.2425	-1.8368	0.2642	-0.1551
Had-Fort	0.7009	1.9537	0.4101	-0.8279	-0.9169
Minerva	-0.3835	-0.9250	-0.3247	-0.5293	1.6978
Pax	-1.2231	0.6066	0.6554	1.0228	-0.9872
Providentia	0.6490	-0.6734	-0.7892	-0.2144	0.6885
Roma	-0.0276	-1.1151	-0.1073	0.3173	0.2604
Ship/Galley	0.2776	-0.6734	2.2125	-1.0540	-0.6492
Spes	-1.1390	1.1891	0.5879	-0.0247	-0.0221

Table 33: reverse designs of 124-125 from *denarii* in hoards closing up to 211 (n=435)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Diana	11	7	7	25	11	**61**
Genius	27	3	17	46	36	**129**
Hercules	9	2	6	10	11	**38**
Roma	16	7	22	31	26	**102**
Spes	21	10	20	33	21	**105**
Qty	**84**	**29**	**72**	**145**	**105**	**435**

χ^2 standardised residuals
$\chi^2 = 7.393$, df = 16, **p-value = 0.3606**

Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**
Diana	-0.2271	1.4546	-0.9745	1.0349	-0.9705
Genius	0.4187	-1.9096	-0.9418	0.4575	0.8713
Hercules	0.6136	-0.3351	-0.1155	-0.7493	0.6034
Roma	-0.8329	0.0767	1.2454	-0.5145	0.2780
Spes	0.1608	1.1339	0.6286	-0.3381	-0.8630

Table 34: reverse designs of 126-127 from *denarii* in hoards closing up to 211 (n=671)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Ann-Abund	35	6	24	44	19	**128**
Pudicitia	26	9	18	55	13	**121**
Star(s) in cres	20	9	23	30	18	**100**
Victoria	25	11	32	67	32	**167**
Virtus	30	17	35	55	18	**155**
Qty	**136**	**52**	**132**	**251**	**100**	**671**

Annexe 2: Hadrian

Table 34: reverse designs of 126-127 from *denarii* in hoards closing up to 211 (n=671)

χ^2 standardised residuals

χ^2 = 21.394, df = 16, **p-value = 0.1638**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Ann-Abund	1.6971	-1.5414	-0.2494	-0.9804	0.7310
Pudicitia	0.1653	0.6325	-1.2273	1.4376	-1.2213
Star(s) in cres	-0.0979	0.1501	0.8257	-0.3686	-0.2225
Victoria	-1.3964	-0.9373	0.0150	0.8523	0.7357
Virtus	-0.1817	1.6550	0.6329	-0.9470	-0.1545

Table 35: reverse designs of 128-129, 129-130, and 130 from *denarii* in hoards closing up to 211 (n=796)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Clementia (128-129, 129-130)	12	5	3	20	9	**49**
Annona-Abundantia (128-129)	5	8	6	23	10	**52**
Pudicitia (Sabina) (128-129)	5	2	4	22	15	**48**
Tranquillitas (128-129, 129-130)	13	7	12	16	13	**61**
Virtus (128-129)	4	5	7	18	11	**45**
Fortuna Redux	11	5	7	38	29	**90**
Justitia (128-129, 129-130)	7	5	6	21	8	**47**
Liberalitas (128-129, 129-130)	12	3	3	19	16	**53**
Roma (129-130, 130)	6	3	8	34	14	**65**
Eastern (128-130)	48	13	46	81	51	**239**
Romulus (130)	6	6	0	17	18	**47**
Qty	**129**	**62**	**102**	**309**	**194**	**796**

χ^2 standardised residuals

χ^2 = 68.899, df = 40, **p-value = 0.003029**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Clementia (128-29, 129-130)	1.4404	0.6058	-1.3085	0.2244	-0.8514
Annona-Abundantia (128-129)	-1.1806	1.9626	-0.2570	0.6263	-0.7510
Pudicitia (Sabina) (128-129)	-0.9964	-0.8992	-0.8672	0.7800	0.9653
Tranquillitas (128-29, 129-130)	0.9905	1.0317	1.4963	-1.5782	-0.4842
Virtus (128-129)	-1.2193	0.7985	0.5137	0.1271	0.0099
Fortuna Redux	-0.9388	-0.7592	-1.3347	0.5182	1.5086
Justitia (128-129, 129-130)	-0.2235	0.6999	-0.0092	0.6450	-1.0208
Liberalitas (128-129, 129-130)	1.1638	-0.5552	-1.4549	-0.3470	0.8578
Roma (129-130, 130)	-1.3969	-0.9168	-0.1140	1.7454	-0.4627
Eastern (128-130)	1.4891	-1.3015	2.7781	-1.2227	-0.9498
Romulus (130)	-0.5858	1.2226	-2.4541	-0.2915	1.9339

Table 36: reverse designs of 130-133 from *denarii* in hoards closing up to 211 (n=507)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Africa	17	2	9	39	23	**90**
Aegyptos	38	20	17	53	52	**180**
Conc (Sabina)	31	10	20	52	46	**159**
Hispania	14	8	6	23	27	**78**
Qty	**100**	**40**	**52**	**167**	**148**	**507**

χ^2 standardised residuals

χ^2 = 14.003, df = 12, **p-value = 0.3005**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Africa	-0.1784	-1.9141	-0.0760	1.7182	-0.6384

Annexe 2: Hadrian

Table 36: reverse designs of 130-133 from *denarii* in hoards closing up to 211 (n=507)						
Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aegyptos	0.4191	1.5388	-0.3402	-0.8169	-0.0751	
Conc (Sabina)	-0.0645	-0.7184	0.9143	-0.0515	-0.0608	
Hispania	-0.3530	0.7442	-0.7071	-0.5312	0.8866	

Table 37: reverse designs of 133-135 from *denarii* in hoards closing up to 211 (n=586)						
Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Conc (Sabina)	11	1	6	14	19	**51**
Felicitas	23	7	18	39	21	**108**
Juno (Sabina)	14	4	7	39	27	**91**
Pietas	11	2	11	11	14	**49**
Salus	31	12	23	64	64	**194**
Tellus	19	13	6	32	23	**93**
Qty	**109**	**39**	**71**	**199**	**168**	**586**

χ^2 standardised residuals χ^2 = 34.185, df = 20, **p-value = 0.0249**					
Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Conc (Sabina)	0.4914	-1.2995	-0.0721	-0.7976	1.1452
Felicitas	0.6495	-0.0700	1.3586	0.3838	-1.7904
Juno (Sabina)	-0.7113	-0.8356	-1.2124	1.4566	0.1784
Pietas	0.6246	-0.6983	2.0780	-1.3826	-0.0127
Salus	-0.8466	-0.2536	-0.1042	-0.2317	1.1240
Tellus	0.4091	2.7375	-1.5693	0.0744	-0.7092

Table 38: reverse designs of 136 from *denarii* in hoards closing up to 211 (n=701)						
Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Conc (Sabina)	19	2	13	22	27	**83**
Fides	42	11	12	66	60	**191**
Moneta	46	15	22	95	71	**249**
Victoria	33	16	20	61	48	**178**
Qty	**140**	**44**	**67**	**244**	**206**	**701**

χ^2 standardised residuals χ^2 = 14.844, df = 12, **p-value = 0.2501**					
Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Conc (Sabina)	0.5953	-1.4062	1.7990	-1.2819	0.5283
Fides	0.6241	-0.2855	-1.4641	-0.0591	0.5168
Moneta	-0.5288	-0.1591	-0.3687	0.8947	-0.2540
Victoria	-0.4276	1.4442	0.7242	-0.1216	-0.5957

Table 39: reverse designs of 137, 137-138, and 138 (Ant Caes) from *denarii* in hoards closing up to 211 (n=712)						
Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aelius (137)	27	18	10	53	42	**150**
Antoninus Caesar (138)	14	6	8	12	16	**56**
Fortuna (137-138)	12	1	11	17	22	**63**
Had *VOTA PVBLICA* (137-138)	15	8	13	40	26	**102**
Modius (137-138)	11	8	9	27	16	**71**
Providentia (137-138)	7	6	9	23	14	**59**
Salus (137-138)	21	13	10	34	24	**102**

Table 39: reverse designs of 137, 137-138, and 138 (Ant Caes) from *denarii* in hoards closing up to 211 (n=712)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Venus (Sabina) (137-138)	26	8	3	41	31	**109**
Qty	**133**	**68**	**73**	**247**	**191**	**712**
χ^2 standardised residuals						
$\chi^2 = 35.915$, df = 28, **p-value = 0.1448**						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	
Aelius (137)	-0.1926	0.9707	-1.3717	0.1336	0.2776	
Antoninus Caesar (138)	1.0943	0.2818	0.9425	-1.6850	0.2522	
Fortuna (137-138)	0.0676	-2.0453	1.7866	-1.0386	1.2405	
Had *VOTA PVBLICA* (137-138)	-0.9286	-0.5580	0.7861	0.7759	-0.2604	
Modius (137-138)	-0.6213	0.4682	0.6377	0.4774	-0.6980	
Providentia (137-138)	-1.2112	0.1538	1.1998	0.5597	-0.4593	
Salus (137-138)	0.4460	1.0440	-0.1416	-0.2328	-0.6428	
Venus (Sabina) (137-138)	1.2497	-0.7470	-2.4456	0.5182	0.3254	

2.4. Results of design-level χ^2 tests on *denarii* from hoards closing up to *c.* 250

Table 40: reverse designs of 117 from *denarii* in hoards closing up to *c.* 250 (n=611)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Concordia	20	17	15	59	63	**174**
Fortuna	13	4	2	18	38	**75**
Justitia	13	9	14	33	42	**111**
Pax	12	2	10	27	40	**91**
Pietas	7	8	11	20	50	**96**
Traj & Had	10	4	2	20	28	**64**
Qty	**75**	**44**	**54**	**177**	**261**	**611**
χ^2 standardised residuals						
$\chi^2 = 28.308$, df = 20, **p-value = 0.1023**						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	
Concordia	-0.2939	1.2627	-0.0964	1.2105	-1.3139	
Fortuna	1.2503	-0.6028	-1.7978	-0.7995	1.0534	
Justitia	-0.1694	0.3560	1.3377	0.1489	-0.7865	
Pax	0.2483	-1.7786	0.6902	0.1243	0.1809	
Pietas	-1.3936	0.4133	0.8636	-1.4810	1.4041	
Traj & Had	0.7649	-0.2836	-1.5374	0.3391	0.1265	

Table 41: reverse designs of 118 from *denarii* in hoards closing up to *c.* 250 (n=1,269)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Concordia	36	7	13	19	55	113	10	**253**
Fortuna	27	4	9	15	39	120	3	**217**
Justitia	18	7	9	17	49	103	12	**215**
Pax	23	7	15	19	39	115	10	**228**
Pietas	36	7	14	15	46	94	9	**221**
Salus	15	2	6	10	24	75	3	**135**
Qty	**155**	**34**	**66**	**95**	**252**	**620**	**47**	**1269**
χ^2 standardised residuals								
$\chi^2 = 27.659$, df = 30, **p-value = 0.5885**								

Annexe 2: Hadrian

Table 41: reverse designs of 118 from *denarii* in hoards closing up to *c.* 250 (n=1,269)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Concordia	0.9170	0.0851	-0.0437	0.0138	0.6714	-0.9542	0.2057
Fortuna	0.0961	-0.7523	-0.6805	-0.3089	-0.6234	1.3577	-1.7768
Justitia	-1.6120	0.5165	-0.6525	0.2255	0.9649	-0.1994	1.4306
Pax	-0.9188	0.3606	0.9124	0.4675	-0.9328	0.3416	0.5353
Pietas	1.7335	0.4433	0.7391	-0.3797	0.3190	-1.3449	0.2848
Salus	-0.3668	-0.8502	-0.3854	-0.0335	-0.5424	1.1134	-0.8944

Table 42: reverse designs of 119-120 from *denarii* in hoards closing up to *c.* 250 (n=1,185)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aeternitas	30	11	10	17	49	105	15	**237**
Concordia	23	2	5	5	17	49	8	**109**
Felicitas	20	1	14	13	45	83	6	**182**
Pax	25	9	13	15	46	113	17	**238**
Pietas	26	4	13	10	42	105	11	**211**
Salus	36	3	11	13	64	74	7	**208**
Qty	**160**	**30**	**66**	**73**	**263**	**529**	**64**	**1185**

χ^2 standardised residuals

$\chi^2 = 46.374$, df = 30, **p-value = 0.02861**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Aeternitas	-0.3536	2.0412	-0.8808	0.6281	-0.4964	-0.0778	0.6149
Concordia	2.1590	-0.4572	-0.4346	-0.6617	-1.4621	0.0489	0.8709
Felicitas	-0.9227	-1.6807	1.2134	0.5340	0.7248	0.1945	-1.2215
Pax	-1.2587	1.2119	-0.0702	0.0884	-0.9386	0.6552	1.1564
Pietas	-0.4664	-0.5805	0.3641	-0.8316	-0.7057	1.1135	-0.1172
Salus	1.4937	-0.9874	-0.1718	0.0521	2.6251	-1.9566	-1.2632

Table 43: reverse designs of 120-121 from *denarii* in hoards closing up to *c.* 250 (n=580)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Felicitas	21	9	13	37	64	8	**152**
Congiarium	11	6	15	20	39	2	**93**
Hilaritas	16	6	8	24	47	4	**105**
Mars	34	11	23	57	92	13	**230**
Qty	**82**	**32**	**59**	**138**	**242**	**27**	**580**

χ^2 standardised residuals

$\chi^2 = 8.0455$, df = 15, **p-value = 0.9219**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Felicitas	-0.1056	0.2120	-0.6261	0.1388	0.0727	0.3474
Congiarium	-0.5925	0.3836	1.8011	-0.4523	0.0316	-1.1195
Hilaritas	0.2998	0.0860	-0.8203	-0.1966	0.4819	-0.4016
Mars	0.2600	-0.4743	-0.0820	0.3076	-0.4048	0.7008

Table 44: reverse designs of 121 from *denarii* in hoards closing up to *c.* 250 (n=1,957)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aeq-Mon	76	14	32	50	128	239	37	**576**
Fortuna	26	4	7	19	62	108	11	**237**
Libertas	52	9	23	24	95	175	11	**389**
Salus	43	7	31	24	68	189	16	**378**

Annexe 2: Hadrian

Table 44: reverse designs of 121 from *denarii* in hoards closing up to *c.* 250 (n=1,957)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Victoria	57	9	26	11	71	183	20	**377**
Qty	**254**	**43**	**119**	**128**	**424**	**894**	**95**	**1957**

χ^2 standardised residuals
χ^2 = 41.96, df = 24, **p-value = 0.01304**

Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**
Aeq-Mon	0.1435	0.3778	-0.5111	2.0082	0.2869	-1.4875	1.7094
Fortuna	-0.8583	-0.5291	-1.9523	0.8886	1.4865	-0.0256	-0.1488
Libertas	0.2127	0.1549	-0.1345	-0.2861	1.1677	-0.2028	-1.8142
Salus	-0.8653	-0.4530	1.6717	-0.1455	-1.5356	1.2420	-0.5485
Victoria	1.1535	0.2489	0.6424	-2.7505	-1.1817	0.8213	0.3972

Table 45: reverse designs of 121-123 from *denarii* in hoards closing up to *c.* 250 (n=1,221)							
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Clementia	13	12	15	30	57	6	**133**
Concordia	24	11	9	38	98	10	**190**
Had-Fort	12	7	10	20	54	9	**112**
Pax	9	7	14	32	53	10	**125**
Roma	86	24	68	155	301	27	**661**
Qty	**144**	**61**	**116**	**275**	**563**	**62**	**1221**

χ^2 standardised residuals
χ^2 = 26.92, df = 20, **p-value = 0.1375**

Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**
Clementia	-0.6781	2.0776	0.6652	0.0082	-0.5524	-0.2899
Concordia	0.3363	0.4894	-2.1303	-0.7327	1.1102	0.1134
Had-Fort	-0.3326	0.5938	-0.1963	-1.0404	0.3280	1.3892
Pax	-1.4955	0.3022	0.6165	0.7250	-0.6108	1.4499
Roma	0.9111	-1.5701	0.6565	0.5021	-0.2168	-1.1331

Table 46: reverse designs of 124-125 from *denarii* in hoards closing up to *c.* 250 (n=837)							
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Diana	16	9	8	32	52	6	**123**
Genius	29	11	20	58	122	13	**253**
Hercules	10	3	7	11	22	1	**54**
Roma	23	10	23	42	92	11	**201**
Spes	24	12	23	46	91	10	**206**
Qty	**102**	**45**	**81**	**189**	**379**	**41**	**837**

χ^2 standardised residuals
χ^2 = 10.676, df = 20, **p-value = 0.9542**

Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**
Diana	0.2611	0.9283	-1.1313	0.8018	-0.4952	-0.0102
Genius	-0.3299	-0.7056	-0.9062	0.1152	0.6951	0.1724
Hercules	1.3329	0.0568	0.7761	-0.3418	-0.4958	-1.0115
Roma	-0.3020	-0.2453	0.8046	-0.5028	0.1033	0.3678
Spes	-0.2203	0.2779	0.6864	-0.0757	-0.2359	-0.0286

Annexe 2: Hadrian

Table 47: reverse designs of 126-127 from *denarii* in hoards closing up to *c.* 250 (n=1,651)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Ann-Abund	48	12	16	25	64	138	9	**312**
Pudicitia	39	11	17	22	79	137	10	**315**
Star in cres	35	4	17	24	48	133	14	**275**
Victoria	35	7	18	34	93	169	15	**371**
Virtus	47	7	29	37	81	159	18	**378**
Qty	**204**	**41**	**97**	**142**	**365**	**736**	**66**	**1651**

χ^2 standardised residuals χ^2 = 26.221, df = 24, **p-value = 0.3421**							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**
Ann-Abund	1.5218	1.5275	-0.5444	-0.3542	-0.5992	-0.0921	-0.9832
Pudicitia	0.0125	1.1361	-0.3503	-0.9784	1.1217	-0.2889	-0.7305
Star in cres	0.1751	-1.0826	0.2098	0.0715	-1.6412	0.9400	0.9068
Victoria	-1.6012	-0.7291	-0.8133	0.3701	1.2124	0.2808	0.0439
Virtus	0.0430	-0.7791	1.4412	0.7873	-0.2809	-0.7325	0.7432

Table 48: reverse designs of 128-129, 129-130, 128-130, and 130 from *denarii* in hoards closing up to *c.* 250 (n=1,652)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Annona-Abundantia (128-129)	9	10	6	25	64	**114**
Clementia (128-129, 129-130)	13	6	4	13	29	**65**
Fortuna Red (128-129, 129-130, 130)	13	5	9	42	71	**140**
Indulgentia (129-130)	6	5	5	21	47	**84**
Justitia (128-129, 129-130)	10	6	10	26	43	**95**
Liberalitas (128-129, 129-130)	13	6	3	23	46	**91**
Pietas (129-130, 130)	7	4	1	20	48	**80**
Pudicitia (Sabina) (128-129)	7	6	5	28	57	**103**
Roma (129-130, 130)	10	4	9	38	55	**116**
Romulus (130)	9	8	5	18	53	**93**
Tranquillitas (128-129, 129-130)	16	9	12	16	41	**94**
Virtus (128-129)	8	8	8	23	66	**113**
Eastern (128-130)	60	20	51	109	224	**464**
Qty	**181**	**97**	**128**	**402**	**844**	**1652**

χ^2 standardised residuals χ^2 = 67.287, df = 48, **p-value = 0.03443**					
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**
Annona-Abundantia (128-129)	-0.9875	1.2779	-0.9531	-0.5203	0.7544
Clementia (128-129, 129-130)	2.2027	1.1176	-0.4617	-0.7083	-0.7302
Fortuna Red (128-129, 129-130, 130)	-0.5972	-1.1231	-0.5609	1.3590	-0.0621
Indulgentia (129-130)	-1.0559	0.0305	-0.5912	0.1237	0.6235
Justitia (128-129, 129-130)	-0.1266	0.1786	0.9727	0.5995	-0.7945
Liberalitas (128-129, 129-130)	0.9594	0.2841	-1.5255	0.1818	-0.0720
Pietas (129-130, 130)	-0.5962	-0.3217	-2.0880	0.1207	1.1150
Pudicitia (Sabina) (128-129)	-1.2755	-0.0194	-1.0550	0.5864	0.6034
Roma (129-130, 130)	-0.7600	-1.0771	0.0040	1.8393	-0.5538
Romulus (130)	-0.3726	1.0866	-0.8217	-0.9734	0.7959
Tranquillitas (128-129, 129-130)	1.7764	1.4815	1.7477	-1.4372	-1.0136
Virtus (128-129)	-1.2450	0.5299	-0.2553	-0.8576	1.0882
Eastern (128-130)	1.2850	-1.3879	2.5097	-0.3680	-0.8479

Annexe 2: Hadrian

Table 49: reverse designs of 130-133 from *denarii* in hoards closing up to *c.* 250 (n=1,143)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Africa	20	10	5	12	43	96	4	**190**
Aegyptos	47	7	31	19	69	193	15	**381**
Conc (Sabina)	40	11	18	25	70	202	15	**381**
Hispania	16	4	12	10	31	112	6	**191**
Qty	**123**	**32**	**66**	**66**	**213**	**603**	**40**	**1143**

χ^2 standardised residuals

χ^2 = 21.994, df = 18, **p-value = 0.2322**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Africa	-0.0987	2.0295	-1.8027	0.3106	1.2761	-0.4231	-1.0274
Aegyptos	0.9370	-1.1227	1.9188	-0.6396	-0.2374	-0.5643	0.4564
Conc (Sabina)	-0.1562	0.1021	-0.8528	0.6396	-0.1187	0.0705	0.4564
Hispania	-1.0045	-0.5826	0.2924	-0.3098	-0.7699	1.1194	-0.2646

Table 50: reverse designs of 133-135 from *denarii* in hoards closing up to *c.* 250 (n=1,403)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Concordia (Sabina)	13	1	6	18	91	**129**
Felicitas	31	11	20	48	115	**225**
Hadrian & Roma	14	5	8	12	40	**79**
Juno (Sabina)	21	7	8	54	167	**257**
Salus	41	22	29	87	228	**407**
Tellus	28	16	8	43	124	**219**
Vesta (Sabina)	13	0	6	16	52	**87**
Qty	**161**	**62**	**85**	**278**	**817**	**1403**

χ^2 standardised residuals

χ^2 = 48.416, df = 24, **p-value = 0.002241**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Concordia (Sabina)	-0.4687	-1.9688	-0.6494	-1.4955	1.8322
Felicitas	1.0195	0.3352	1.7249	0.5117	-1.3998
Hadrian & Roma	1.6388	0.8076	1.4690	-0.9235	-0.8851
Juno (Sabina)	-1.5637	-1.2929	-1.9185	0.4311	1.4177
Salus	-0.8348	0.9465	0.8744	0.7076	-0.5850
Tellus	0.5723	2.0322	-1.4462	-0.0598	-0.3125
Vesta (Sabina)	0.9547	-1.9608	0.3176	-0.2984	0.1880

Table 51: reverse designs of 136 from *denarii* in hoards closing up to *c.* 250 (n=1,687)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Conc (Sabina)	20	4	3	13	37	107	9	**193**
Fides	46	13	16	17	97	216	14	**419**
Moneta	59	11	27	25	128	342	28	**620**
Nem-Vict	30	9	19	20	69	156	10	**313**
Victoria	17	1	9	7	23	82	3	**142**
Qty	**172**	**38**	**74**	**82**	**354**	**903**	**64**	**1687**

χ^2 standardised residuals

χ^2 = 24.396, df = 24, **p-value = 0.4391**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Conc (Sabina)	0.0727	-0.1666	-1.8786	1.1815	-0.5498	0.3633	0.6202
Fides	0.5019	1.1594	-0.5550	-0.7459	0.9680	-0.5528	-0.4755

Annexe 2: Hadrian

Table 51: reverse designs of 136 from *denarii* in hoards closing up to *c.* 250 (n=1,687)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Moneta	-0.5299	-0.7936	-0.0376	-0.9356	-0.1842	0.5562	0.9235	
Nem-Victoria	-0.3385	0.7342	1.4223	1.2270	0.4097	-0.8915	-0.5439	
Victoria	0.6629	-1.2293	1.1104	0.0372	-1.2452	0.6873	-1.0285	

Table 52: reverse designs of 137, 137-138, and 138 from *denarii* in hoards closing up to *c.* 250 (n=1,749)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aelius (137)	33	17	23	13	40	199	10	**335**
Antoninus Caesar (138)	18	8	9	11	21	87	8	**162**
Fortuna (137-138)	15	10	5	14	25	103	3	**175**
Had *VOT PVB* (137-138)	22	6	13	16	57	140	8	**262**
Modius (137-138)	17	2	11	9	30	74	2	**145**
Providentia (137-138)	11	4	9	11	34	92	8	**169**
Salus (137-138)	24	6	18	11	47	116	9	**231**
Venus (137-138)	31	11	12	5	47	154	10	**270**
Qty	**171**	**64**	**100**	**90**	**301**	**965**	**58**	**1749**

χ^2 standardised residuals
$\chi^2 = 56.269$, df = 42, **p-value = 0.06945**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Aelius (137)	0.0432	1.3543	0.8788	-1.0208	-2.3249	1.0420	-0.3328
Antoninus Caesar (138)	0.5431	0.8510	-0.0862	0.9226	-1.3030	-0.2520	1.1337
Fortuna (137-138)	-0.5101	1.4212	-1.5825	1.6645	-0.9325	0.6559	-1.1637
Had *VOT PVB* (137-138)	-0.7144	-1.1585	-0.5116	0.6858	1.7737	-0.3790	-0.2335
Modius (137-138)	0.7498	-1.4352	0.9410	0.5633	1.0101	-0.6711	-1.2808
Providentia (137-138)	-1.3588	-0.8783	-0.2132	0.7812	0.9114	-0.1289	1.0120
Salus (137-138)	0.2978	-0.8437	1.3187	-0.2572	1.1491	-1.0145	0.4840
Venus (137-138)	0.8957	0.3563	-0.8749	-2.3860	0.0783	0.4120	0.3497

Annexe 3: Antoninus Pius

3.1: Results of design-level χ^2 tests on *denarii* from hoards closing up to 180

Table: 1: Reverse designs of 138, 138-139, and 139 from *denarii* in hoards closing up to 180 (n=241)
No χ^2 testing: sample sizes too small

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aequitas	4	4	0	8	2	**18**
Bust of Aurelius	1	2	0	0	1	**4**
Clasped hands on caduceus	5	3	3	13	4	**28**
Concordia	3	1	0	2	2	**8**
Diana	2	1	1	4	2	**10**
Felicitas	6	2	4	11	1	**24**
Fides	1	2	0	4	3	**10**
Fortuna	5	2	1	5	2	**15**
Libertas	2	0	2	4	2	**10**
Minerva	6	4	5	9	4	**28**
Modius	5	5	2	16	0	**28**
Pax	3	1	5	6	6	**21**
Priestly implements	5	2	4	8	1	**20**
Winged fulmen	0	0	0	1	0	**1**
Victoria	2	1	0	7	0	**10**
Wolf & twins	1	2	0	1	2	**6**
Qty	**51**	**32**	**27**	**99**	**32**	**241**

Table 2: Reverse designs of 139-141 (Faustina I Augusta) from *denarii* in hoards closing up to 180 (n=55)
No χ^2 testing: sample sizes too small

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Concordia	2	0	1	8	3	**14**
Juno	4	1	6	13	4	**28**
Throne	5	0	2	2	3	**12**
Vesta	1	0	0	0	0	**1**
Qty	**12**	**1**	**9**	**23**	**10**	**55**

Table 3: Reverse designs of 140-143 from *denarii* in hoards closing up to 180 (n=343)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aequitas	15	5	15	23	1	**59**
Antoninus in armour	0	0	0	0	1	**1**
Apollo	2	4	4	12	4	**26**
Clementia	12	4	6	18	4	**44**
Concordia	7	2	1	9	1	**20**
Genio Senatus	5	1	8	21	2	**37**
Genio Populi Romani	6	5	7	10	2	**30**
Italia	5	0	7	9	1	**22**
Modius	4	6	4	18	9	**41**
Moneta	3	0	3	2	0	**8**
Ops	0	1	0	0	1	**2**
Pax	2	4	3	3	0	**12**
Salus	1	0	2	1	1	**5**
Wolf & twins	0	0	1	3	0	**4**
Tranquillitas	1	0	2	4	1	**8**

Annexe 3: Antoninus Pius

Table 3: Reverse designs of 140-143 from *denarii* in hoards closing up to 180 (n=343)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Virtus/Roma	1	4	0	7	3	**15**
Winged fulmen	0	2	1	3	3	**9**
Qty	**64**	**38**	**64**	**143**	**34**	**343**

χ^2 standardised residuals					
χ^2 = 15.362, df = 12, **p-value = 0.22**					
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**
Aequitas	0.6694	-0.5218	0.8593	-0.7781	-
Clementia	1.1169	-0.1689	-0.7954	-0.1512	-
Genio Senatus	-0.9481	-1.4391	0.2770	1.1581	-
Genio Populi Romani	-0.0378	1.1191	0.4968	-0.8460	-
Modius	-1.1231	1.3495	-1.0221	0.7967	-

Table 4: Reverse designs of 140 and 140-144 (Aurelius Caesar) from *denarii* in hoards closing up to 180 (n=166)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Bust of Aurelius	12	8	15	29	4	**68**
Priestly implements	9	6	18	8	10	**51**
Honos	1	1	3	8	1	**14**
Juventas	7	6	8	10	2	**33**
Qty	**29**	**21**	**44**	**55**	**17**	**166**

χ^2 standardised residuals					
χ^2 = 9.4671, df = 6, **p-value = 0.149**					
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**
Bust of Aurelius	-0.3241	-0.4602	-0.9776	1.4634	-
Priestly implements	0.1923	-0.0120	1.6041	-1.6389	-
Juventas	0.2445	0.6750	-0.4402	-0.2179	-

Table 5: Reverse designs of 141 (Diva Faustina I) from *denarii* in hoards closing up to 180 (n=168)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Aeternitas	2	2	10	19	5	**38**
Antoninus & Faustina	1	4	4	10	2	**21**
Carpentum	1	0	0	0	0	**1**
Ceres	70	57	123	370	82	**702**
Eagle	1	0	0	2	1	**4**
Fortuna	6	2	9	14	4	**35**
Temple of Faustina	1	5	11	24	2	**43**
Juno	32	17	31	64	25	**169**
Peacock	3	4	12	48	5	**72**
Pietas	22	20	23	77	26	**168**
Providentia	17	32	34	381	24	**488**
Star	0	0	0	2	1	**3**
Throne	7	5	6	23	6	**47**
Venus	5	2	13	25	13	**58**
Vesta	14	10	17	51	11	**103**
Qty	**182**	**160**	**293**	**1110**	**207**	**1952**
χ^2 standardised residuals						
χ^2 = 167.04, df = 24, **p-value < 2.2e-16**						

Annexe 3: Antoninus Pius

Table 5: Reverse designs of 141 (Diva Faustina I) from *denarii* in hoards closing up to 180 (n=168)					
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**
Ceres	0.6183	0.0480	2.1987	-1.7508	0.9069
Juno	4.1323	0.9112	1.3606	-3.3976	1.6894
Peacock	-1.4205	-0.7506	0.5129	0.9984	-0.9459
Pietas	1.6329	1.7507	-0.2340	-2.0290	1.9569
Providentia	-4.1940	-1.1750	-4.3161	5.9157	-3.8395
Venus	-0.1603	-1.2387	1.6147	-1.4658	2.7751
Vesta	1.4443	0.5862	0.5701	-1.0970	0.0348

Table 6: Reverse designs of 143-144 and 144 from *denarii* in hoards closing up to 180 (n=100) **No χ^2 testing: sample sizes too small*						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Honos (Aurelius Caes)	1	2	4	3	2	**12**
Pax	1	2	4	10	0	**17**
Victoria	10	5	14	27	3	**59**
Virtus/Roma	0	0	1	6	1	**8**
Winged caduceus	1	2	0	0	1	**4**
Qty.	**13**	**11**	**23**	**46**	**7**	**100**

Table 7: Reverse designs of 145-147 and 146-147 (Aurelius Caesar) from *denarii* in hoards closing up to 180 (n=153)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Fides	0	0	0	1	0	**1**
Honos	24	6	21	31	23	**105**
Spes	4	1	20	13	2	**40**
Qty	**28**	**8**	**42**	**50**	**25**	**153**
χ^2 standardised residuals χ^2 = 16.31, df = 3, **p-value = 0.0009796**						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	
Honos	0.8731	-	-1.5513	-0.1006	1.1961	
Spes	-1.3911	-	2.4715	0.1603	-1.9056	

Table 8: Reverse designs of 145-161 from *denarii* in hoards closing up to 180 (n=878)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Aequitas (Ant)	5	4	8	10	1	**28**
Annona (Ant)	0	0	0	1	1	**2**
VOT SVS DEC III (Ant)	2	1	0	1	3	**7**
Hands on cornucopia (Ant)	11	4	16	22	8	**61**
Concordia (Ant)	7	5	12	10	3	**37**
Temple Aug & Livia (Ant)	1	1	4	3	2	**11**
Genius (Ant)	0	0	1	0	0	**1**
Liberalitas *LIB IIII* (Ant)	10	9	23	31	12	**85**
Pax (Ant)	0	1	5	9	6	**21**
Pietas (Ant)	0	0	0	1	0	**1**
Virtus (Ant)	2	0	2	10	0	**14**
Winged fulmen (Ant)	13	11	16	28	17	**85**
Concordia (FII)	15	18	23	182	26	**264**
Laetitia (FII)	0	0	1	4	4	**9**
Pudicitia (FII)	6	3	9	25	3	**46**

Annexe 3: Antoninus Pius

Table 8: Reverse designs of 145-161 from *denarii* in hoards closing up to 180 (n=878)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Spes (FII)	6	11	4	31	22	**74**
Throne (FII)	0	2	0	0	1	**3**
Venus (FII)	11	14	15	67	18	**125**
"Woman" (FII)	3	0	1	0	0	**4**
Qty	**92**	**84**	**140**	**435**	**127**	**878**

χ^2 standardised residuals
χ^2 = 92.59, df = 20, **p-value = 2.604e-11**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Hands on cornucopia (Ant)	2.1585	-0.7784	2.5597	-1.7274	-0.3501
Liberalitas *LIB IIII* (Ant)	0.6740	0.2772	3.2261	-1.9873	-0.1732
Winged fulmen (Ant)	1.7292	0.9753	1.1952	-2.4385	1.2345
Concordia (FII)	-2.0170	-1.4830	-2.2881	3.8123	-2.1058
Spes (FII)	-0.3911	1.4426	-1.9723	-1.2077	3.3245
Venus (FII)	-0.2574	0.5562	-0.5912	0.2453	-0.1281

Table 9: Reverse designs of 147-148 from *denarii* in hoards closing up to 180 (n=79)
No χ^2 testing: sample sizes too small

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aequitas (Ant)	2	0	0	1	0	**3**
Annona (Ant)	3	3	3	11	1	**21**
Antoninus sacrificing (Ant)	3	2	1	2	0	**8**
Genius (Ant)	0	0	0	1	0	**1**
Wreath *PRIMI DECENNALES* (Ant)	0	0	0	1	2	**3**
Salus (Ant)	3	0	2	8	2	**15**
Fides (Aurelius Caes)	0	0	0	2	0	**2**
Minerva (Aurelius Caes)	6	0	4	9	6	**25**
Vesta (Aurelius Caes)	0	0	1	0	0	**1**
Qty	**17**	**5**	**11**	**35**	**11**	**79**

Table 10: Reverse designs of 148-149 from *denarii* in hoards closing up to 180 (n=331)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aequitas (Ant)	7	6	11	13	4	**41**
Annona (Ant)	7	6	13	37	11	**74**
Antoninus sacrificing (Ant)	1	2	4	14	2	**23**
Bonus Eventus (Ant)	2	3	1	8	3	**17**
Felicitas (Ant)	2	2	1	7	5	**17**
Fortuna (Ant)	7	2	4	15	6	**34**
Salus (Ant)	5	3	19	35	11	**73**
Clementia (Aurelius Caes)	1	1	3	6	0	**11**
Minerva (Aurelius Caes)	4	3	7	12	3	**29**
Providentia (Aurelius Caes)	1	1	0	8	0	**10**
"Woman" (Aurelius Caes)	0	0	0	1	1	**2**
Qty	**37**	**29**	**63**	**156**	**46**	**331**

χ^2 standardised residuals
χ^2 = 2.5072, df = 4, **p-value = 0.6433**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Annona (Ant)	0.3903	0.6903	-0.7746	0.1254	-0.0225
Salus (Ant)	-0.3929	-0.6950	0.7799	-0.1263	0.0226

Annexe 3: Antoninus Pius

Table 11: Reverse designs of 149-150 and 150-151 from *denarii* in hoards closing up to 180 (n=104) ***No χ^2 testing: sample sizes too small**						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Bonus Eventus	1	0	2	6	4	**13**
Felicitas	0	0	3	4	0	**7**
Fortuna	2	0	3	9	2	**16**
Genius	1	0	3	0	1	**5**
Pax	0	3	8	13	5	**29**
Pietas	1	0	5	6	2	**14**
Tranquillitas	3	1	3	3	8	**18**
Vesta	0	0	0	2	0	**2**
Qty	**8**	**4**	**27**	**43**	**22**	**104**

Table 12: Reverse designs of 151-152 from *denarii* in hoards closing up to 180 (n=146) ***No χ^2 testing: sample sizes too small**						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Annona (Ant)	1	2	7	9	4	**23**
Congiarium *LIB VII* (Ant)	0	0	0	0	1	**1**
Fortuna (Ant)	0	1	6	7	2	**16**
Pax (Ant)	0	1	3	6	9	**19**
Pietas (Ant)	0	0	0	8	2	**10**
Roma/Virt (Ant)	1	0	0	0	0	**1**
Tranquillitas (Ant)	0	2	6	11	3	**22**
Vesta (Ant)	4	0	5	6	3	**18**
Clementia (Aurelius Caes)	2	0	5	2	5	**14**
Genius Exercitus (Aurelius Caes)	3	1	6	8	3	**21**
Virtus (Aurelius Caes)	0	0	0	0	1	**1**
Qty	**11**	**7**	**38**	**57**	**33**	**146**

Table 13: Reverse designs of 152-153 from *denarii* in hoards closing up to 180 (n=234) ***No χ^2 testing: sample sizes too small**						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Annona (Ant)	2	1	9	54	7	**73**
Fortuna (Ant)	7	3	8	16	5	**39**
Liberalitas *LIB VII* (Ant)	0	0	5	2	0	**7**
Shrine (Ant)	0	0	0	0	1	**1**
Vesta (Ant)	7	4	7	45	13	**76**
Genius Exercitus (Aurelius Caes)	4	3	10	16	5	**38**
Qty	**20**	**11**	**39**	**133**	**31**	**234**

Table 14: Reverse designs of 153-154 from *denarii* in hoards closing up to 180 (n=379) ***No χ^2 testing: sample sizes too small**						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Annona (Ant)	3	1	6	102	4	**116**
Congiarium *LIB VII* (Ant)	0	0	1	1	0	**2**
Fortuna (Ant)	5	6	1	63	4	**79**
Liberalitas *LIB VII* (Ant)	1	0	1	14	2	**18**
Vesta (Ant)	2	1	5	78	10	**96**
Genius Exercitus (Aurelius Caes)	0	4	2	12	5	**23**
Minerva (Aurelius Caes)	1	1	5	34	2	**43**

Annexe 3: Antoninus Pius

Table 14: Reverse designs of 153-154 from *denarii* in hoards closing up to 180 (n=379) **No χ^2 testing: sample sizes too small*						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Virtus (Aurelius Caes)	0	0	0	2	0	**2**
Qty	**12**	**13**	**21**	**306**	**27**	**379**

Table 15: Reverse designs of 154-155 from *denarii* in hoards closing up to 180 (n=563) **No χ^2 testing: sample sizes too small*						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Annona (Ant)	5	0	5	154	5	**169**
Fortuna (Ant)	3	1	5	77	0	**86**
Vesta (Ant)	3	0	9	148	9	**169**
Minerva (Aurelius Caes)	3	3	7	125	1	**139**
Qty	**14**	**4**	**26**	**504**	**15**	**563**

Table 16: Reverse designs of 155-156 from *denarii* in hoards closing up to 180 (n=190)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Annona (Ant)	2	7	4	30	5	**48**
Ceres (Ant)	2	1	1	5	0	**9**
Fortuna (Ant)	0	3	2	13	4	**22**
Pax (Ant)	6	4	6	24	4	**44**
Pietas (Ant)	1	0	0	4	0	**5**
Salus (Ant)	2	1	0	9	4	**16**
Aequitas (Aurelius Caes)	1	2	10	8	1	**22**
Genio Populi Romani (Aurelius Caes)	1	0	1	3	3	**8**
Providentia (Aurelius Caes)	0	0	2	1	0	**3**
Virtus (Aurelius Caes)	2	1	1	9	0	**13**
Qty	**17**	**19**	**27**	**106**	**21**	**190**

χ^2 standardised residuals χ^2 = 8.0667, df = 4, **p-value = 0.08916**					
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**
Annona (Ant)	-	-	-1.5072	0.7600	0.2224
Pax (Ant)	-	-	-0.4763	0.2582	0.0270
Aurelius Caes	-	-	1.9520	-1.0011	-0.2476

Table 17: Reverse designs of 156-157 from *denarii* in hoards closing up to 180 (n=203)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Annona (Ant)	5	7	2	33	12	**59**
Ceres (Ant)	1	2	2	8	3	**16**
Felicitas (Ant)	0	0	0	3	0	**3**
Fortuna Obsequens (Ant)	0	0	0	0	1	**1**
Jupiter (Ant)	0	0	1	1	0	**2**
Salus (Ant)	2	3	4	23	14	**46**
Securitas (Ant)	1	0	0	1	1	**3**
Felicitas (Aurelius Caes)	1	0	4	6	2	**13**
Securitas (Aurelius Caes)	0	0	0	4	0	**4**
Virtus (Aurelius Caes)	7	5	11	26	7	**56**
Qty	**17**	**17**	**24**	**105**	**40**	**203**
χ^2 standardised residuals χ^2 = 11.676, df = 4, **p-value = 0.01993**						

Annexe 3: Antoninus Pius

Table 17: Reverse designs of 156-157 from *denarii* in hoards closing up to 180 (n=203)					
Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Annona (Ant)	-	-	-1.6474	0.7038	0.0729
Salus (Ant)	-	-	-0.5572	-0.4894	1.1713
Virtus (Aurelius Caes)	-	-	2.2404	-0.2550	-1.2060

Table 18: Reverse designs of 157-158 from *denarii* in hoards closing up to 180 (n=145)
No χ^2 testing: sample sizes too small

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aequitas (Ant)	0	2	1	5	1	**9**
Annona (Ant)	5	7	9	37	24	**82**
Antoninus sacrificing (Ant)	0	1	0	0	1	**2**
Fortuna (Ant)	0	0	0	3	0	**3**
Genius (Ant)	0	0	1	0	0	**1**
Liberalitas *LIB VIII* (Ant)	0	1	0	1	1	**3**
Temple Augustus & Livia (Ant)	1	1	1	0	1	**4**
Roma (Ant)	1	1	0	0	0	**2**
Felicitas (Aurelius Caes)	0	3	9	14	10	**36**
Spes (Aurelius Caes)	0	0	1	2	0	**3**
Qty	**7**	**16**	**22**	**62**	**38**	**145**

Table 19: Reverse designs of 158-159 from *denarii* in hoards closing up to 180 (n=135)
No χ^2 testing: sample sizes too small

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
VOT SOL DEC II (Ant)	1	1	2	6	1	**11**
VOT SVS DEC III (Ant)	1	5	1	19	3	**29**
Fortuna Obsequens (Ant)	1	1	3	5	7	**17**
Temple Augustus & Livia (Ant)	2	2	4	17	3	**28**
Shrine (Ant)	1	1	2	0	1	**5**
Spes (Aurelius Caes)	3	2	5	11	2	**23**
Virtus (Aurelius Caes)	2	0	9	9	2	**22**
Qty	**11**	**12**	**26**	**67**	**19**	**135**

Table 20: Reverse designs of 159-160 and 160-161 from *denarii* in hoards closing up to 180 (n=239)
No χ^2 testing: sample sizes too small

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
VOT SVS DEC III (Ant)	0	0	3	2	0	**5**
Felicitas *FELIC SAEC* (Ant)	3	4	17	26	3	**53**
Fortuna (Ant)	1	3	3	12	2	**21**
Liberalitas *LIB VIIII* (Ant)	0	1	6	3	3	**13**
Temple Augustus & Livia (Ant)	0	0	0	1	0	**1**
Pax (Ant)	3	4	10	25	4	**46**
Pietas (Ant)	0	0	0	3	1	**4**
Roma (Ant)	0	2	1	16	4	**23**
Salus (Ant)	2	3	8	15	3	**31**
Mars (Aurelius Caes)	2	1	5	9	2	**19**
Minerva (Aurelius Caes)	0	2	5	7	4	**18**
Pietas (Aurelius Caes)	0	0	0	5	0	**5**
Qty	**11**	**20**	**58**	**124**	**26**	**239**

3.2: Results of design-level χ^2 tests on *denarii* from hoards closing up to 192

Table 21: Reverse designs of 138, 138-139, and 139 from *denarii* in hoards closing up to 192 (n=319)
No χ^2 testing: sample sizes too small

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aequitas	5	4	0	12	3	**24**
Bust of Aurelius	1	2	0	0	3	**6**
Hands over caduceus	6	5	3	16	8	**38**
Concordia	4	1	0	4	2	**11**
Diana	4	1	1	8	3	**17**
Felicitas	10	4	4	15	4	**37**
Fides	2	3	0	6	4	**15**
Fortuna	5	2	1	7	5	**20**
Libertas	2	0	2	4	2	**10**
Minerva	13	4	5	11	4	**37**
Modius	6	5	2	22	0	**35**
Pax	6	1	5	6	7	**25**
Priestly implements	7	2	4	10	1	**24**
Winged fulmen	0	0	0	1	0	**1**
Victoria	2	1	0	9	0	**12**
Wolf & twins	1	2	0	2	2	**7**
Qty	**74**	**37**	**27**	**133**	**48**	**319**

Table 22: Reverse designs of 139-141 (Faustina I Augusta) from *denarii* in hoards closing up to 192 (n=76)
No χ^2 testing: sample sizes too small

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Concordia	4	0	1	8	3	**16**
Juno	11	1	7	17	8	**44**
Throne	7	0	2	2	4	**15**
Vesta	1	0	0	0	0	**1**
Qty	**23**	**1**	**10**	**27**	**15**	**76**

Table 23: Reverse designs of 140-143 from *denarii* in hoards closing up to 192 (n=440)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aequitas	19	6	15	31	4	**75**
Antoninus in armour	0	0	0	1	1	**2**
Apollo	6	5	4	13	5	**33**
Clementia	19	6	6	24	7	**62**
Concordia	7	2	1	9	1	**20**
Genio Senatus	7	1	9	25	4	**46**
Genio Populi Romani	10	5	7	12	2	**36**
Italia	5	0	7	11	4	**27**
Modius	7	6	4	26	10	**53**
Moneta	3	0	3	2	0	**8**
Ops	0	1	0	0	1	**2**
Pax	4	4	3	7	0	**18**
Salus	1	0	2	1	2	**6**
Wolf & twins	0	0	1	3	0	**4**
Tranquillitas	1	0	2	5	2	**10**
Virtus/Roma	8	4	0	10	5	**27**
Winged fulmen	0	2	1	4	4	**11**

Annexe 3: Antoninus Pius

Table 23: Reverse designs of 140-143 from *denarii* in hoards closing up to 192 (n=440)						
Qty	**97**	**42**	**65**	**184**	**52**	**440**
χ^2 standardised residuals						
χ^2 = 25.343, df = 20, **p-value = 0.1886**						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	
Aequitas	0.4606	-0.2401	1.0989	-0.2694	-1.2625	
Clementia	1.2948	0.2263	-1.0944	-0.5586	0.3409	
Genio Senatus	-1.0763	-1.5183	0.7847	1.1291	-0.2650	
Genio Populi Romani	0.6263	1.0232	0.6755	-0.9154	-0.8324	
Modius	-1.4618	0.6120	-1.4113	0.6272	2.0661	

Table 24: Reverse designs of 140 and 140-144 (Aurelius Caesar) from *denarii* in hoards closing up to 192 (n=211)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Bust of Aurelius	15	9	15	38	9	**86**
Priestly implements	13	7	18	17	12	**67**
Honos	2	2	3	9	1	**17**
Juventas	9	6	8	13	5	**41**
Qty	**39**	**24**	**44**	**77**	**27**	**211**
χ^2 standardised residuals						
χ^2 = 8.0292, df = 8, **p-value = 0.4306**						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	
Bust of Aurelius	-0.3462	-0.2410	-0.7448	1.4308	-0.7440	
Priestly implements	0.0620	-0.2169	1.0205	-1.3381	1.0080	
Juventas	0.4221	0.6263	-0.2259	-0.3617	-0.2111	

Table 25: Reverse designs of 141-161 (Diva Faustina I) from *denarii* in hoards closing up to 192 (n=2,469)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Aeternitas	5	3	10	20	6	**44**
Antoninus & Faustina	4	4	4	12	9	**33**
Carpentum	1	0	0	0	0	**1**
Ceres	129	67	128	439	137	**900**
Eagle	1	0	0	2	2	**5**
Fortuna	7	3	9	19	8	**46**
Temple of Faustina	4	6	12	27	7	**56**
Juno	51	19	31	87	42	**230**
Peacock	11	5	12	52	13	**93**
Pietas	32	26	24	96	40	**218**
Providentia	39	37	34	412	36	**558**
Star	0	0	0	3	2	**5**
Throne	13	5	6	26	11	**61**
Venus	9	2	13	32	18	**74**
Vesta	26	12	19	61	27	**145**
Qty	**332**	**189**	**302**	**1288**	**358**	**2469**
χ^2 standardised residuals						
χ^2 = 189.28, df = 40, **p-value < 2.2e-16**						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	
Aeternitas	-0.3762	-0.1947	1.9752	-0.6375	-0.1038	
Ceres	0.7282	-0.2003	1.6547	-1.5061	0.7917	
Fortuna	0.3282	-0.2719	1.4078	-1.0406	0.5690	

Annexe 3: Antoninus Pius

Table 25: Reverse designs of 141-161 (Diva Faustina I) from *denarii* in hoards closing up to 192 (n=2,469)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Temple of Faustina	-1.2859	0.8359	1.9511	-0.4339	-0.3426	
Juno	3.6112	0.3470	0.5147	-3.0556	1.6220	
Peacock	-0.4249	-0.7865	0.1691	0.4664	-0.0635	
Pietas	0.4976	2.2974	-0.5389	-1.7082	1.6135	
Throne	-4.1581	-0.8536	-4.1748	6.9900	-4.8694	
Providentia	1.6760	0.1606	-0.5464	-1.0561	0.7881	
Venus	-0.3006	-1.5342	1.2954	-1.0895	2.3029	
Vesta	1.4739	0.2821	0.2799	-1.7204	1.4027	

Table 26: Reverse designs of 143-44 and 144 from *denarii* in hoards closing up to 192 (n=133) **No χ^2 testing: sample sizes too small*						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Honos (Aurelius Caes)	2	3	4	4	3	**16**
Pax	3	2	4	10	0	**19**
Victoria	16	5	14	35	10	**80**
Virtus/Roma	2	0	1	7	1	**11**
Winged caduceus	2	3	0	1	1	**7**
Qty	**25**	**13**	**23**	**57**	**15**	**133**

Table 27: Reverse designs of 145-147 and 146-147 (Aurelius Caesar) from *denarii* in hoards closing up to 192 (n=201)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Fides	0	0	0	1	1	**2**
Honos	36	9	21	46	34	**146**
Spes	7	1	20	14	3	**45**
Virtus	0	1	1	6	0	**8**
Qty	**43**	**11**	**42**	**67**	**38**	**201**
χ^2 standardised residuals χ^2 = 20.16, df = 3, **p-value = 0.0001573**						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	
Honos	0.6053	-	-1.8010	0.0869	1.1327	
Spes	-1.0680	-	3.1780	-0.1533	-1.9988	

Table 28: Reverse designs of 145-61 from *denarii* in hoards closing up to 192 (n=1,131)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Aequitas (Ant)	9	4	8	13	2	**36**
Annona (Ant)	1	0	0	1	1	**3**
VOT SVS DEC III (Ant)	4	1	0	4	3	**12**
Hands on cornucopia (Ant)	19	6	16	31	17	**89**
Concordia (Ant)	9	6	12	18	10	**55**
Temple Augustus & Livia (Ant)	4	2	4	3	2	**15**
Genius (Ant)	0	0	1	0	0	**1**
Liberal *LIB IIII* (Ant)	16	9	23	37	16	**101**
Pax (Ant)	4	2	5	13	6	**30**
Pietas (Ant)	0	0	0	2	0	**2**
Virtus (Ant)	3	0	2	11	2	**18**
Winged fulmen (Ant)	18	12	16	39	25	**110**
Concordia (FII)	34	19	24	197	40	**314**

Annexe 3: Antoninus Pius

Table 28: Reverse designs of 145-61 from *denarii* in hoards closing up to 192 (n=1,131)						
Laetitia (FII)	0	0	1	8	4	**13**
Pudicitia (FII)	9	4	9	30	5	**57**
Spes (FII)	19	12	4	35	32	**102**
Throne (FII)	0	2	0	0	1	**3**
Venus (FII)	24	17	16	77	29	**163**
"Woman" (FII)	3	0	1	2	1	**7**
Qty	**176**	**96**	**142**	**521**	**196**	**1131**

χ^2 standardised residuals
χ^2 = 92.894, df = 28, **p-value = 6.958e-09**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Hands over cornucopia (Ant)	1.5658	-0.5913	1.5910	-1.6531	0.3474
Concordia (Ant)	0.2743	0.5905	2.0692	-1.5276	0.1104
Liberalitas *LIB IIII* (Ant)	0.2359	0.1145	3.0796	-1.4963	-0.4117
Winged fulmen (Ant)	0.3879	0.8351	0.7344	-1.7423	1.2939
Concordia (FII)	-1.8829	-1.5285	-2.2740	4.1221	-2.0380
Pudicitia (FII)	0.1670	-0.4021	0.7985	0.6411	-1.5831
Spes (FII)	0.9651	1.0992	-2.3763	-1.8461	3.3296
Venus (FII)	-0.0695	0.8075	-0.8413	0.0780	0.0711

Table 29: Reverse designs of 147-148 from *denarii* in hoards closing up to 192 (n=117)
No χ^2 testing: sample sizes too small

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aequitas (Ant)	2	0	0	1	0	**3**
Annona (Ant)	6	4	6	19	5	**40**
Antoninus sacrificing (Ant)	3	2	1	4	0	**10**
Genius (Ant)	0	0	0	1	0	**1**
Wreath *PRIMI DECENNALES* (Ant)	0	0	0	1	2	**3**
Salus (Ant)	3	2	3	11	2	**21**
Fides (Aurelius Caes)	0	0	0	2	0	**2**
Minerva (Aurelius Caes)	11	0	4	10	11	**36**
Vesta (Aurelius Caes)	0	0	1	0	0	**1**
Qty	**25**	**8**	**15**	**49**	**20**	**117**

Table 30: Reverse designs of 148-149 from *denarii* in hoards closing up to 192 (n=463)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aequitas (Ant)	18	6	12	19	7	**62**
Annona (Ant)	16	8	16	46	16	**102**
Antoninus sacrificing (Ant)	2	2	4	15	2	**25**
Bonus Eventus (Ant)	4	3	1	10	6	**24**
Felicitas (Ant)	5	2	1	8	7	**23**
Fortuna (Ant)	10	3	5	15	7	**40**
Salus (Ant)	14	6	19	44	19	**102**
Clementia (Aurelius Caes)	2	2	3	10	0	**17**
Minerva (Aurelius Caes)	7	5	7	20	8	**47**
Providentia (Aurelius Caes)	3	1	0	13	1	**18**
"Woman" (Aurelius Caes)	0	0	0	1	2	**3**
Qty	**81**	**38**	**68**	**201**	**75**	**463**

χ^2 standardised residuals
χ^2 = 16.487, df = 16, **p-value = 0.4195**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube

Annexe 3: Antoninus Pius

Table 30: Reverse designs of 148-149 from *denarii* in hoards closing up to 192 (n=463)					
Aequitas (Ant)	2.0711	0.4891	0.6917	-1.4801	-0.8151
Annona (Ant)	-0.5291	-0.0306	-0.0432	0.3284	0.0879
Fortuna (Ant)	1.0609	-0.0962	-0.5331	-0.5275	0.3479
Salus (Ant)	-0.9971	-0.7339	0.7027	0.0263	0.8462
Aurelius Caes	-0.8248	0.4857	-0.9474	1.2374	-0.5658

Table 31: Reverse designs of 149-150 and 150-151 from *denarii* in hoards closing up to 192 (n=137)
No χ^2 testing: sample sizes too small

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Bonus Eventus	1	0	2	7	4	**14**
Felicitas	0	0	3	6	0	**9**
Fortuna	2	0	3	17	2	**24**
Genius	1	0	3	1	1	**6**
Pax	1	4	9	17	5	**36**
Pietas	3	1	5	8	4	**21**
Tranquillitas	5	2	3	5	9	**24**
Vesta	0	1	0	2	0	**3**
Qty	**13**	**8**	**28**	**63**	**25**	**137**

Table 32: Reverse designs of 151-152 from *denarii* in hoards closing up to 192 (n=193)
No χ^2 testing: sample sizes too small

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Annona (Ant)	1	2	7	11	6	**27**
Congiarium *LIB VII* (Ant)	0	0	0	0	1	**1**
Fortuna (Ant)	2	2	6	9	3	**22**
Pax (Ant)	1	2	3	8	10	**24**
Pietas (Ant)	0	0	1	8	4	**13**
Roma/Virt (Ant)	1	0	0	0	0	**1**
Tranquillitas (Ant)	2	3	6	15	4	**30**
Vesta (Ant)	6	1	5	10	6	**28**
Clementia (Aurelius Caes)	2	0	6	6	5	**19**
Genius Exercitus (Aurelius Caes)	6	2	6	9	3	**26**
Virtus (Aurelius Caes)	0	1	0	0	1	**2**
Qty	**21**	**13**	**40**	**76**	**43**	**193**

Table 33: Reverse designs of 152-153 from *denarii* in hoards closing up to 192 (n=285)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Annona (Ant)	9	2	9	58	10	**88**
Fortuna (Ant)	7	3	8	19	6	**43**
Liberalitas *LIB VII* (Ant)	1	0	5	6	1	**13**
Shrine (Ant)	0	0	0	0	1	**1**
Vesta (Ant)	13	4	7	49	20	**93**
Genius Exercitus (Aurelius Caes)	9	4	10	18	6	**47**
Qty	**39**	**13**	**39**	**150**	**44**	**285**

χ^2 standardised residuals
χ^2 = 17.017, df = 9, **p-value = 0.04845**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Annona (Ant)	-1.0302	-	-0.6931	1.4434	-1.0690
Fortuna (Ant)	0.4567	-	1.1885	-0.7038	-0.2005
Vesta (Ant)	-0.0300	-	-1.3808	-0.0957	1.4480

Annexe 3: Antoninus Pius

Table 33: Reverse designs of 152-153 from *denarii* in hoards closing up to 192 (n=285)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Genius Exercitus (Aurelius Caes)	1.0596	-	1.8204	-1.2247	-0.3780	

Table 34: Reverse designs of 153-154 from *denarii* in hoards closing up to 192 (n=436) **No χ² testing: sample sizes too small*						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Annona (Ant)	6	3	6	112	7	**134**
Congiarium *LIB VII* (Ant)	0	0	1	1	0	**2**
Fortuna (Ant)	8	6	1	68	7	**90**
Liberalitas *LIB VII* (Ant)	2	0	1	16	3	**22**
Vesta (Ant)	4	5	6	81	13	**109**
Genius Exercitus (Aurelius Caes)	1	4	2	14	6	**27**
Minerva (Aurelius Caes)	3	1	5	36	3	**48**
Virtus (Aurelius Caes)	0	0	0	3	1	**4**
Qty	**24**	**19**	**22**	**331**	**40**	**436**

Table 35: Reverse designs of 154-155 from *denarii* in hoards closing up to 192 (n=600)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Annona (Ant)	5	0	6	161	9	**181**
Felicitas (Ant)	1	0	0	0	0	**1**
Fortuna (Ant)	4	2	5	77	0	**88**
Vesta (Ant)	3	1	9	159	10	**182**
Minerva (Aurelius Caes)	5	4	7	128	4	**148**
Qty	**18**	**7**	**27**	**525**	**23**	**600**
χ^2 standardised residuals χ^2 = 2.1314, df = 4, **p-value = 0.7116**						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	
Annona (Ant)	-	-	-0.6615	0.0842	0.2754	
Vesta (Ant)	-	-	0.3750	-0.2164	0.5884	
Minerva (Aurelius Caes)	-	-	0.3201	0.1502	-0.9758	

Table 36: Reverse designs of 155-156 from *denarii* in hoards closing up to 192 (n=250)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Annona (Ant)	8	9	4	38	9	**68**
Ceres (Ant)	4	1	1	6	1	**13**
Fortuna (Ant)	3	4	2	18	4	**31**
Pax (Ant)	7	5	6	28	7	**53**
Pietas (Ant)	1	1	0	4	0	**6**
Salus (Ant)	2	2	0	9	4	**17**
Aequitas (Aurelius Caes)	4	3	10	11	3	**31**
Genio Populi Romani (Aurelius Caes)	1	1	1	3	3	**9**
Providentia (Aurelius Caes)	0	0	2	1	0	**3**
Virtus (Aurelius Caes)	4	2	1	12	0	**19**
Qty	**34**	**28**	**27**	**130**	**31**	**250**
χ^2 standardised residuals χ^2 = 9.253, df = 8, **p-value = 0.3214**						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	
Annona (Ant)	-0.3074	0.5753	-1.6469	0.5856	0.2886	

Annexe 3: Antoninus Pius

Table 36: Reverse designs of 155-156 from *denarii* in hoards closing up to 192 (n=250)					
Pax (Ant)	0.0187	-0.3292	-0.3606	0.2053	0.2490
Aurelius Caes	0.3047	-0.2981	2.0582	-0.8031	-0.5324

Table 37: Reverse designs of 156-157 from *denarii* in hoards closing up to 192 (n=284)

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Annona (Ant)	13	8	3	42	19	**85**
Ceres (Ant)	7	2	2	8	4	**23**
Felicitas (Ant)	0	0	0	3	0	**3**
Fortuna Obsequens (Ant)	1	0	0	0	1	**2**
Jupiter (Ant)	0	0	1	1	0	**2**
Salus (Ant)	2	4	4	31	21	**62**
Securitas (Ant)	1	1	0	4	2	**8**
Felicitas (Aurelius Caes)	6	1	4	10	5	**26**
Securitas (Aurelius Caes)	1	0	0	4	0	**5**
Virtus (Aurelius Caes)	10	6	12	33	7	**68**
Qty	**41**	**22**	**26**	**136**	**59**	**284**

χ^2 standardised residuals
$\chi^2 = 23.058$, df = 8, **p-value = 0.003291**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Annona (Ant)	0.9912	0.3313	-1.6461	0.0144	0.0971
Salus (Ant)	-1.9401	-0.5226	-0.6319	0.0782	2.0227
Virtus (Aurelius Caes)	0.7443	0.1287	2.4438	-0.0908	-2.0400

Table 38: Reverse designs of 157-158 from *denarii* in hoards closing up to 192 (n=212)
***No χ^2 testing: sample sizes too small**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aequitas (Ant)	0	2	1	5	2	**10**
Annona (Ant)	13	11	9	47	31	**111**
Antoninus sacrificing (Ant)	0	1	0	1	1	**3**
Felicitas (Ant)	1	0	0	0	0	**1**
Fortuna (Ant)	1	0	0	4	0	**5**
Genius (Ant)	0	0	1	0	0	**1**
Liberalitas *LIB VIII* (Ant)	0	1	0	1	1	**3**
Temple Augustus & Livia (Ant)	1	1	1	1	1	**5**
Roma (Ant)	1	1	0	3	1	**6**
Felicitas (Aurelius Caes)	9	5	10	25	10	**59**
Spes (Aurelius Caes)	1	0	1	6	0	**8**
Qty	**27**	**22**	**23**	**93**	**47**	**212**

Table 39: Reverse designs of 158-159 from *denarii* in hoards closing up to 192 (n=175)
***No χ^2 testing: sample sizes too small**

Design	Britain	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
VOTA SOL/SVSC DEC II/III (Ant)	3	7	4	31	5	**50**
Fortuna Osequens (Ant)	4	1	3	7	9	**24**
Temple Augustus & Livia (Ant)	3	2	4	23	5	**37**
Salus (Ant)	0	0	0	0	1	**1**
Shrine (Ant)	2	1	2	0	1	**6**
Spes (Aurelius Caes)	6	2	5	13	2	**28**
Virtus (Aurelius Caes)	3	0	9	12	5	**29**
Qty	**21**	**13**	**27**	**86**	**28**	**175**

Table 40: Reverse designs of 159-160 and 160-161 from *denarii* in hoards closing up to 192 (n=320)						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
VOT SVS DEC III (Ant)	0	0	3	2	0	**5**
Felicitas *FELIC SAEC* (Ant)	5	4	17	32	8	**66**
Fortuna (Ant)	2	4	3	19	7	**35**
Liberalitas *LIB VIIII* (Ant)	0	1	6	4	3	**14**
Temple Augustus & Livia (Ant)	0	0	0	1	0	**1**
Pax (Ant)	9	5	11	33	8	**66**
Pietas (Ant)	1	0	0	4	1	**6**
Roma (Ant)	2	2	1	18	4	**27**
Salus (Ant)	6	3	8	21	5	**43**
Shrine (Ant)	0	0	1	0	0	**1**
Mars (Aurelius Caes)	5	1	5	14	5	**30**
Minerva (Aurelius Caes)	0	2	5	7	4	**18**
Pietas (Aurelius Caes)	0	0	0	8	0	**8**
Qty	**30**	**22**	**60**	**163**	**45**	**320**
χ^2 standardised residuals						
χ^2 = 3.6547, df = 8, **p-value = 0.8869**						
Design	**Britain**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	
Felicitas *FELIC SAEC* (Ant)	-0.647	-0.104	1.002	-0.174	-0.262	
Pax (Ant)	0.902	0.384	-0.641	0.000	-0.262	
Aurelius Caes	-0.277	-0.304	-0.392	0.189	0.569	

3.3: Results of design-level χ^2 tests on *denarii* from hoards closing up to 211

Table 41: Reverse designs of 138, 138-139, and 139 from *denarii* in hoards closing up to 211 (n=475)							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Aequitas	5	3	5	0	13	6	**32**
Bust of Aurelius	1	1	2	3	16	3	**26**
Hands over caduceus	6	6	8	0	0	13	**33**
Concordia	4	3	1	0	4	4	**16**
Diana	4	1	2	1	8	8	**24**
Eagle on globe	0	0	0	0	0	1	**1**
Felicitas	11	3	5	4	16	13	**52**
Fides	2	4	3	0	7	10	**26**
Fortuna	6	5	2	1	7	12	**33**
Libertas	3	1	1	2	5	6	**18**
Minerva	14	2	5	5	11	13	**50**
Modius	8	3	5	2	23	8	**49**
Pax	8	6	1	5	8	15	**43**
Priestly implements	7	4	2	4	11	10	**38**
Winged fulmen	0	0	0	0	1	0	**1**
Vesta	0	0	0	0	0	2	**2**
Victoria	2	3	1	0	9	4	**19**
Wolf & twins	2	1	2	0	2	5	**12**
Qty	**83**	**46**	**45**	**27**	**141**	**133**	**475**
χ^2 standardised residuals							
χ^2 = 40.653, df = 21, **p-value = 0.006188**							

Annexe 3: Antoninus Pius

Table 41: Reverse designs of 138, 138-139, and 139 from *denarii* in hoards closing up to 211 (n=475)						
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**
Aequitas	-0.6919	-	0.8313	-	1.2063	-1.1149
Hands on caduceus	-0.1334	-	2.6671	-	-2.9454	1.4273
Felicitas	0.1355	-	-0.1559	-	0.4054	-0.4239
Fortuna	-0.1334	-	-0.6783	-	-0.5687	1.0897
Minerva	1.2308	-	-0.0542	-	-0.7576	-0.2598
Modius	-0.7235	-	-0.1056	-	2.3572	-1.6652
Pax	0.1792	-	-1.4403	-	-0.7116	1.4275
Priestly implements	-0.0150	-	-0.8326	-	0.4384	0.0809

Table 42: Reverse designs of 139-141 (Faustina I Augusta) from *denarii* in hoards closing up to 211 (n=121) **No χ^2 testing: sample sizes too small*							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Concordia	4	1	1	1	10	6	**23**
Juno	12	7	1	7	19	20	**66**
Throne	12	4	0	2	2	8	**28**
Vesta	2	2	0	0	0	0	**4**
Qty	**30**	**14**	**2**	**10**	**31**	**34**	**121**

Table 43: Reverse designs of 140-143 from *denarii* in hoards closing up to 211 (n=658)							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Aequitas	22	13	11	15	36	19	**116**
Ant in armour	1	2	0	0	1	1	**5**
Apollo	8	5	7	4	13	11	**48**
Hands on caduceus	0	0	0	0	2	0	**2**
Clementia	21	10	9	6	25	24	**95**
Concordia	9	5	3	1	9	6	**33**
Genio Senatus	9	7	2	9	26	9	**62**
Genio Populi Romani	13	4	5	7	14	12	**55**
Italia	8	5	1	7	12	8	**41**
Modius	10	5	8	4	28	26	**81**
Moneta	4	1	1	3	2	2	**13**
Ops	0	1	1	0	0	1	**3**
Pax	5	3	4	3	7	4	**26**
Salus	1	0	0	2	1	2	**6**
Wolf & twins	0	3	0	1	4	0	**8**
Tranquillitas	1	2	0	2	5	2	**12**
Virtus/Roma	9	2	5	0	11	7	**34**
Winged fulmen	0	3	3	1	4	7	**18**
Qty	**121**	**71**	**60**	**65**	**200**	**141**	**658**

χ^2 standardised residuals χ^2 = 25.343, df = 20, **p-value = 0.1886**						
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**
Aequitas	0.1580	0.5830	0.3407	0.9887	-0.0970	-1.2916
Clementia	0.8576	0.3128	0.3053	-1.1417	-0.9067	0.6770
Genio Senatus	-0.7026	0.4475	-1.4351	1.1171	1.4574	-1.2570
Genio Populi Romani	0.9177	-0.5434	0.1352	0.6331	-0.8036	-0.0295
Modius	-1.2593	-0.9801	0.4058	-1.4458	0.4852	1.9366

Annexe 3: Antoninus Pius

Table 44: Reverse designs of 140 and 140-144 (Aurelius Caesar) from *denarii* in hoards closing up to 211 (n=309)							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Bust of Aurelius	17	11	12	15	39	29	**123**
Priestly implements	17	11	11	18	21	31	**109**
Honos	3	0	2	3	9	6	**23**
Juventas	12	1	8	8	13	12	**54**
Qty	**49**	**23**	**33**	**44**	**82**	**78**	**309**

χ^2 standardised residuals

χ^2 = 11.011, df = 10, **p-value = 0.3566**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Bust of Aurelius	-0.6257	0.3524	-0.3648	-0.6270	1.3573	-0.3531
Priestly implements	-0.1269	0.7546	-0.2370	0.6006	-1.2933	0.6795
Juventas	1.1247	-1.6040	0.8874	0.0930	-0.2110	-0.4324

Table 45: Reverse designs of 141-161 (Diva Faustina I) from *denarii* in hoards closing up to 211 (n=3,691)							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Aeternitas	8	7	6	10	29	15	**75**
Antoninus & Faustina	6	7	7	4	12	15	**51**
Carpentum	1	0	0	0	0	0	**1**
Ceres	193	124	103	129	455	312	**1316**
Eagle	1	0	1	0	2	3	**7**
Fortuna	13	11	9	9	21	26	**89**
Temple of Faustina	10	6	12	12	30	23	**93**
Juno	71	40	28	31	88	99	**357**
Peacock	13	17	10	12	53	38	**143**
Pietas	48	50	35	24	98	101	**356**
Providentia	62	47	55	34	419	109	**726**
Star	0	1	2	0	3	2	**8**
Throne	13	11	10	6	30	23	**93**
Venus	11	9	6	13	34	35	**108**
Vesta	40	36	30	19	70	73	**268**
Qty	**490**	**366**	**314**	**303**	**1344**	**874**	**3691**

χ^2 standardised residuals

χ^2 = 247, df = 50, **p-value < 2.2e-16**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Aeternitas	-0.6254	-0.1502	-0.1162	1.5325	0.2933	-0.6360
Ceres	1.3582	-0.5264	-0.7036	1.9599	-1.2245	0.1069
Fortuna	0.3380	0.7447	0.5615	0.6115	-2.0301	1.0977
Temple of Faustina	-0.6736	-1.0515	1.5032	1.5621	-0.6947	0.2316
Juno	3.4130	0.7971	-0.3558	0.2848	-3.7367	1.6215
Peacock	-1.3802	0.7646	-0.5762	0.0587	0.0881	0.7411
Pietas	0.0946	2.5011	0.9400	-0.9912	-2.8340	1.8679
Providentia	-3.5170	-2.9188	-0.7561	-3.3464	9.3937	-4.7464
Throne	0.1794	0.5981	0.7872	-0.6040	-0.6947	0.2316
Venus	-0.8877	-0.5109	-1.0165	1.3700	-0.8820	1.8930
Vesta	0.7295	1.8513	1.5858	-0.6617	-2.8400	1.2389

Annexe 3: Antoninus Pius

Table 46: Reverse designs of 143-144 and 144 from *denarii* in hoards closing up to 211 (n=201)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Honos (Aurelius Caes)	3	1	3	4	6	5	**22**
Pax	4	3	4	4	11	1	**27**
Victoria	23	12	8	14	36	29	**122**
Virtus/Roma	2	2	2	1	7	5	**19**
Winged caduceus	3	1	3	0	2	2	**11**
Qty	**35**	**19**	**20**	**23**	**62**	**42**	**201**

Table 47: Reverse designs of 145-147 and 146-147 (Aurelius Caesar) from *denarii* in hoards closing up to 211 (n=309)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Fides	0	0	0	0	1	2	**3**
Honos	45	28	12	21	56	66	**228**
Spes	8	6	3	20	15	10	**62**
Virtus	2	2	2	1	6	3	**16**
Qty	**55**	**36**	**17**	**42**	**78**	**81**	**309**

χ^2 standardised residuals
χ^2 = 22.917, df = 5, **p-value = 0.00035**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Honos	0.5225	0.2505		-1.9743	0.0312	0.8161
Spes	-0.9997	-0.4793		3.7775	-0.0596	-1.5615

Table 48: Reverse designs of 145-161 from *denarii* in hoards closing up to 211 (n=1,748)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aequitas (Ant)	10	7	6	8	13	15	**59**
Annona (Ant)	1	0	2	0	1	1	**5**
VOT SVS DEC III (Ant)	5	0	0	0	5	4	**14**
Congiarium *LIB IIII* (Ant)	0	0	0	0	1	0	**1**
Hands on cornucopia (Ant)	27	28	13	16	35	38	**157**
Concordia (Ant)	13	2	10	12	21	21	**79**
Felicitas (Ant)	0	1	0	0	0	1	**2**
Fortuna (Ant)	0	0	0	0	0	1	**1**
Temple Aug & Livia (Ant)	5	4	2	4	3	5	**23**
Genius (Ant)	0	0	0	1	0	0	**1**
Liberalitas *LIB IIII* (Ant)	19	31	15	23	41	46	**175**
Pax (Ant)	5	3	3	5	13	14	**43**
Pietas (Ant)	0	0	0	0	2	0	**2**
Virtus (Ant)	5	3	0	2	11	3	**24**
Winged fulmen (Ant)	25	14	17	16	40	46	**158**
Concordia (FII)	49	43	33	24	204	79	**432**
Laetitia (FII)	2	4	2	1	9	5	**23**
Pudicitia (FII)	15	3	11	9	31	23	**92**
Spes (FII)	28	26	21	4	35	53	**167**
Throne (FII)	0	0	2	0	0	1	**3**
Venus (FII)	36	44	28	16	80	75	**279**
"Woman" (FII)	3	0	1	1	2	1	**8**
Qty	**248**	**213**	**166**	**142**	**547**	**432**	**1748**

χ^2 standardised residuals
χ^2 =1.32.79, df = 40, **p-value = 6.969e-12**

Annexe 3: Antoninus Pius

Table 48: Reverse designs of 145-161 from *denarii* in hoards closing up to 211 (n=1,748)						
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**
Aequitas (Ant)	0.6299	-0.1148	0.1317	1.5061	-1.2709	0.0992
Hands on cornucopia (Ant)	1.1111	1.9378	-0.5476	0.9656	-2.0152	-0.1453
Concordia (Ant)	0.6113	-2.4894	0.8650	2.2548	-0.7479	0.3216
Liberalitas *LIB IIII* (Ant)	-1.0773	2.0008	-0.4541	2.3992	-1.8590	0.3999
Winged fulmen (Ant)	0.6510	-1.2605	0.4545	0.9400	-1.3421	1.0941
Concordia (FII)	-1.4219	-1.4388	-1.3378	-1.8025	5.9203	-2.7114
Pudicitia (FII)	0.6207	-2.4877	0.7167	0.6007	0.4127	0.0422
Spes (FII)	0.9965	1.1669	1.2230	-2.5638	-2.3867	1.8056
Venus (FII)	-0.4433	1.6039	0.2146	-1.3428	-0.7809	0.7049

Table 49: Reverse designs of 147-148 from *denarii* in hoards closing up to 211 (n=207)							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Aequitas (Ant)	2	0	0	0	1	0	**3**
Annona (Ant)	11	10	10	6	22	15	**74**
Ant sacrificing (Ant)	3	4	3	1	5	1	**17**
Genius (Ant)	0	0	1	0	1	0	**2**
PRIMI DECENN (Ant)	1	2	0	0	1	4	**8**
Salus (Ant)	5	4	5	3	14	7	**38**
Fides (Aurelius Caes)	0	2	0	0	2	1	**5**
Minerva (Aurelius Caes)	13	12	3	4	11	16	**59**
Vesta (Aurelius Caes)	0	0	0	1	0	0	**1**
Qty	**35**	**34**	**22**	**15**	**57**	**44**	**207**
χ² standardised residuals							
χ² = 9.7173, df = 8, **p-value = 0.2854**							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	
Annona (Ant)	-0.3157	-0.4918	0.9090	-	0.3447	-0.3148	
Salus (Ant)	-0.4917	-0.8207	0.5773	-	1.0724	-0.4749	
Aurelius Caes	0.7117	1.1504	-1.4086	-	-1.1860	0.6979	

Table 50: Reverse designs of 148-149 from *denarii* in hoards closing up to 211 (n=697)							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Aequitas (Ant)	22	12	8	12	26	18	**98**
Annona (Ant)	24	21	11	16	49	32	**153**
Ant sacrificing (Ant)	3	3	4	4	15	6	**35**
Bonus Eventus (Ant)	7	4	3	1	10	11	**36**
Felicitas (Ant)	6	3	3	1	8	12	**33**
Fortuna (Ant)	10	8	5	5	20	16	**64**
Salus (Ant)	16	14	7	19	51	38	**145**
Clem (Aurelius Caes)	4	4	2	3	12	3	**28**
Minerva (Aurel Caes)	7	12	8	7	21	13	**68**
Provid (Aurel Caes)	6	5	2	0	13	8	**34**
"Woman" (Aurel Caes)	0	0	0	0	1	2	**3**
Qty	**105**	**86**	**53**	**68**	**226**	**159**	**697**
χ² standardised residuals							
χ² = 16.737, df = 20, **p-value = 0.67**							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	
Aequitas (Ant)	1.9013	-0.1580	0.3353	0.5479	-1.0439	-0.7517	
Annona (Ant)	0.2164	0.3142	-0.0284	0.0008	-0.1128	-0.2661	

Annexe 3: Antoninus Pius

Table 50: Reverse designs of 148-149 from *denarii* in hoards closing up to 211 (n=697)							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Fortuna (Ant)	0.1273	-0.0707	0.1667	-0.6539	-0.1818	0.5258	
Salus (Ant)	-1.2352	-1.0632	-1.0838	0.9862	0.5543	1.1019	
Aurelius Caes	-0.6628	0.9578	0.7586	-1.0473	0.5644	-0.5846	

Table 51: Reverse designs of 149-150 and 150-151 from *denarii* in hoards closing up to 211 (n=228) **No χ² testing: sample sizes too small*							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Antoninus & Faustina II	0	0	1	0	0	0	**1**
Bonus Eventus	1	5	1	2	7	6	**22**
Felicitas	1	2	1	3	6	1	**14**
Fortuna	3	9	0	3	19	5	**39**
Genius	2	2	1	3	2	2	**12**
Pax	3	6	8	9	17	15	**58**
Pietas	5	5	2	5	9	8	**34**
Tranquillitas	6	10	4	3	7	15	**45**
Vesta	0	0	1	0	2	0	**3**
Qty	**21**	**39**	**19**	**28**	**69**	**52**	**228**

Table 52: Reverse designs of 151-152 from *denarii* in hoards closing up to 211 (n=328) **No χ² testing: sample sizes too small*							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Annona (Ant)	2	6	7	7	11	27	**60**
Congiarium *LIB VII* (Ant)	0	0	0	0	0	1	**1**
Fortuna (Ant)	2	6	2	6	9	9	**34**
Pax (Ant)	3	1	2	3	8	22	**39**
Pietas (Ant)	1	3	0	1	11	6	**22**
Roma/Virt (Ant)	1	0	0	0	0	0	**1**
Tranquillitas (Ant)	2	3	4	6	17	6	**38**
Vesta (Ant)	6	13	4	5	15	23	**66**
Clementia (Aurelius Caes)	3	3	0	6	6	6	**24**
Genius Exerc (Aurelius Caes)	7	5	4	6	11	8	**41**
Virtus (Aurelius Caes)	0	0	1	0	0	1	**2**
Qty	**27**	**40**	**24**	**40**	**88**	**109**	**328**

Table 53: Reverse designs of 152-153 from *denarii* in hoards closing up to 211 (n=434)							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Annona (Ant)	11	11	4	9	60	26	**121**
Fortuna (Ant)	11	9	4	8	23	18	**73**
Liberalitas *LIB VII* (Ant)	3	0	0	5	9	3	**20**
Shrine (Ant)	0	0	0	0	0	1	**1**
Vesta (Ant)	20	14	6	7	58	42	**147**
Gen Exerc (Aurel Caes)	13	7	6	10	19	17	**72**
Qty	**58**	**41**	**20**	**39**	**169**	**107**	**434**
χ^2 standardised residuals χ^2 = 20.814, df = 15, **p-value = 0.1429**							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	
Annona (Ant)	-1.2739	-0.2920	-0.7682	-0.3046	1.9168	-0.7603	
Fortuna (Ant)	0.4100	0.6512	0.2473	0.8119	-0.9930	-0.0482	

Annexe 3: Antoninus Pius

Table 53: Reverse designs of 152-153 from *denarii* in hoards closing up to 211 (n=434)							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Vesta (Ant)	0.0958	-0.1553	-0.4193	-1.4665	0.1393	0.8818	
Gen Exerc (Aurel Caes)	1.1018	-0.0552	1.3460	1.6728	-1.6839	-0.2257	

Table 54: Reverse designs of 153-154 from *denarii* in hoards closing up to 211 (n=542)							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Annona (Ant)	6	11	5	6	113	21	**162**
Congiarium LIB VII (Ant)	0	1	0	1	1	1	**4**
Fortuna (Ant)	9	2	9	1	69	12	**102**
Liberalitas *LIB VII* (Ant)	2	6	0	1	16	5	**30**
Vesta (Ant)	4	17	8	6	81	27	**143**
Gen Exerc (Aurel Caes)	2	6	5	2	14	9	**38**
Minerva (Aurel Caes)	3	7	1	5	37	5	**58**
Virtus (Aurelius Caes)	0	1	0	0	3	1	**5**
Qty	**26**	**51**	**28**	**22**	**334**	**81**	**542**
χ^2 standardised residuals							
χ^2 = 24.059, df = 10, **p-value = 0.007446**							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	
Annona (Ant)	-0.5682	-0.2723	-1.2695	0.3629	0.8129	-0.5897	
Fortuna (Ant)	1.9423	-2.0126	1.4848	-1.2510	0.3804	-0.7832	
Vesta (Ant)	-1.0356	1.9896	0.0972	0.6702	-1.1865	1.2891	

Table 55: Reverse designs of 154-155 from *denarii* in hoards closing up to 211 (n=687)							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Annona (Ant)	5	7	2	6	162	19	**201**
Felicitas (Ant)	1	0	0	0	0	0	**1**
Fortuna (Ant)	4	10	5	5	77	12	**113**
Vesta (Ant)	3	8	9	9	162	23	**214**
Minerva (Aurel Caes)	5	5	4	7	128	9	**158**
Qty	**18**	**30**	**20**	**27**	**529**	**63**	**687**
χ^2 standardised residuals							
χ^2 = 7.8922, df = 8, **p-value = 0.4441**							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	
Annona (Ant)	-	0.0000	-1.4184	-0.6126	0.3021	0.2722	
Vesta (Ant)	-	0.1691	1.4084	0.2469	-0.6366	0.8632	
Minerva (Aurel Caes)	-	-0.1986	-0.0485	0.4035	0.4056	-1.3218	

Table 56: Reverse designs of 155-156 from *denarii* in hoards closing up to 211 (n=687)							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Qty**
Annona (Ant)	10	11	11	4	40	28	**104**
Ceres (Ant)	4	4	1	1	6	3	**19**
Fortuna (Ant)	7	4	5	2	18	10	**46**
Pax (Ant)	11	10	5	6	29	17	**78**
Pietas (Ant)	2	1	2	0	4	7	**16**
Salus (Ant)	4	5	2	0	13	10	**34**
Aequitas (AurelCaes)	8	5	4	10	12	11	**50**
Gen Pop Rom (Aurel Caes)	1	3	1	1	3	3	**12**
Provid (Aurel Caes)	0	0	0	2	1	0	**3**

Annexe 3: Antoninus Pius

Table 56: Reverse designs of 155-156 from *denarii* in hoards closing up to 211 (n=687)							
Virtus (Aurelius Caes)	5	9	5	1	12	3	**35**
Qty	**52**	**52**	**36**	**27**	**138**	**92**	**397**

χ^2 standardised residuals χ^2 = 13.985, df = 10, **p-value = 0.1737**						
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**
Annona (Ant)	-0.8094	-0.8052	0.4558	-1.6306	0.7067	1.0738
Pax (Ant)	0.4240	-0.1575	-0.8172	-0.2477	0.4190	-0.0360
Aurelius Caes	0.4509	0.9602	0.2569	1.8817	-1.0908	-1.0633

Table 57: Reverse designs of 156-157 from *denarii* in hoards closing up to 211 (n=459)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Annona (Ant)	19	15	11	3	43	41	**132**
Ceres (Ant)	7	6	2	2	8	8	**33**
Felicitas (Ant)	0	0	0	0	3	2	**5**
Fort Obsequens (Ant)	2	0	0	0	1	1	**4**
Jupiter (Ant)	0	0	0	1	1	0	**2**
Salus (Ant)	7	10	6	4	32	35	**94**
Securitas (Ant)	3	0	1	0	4	7	**15**
Felicitas (Aurel Caes)	10	16	5	4	11	16	**62**
Securitas (Aurel Caes)	1	0	0	0	4	1	**6**
Virtus (Aurelius Caes)	16	17	6	12	34	21	**106**
Qty	**65**	**64**	**31**	**26**	**141**	**132**	**459**

χ^2 standardised residuals χ^2 = 19.325, df = 10, **p-value = 0.03633**						
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**
Annona (Ant)	0.5631	-0.4157	0.6136	-1.6570	-0.0512	0.3919
Salus (Ant)	-1.4185	-0.5485	-0.2007	-0.5948	0.2049	1.4380
Virtus (Aurelius Caes)	0.7074	0.9805	-0.4957	**2.4092**	-0.1358	-1.7915

Table 58: Reverse designs of 157-158 from *denarii* in hoards closing up to 211 (n=459)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
Aequitas (Ant)	0	1	2	1	5	3	**12**
Annona (Ant)	30	24	22	9	51	44	**180**
Ant sacrificing (Ant)	0	2	3	0	1	4	**10**
Felicitas (Ant)	1	0	0	0	0	0	**1**
Fortuna (Ant)	5	1	0	0	5	1	**12**
Genius (Ant)	0	0	0	1	0	0	**1**
Liberalitas *LIB VIII* (Ant)	3	0	1	0	2	2	**8**
Temple Aug & Livia (Ant)	2	0	1	1	2	1	**7**
Roma (Ant)	2	0	1	0	3	2	**8**
Felicitas (Aurel Caes)	12	12	9	10	26	20	**89**
Spes (Aurelius Caes)	1	4	1	1	6	1	**14**
Qty	**65**	**64**	**31**	**26**	**141**	**132**	**459**

χ^2 standardised residuals χ^2 = 4.9227, df = 5, **p-value = 0.4254**						
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**
Annona (Ant)	0.5068	-0.2858	0.3650	-1.0432	-0.2466	0.4133
Aurelius Caes	-0.6699	0.3778	-0.4825	1.3791	0.3260	-0.5463

Annexe 3: Antoninus Pius

Table 59: Reverse designs of 158-159 from *denarii* in hoards closing up to 211 (n=289)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
VOTA SOL/SVSC DEC II/III (Ant)	9	17	12	5	35	19	**96**
Felicitas (Ant)	0	0	1	0	0	0	**1**
Fortuna Obsequens (Ant)	8	4	3	3	7	10	**35**
Temple Aug & Livia (Ant)	6	13	2	4	24	17	**66**
Salus (Ant)	0	2	0	0	0	1	**3**
Shrine (Ant)	2	0	2	2	0	3	**9**
Spes (Aurelius Caes)	7	4	3	5	14	6	**39**
Virtus (Aurelius Caes)	4	6	1	9	12	8	**40**
Qty	**36**	**46**	**24**	**27**	**92**	**64**	**289**

χ^2 standardised residuals

χ^2 = 18.907, df = 10, **p-value = 0.04146**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
VOTA SOL/SVSC DEC II/III (Ant)	-0.4216	0.2672	1.8037	-1.6091	0.1961	-0.2055
Temple Aug & Livia (Ant)	-0.4199	0.6181	-1.3194	-0.8250	0.1496	0.8937
Aurelius Caes	0.8485	-0.8594	-0.7824	2.5278	-0.3530	-0.5904

Table 60: Reverse designs of 159-160 and 160-161 from *denarii* in hoards closing up to 211 (n=500)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Qty
VOT SVS DEC III (Ant)	0	0	0	3	2	0	**5**
Felic *FELIC SAEC* (Ant)	10	11	7	17	33	22	**100**
Fortuna (Ant)	5	12	5	3	19	12	**56**
Liberalitas *LIB VIIII* (Ant)	1	1	1	6	4	4	**17**
Temple Aug & Livia (Ant)	0	0	0	0	1	1	**2**
Pax (Ant)	12	15	9	12	37	13	**98**
Pietas (Ant)	1	4	2	0	4	8	**19**
Roma (Ant)	3	4	4	1	18	8	**38**
Salus (Ant)	11	19	6	8	21	17	**82**
Shrine (Ant)	0	0	0	1	0	0	**1**
Mars (Aurelius Caes)	5	5	1	5	14	8	**38**
Minerva (Aurel Caes)	1	7	4	5	9	6	**32**
Pietas (Aurelius Caes)	1	3	0	0	8	0	**12**
Qty	**50**	**81**	**39**	**61**	**170**	**99**	**500**

χ^2 standardised residuals

χ^2 = 16.516, df = 20, **p-value = 0.6841**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube
Felic *FELIC SAEC* (Ant)	-0.2333	-1.4999	-0.2369	1.4568	-0.1260	0.7731
Fortuna (Ant)	-0.4190	0.7580	0.3443	-1.4290	0.0253	0.4796
Pax (Ant)	0.4463	-0.4577	0.5468	0.0811	0.6857	-1.2364
Salus (Ant)	0.7311	1.2973	-0.1108	-0.5775	-1.2664	0.4342
Aurelius Caes	-0.6152	0.2330	-0.5099	0.0611	0.6350	-0.3327

3.4: Results of design-level χ^2 tests on *denarii* from hoards closing up to *c.* 250

Table 61: Reverse designs of 138, 138-139 and 139 from *denarii* in hoards closing up to *c.* 250 (n=1,214)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas	11	3	8	0	21	36	3	**82**
Bust of Aurelius	3	1	2	0	0	23	2	**31**
Hands on caduceus	8	6	13	5	19	85	9	**145**
Concordia	4	3	1	0	4	10	0	**22**
Diana	6	1	2	2	10	50	6	**77**
Eagle on globe	0	0	0	0	1	2	0	**3**
Felicitas	14	3	6	4	22	69	3	**121**
Fides	3	4	6	1	9	54	4	**81**
Fortuna	8	5	6	1	10	49	3	**82**
Libertas	4	1	1	2	9	31	2	**50**
Minerva	14	2	5	5	17	42	3	**88**
Modius	9	3	8	2	27	61	3	**113**
Pax	12	6	4	5	18	78	7	**130**
Priestly implements	14	5	4	4	19	73	0	**119**
Standards	0	0	1	0	0	3	0	**4**
Winged fulmen	0	0	0	0	1	0	0	**1**
Vesta	0	0	0	0	0	2	0	**2**
Victoria	3	3	2	2	13	21	2	**46**
Virtus		0	0	0	0	1	0	**1**
Wolf & twins	2	1	2	1	5	5	0	**16**
Qty	**115**	**47**	**71**	**34**	**205**	**695**	**47**	**1214**

χ^2 standardised residuals
$\chi^2 = 40.747$, df = 27, **p-value = 0.04355**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Aequitas	1.0230	-	1.3032	-	1.8522	-1.8307	-
Hands on caduceus	-1.4547	-	1.6166	-	-0.8565	0.5312	-
Diana	-0.4604	-	-1.1898	-	-0.7265	0.9609	-
Felicitas	0.6353	-	-0.5147	-	0.3247	-0.2671	-
Fides	-1.6849	-	0.5477	-	-1.1828	1.1445	-
Fortuna	0.0822	-	0.5137	-	-0.9528	0.3124	-
Minerva	1.9770	-	-0.0877	-	0.6778	-1.1406	-
Modius	-0.6513	-	0.3780	-	1.7202	-0.7799	-
Pax	0.0224	-	-1.2687	-	-0.5963	0.7198	-
Priestly implements	0.6693	-	-1.2309	-	-0.2980	0.2841	-

Table 62: Reverse designs of 139-141 (Faustina I Augusta) from *denarii* in hoards closing up to c. 250 (n=325)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Concordia	6	1	1	1	15	42	1	**67**
Juno	16	8	2	11	24	124	5	**190**
Throne	14	4	0	3	4	35	2	**62**
Vesta	2	2	0	0	0	0	2	**6**
Qty	**38**	**15**	**3**	**15**	**43**	**201**	**10**	**325**

Annexe 3: Antoninus Pius

Table 63: Reverse designs of 140-143 from *denarii* in hoards closing up to c. 250 (n=1,621)								
Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas	28	13	19	18	58	140	13	**289**
Ant in armour	1	2	0	1	2	11	0	**17**
Apollo	13	5	9	5	20	66	5	**123**
Hands on caduc	1	0	1	2	2	1	1	**8**
Clementia	26	10	15	6	37	121	12	**227**
Concordia	13	5	5	5	12	52	1	**93**
Genio Senatus	13	7	7	10	32	63	8	**140**
Gen Pop Rom	15	4	5	9	18	68	4	**123**
Italia	10	5	4	7	20	33	9	**88**
Modius	14	5	15	6	36	131	8	**215**
Moneta	4	1	2	3	4	14	0	**28**
Ops	0	1	1	0	1	4	1	**8**
Pax	9	3	4	4	15	28	3	**66**
Salus	1	0	1	2	1	8	0	**13**
Wolf & twins	1	3	0	1	4	12	5	**26**
Tranquillitas	2	2	0	3	6	13	0	**26**
Virtus/Roma	11	2	6	0	20	44	4	**87**
Winged fulmen	3	3	4	1	4	28	1	**44**
Qty	**165**	**71**	**98**	**83**	**292**	**837**	**75**	**1621**
χ^2 standardised residuals								
χ^2 = 25.992, df = 25, **p-value = 0.408**								
Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	
Aequitas	-0.0367	0.4798	0.2099	1.0788	0.8332	-1.0010	-	
Apollo	0.2724	0.0608	0.4524	-0.3977	-0.4727	0.1068	-	
Clementia	0.8613	0.3809	0.2383	-1.4797	-0.5502	0.2127	-	
Genio Senatus	-0.1319	0.6672	-0.5640	1.2843	1.4306	-1.1558	-	
Gen Pop Rom	0.8155	-0.4095	-1.0046	1.2133	-0.9329	0.2850	-	
Modius	-1.5540	-1.2103	0.3853	-1.3829	-0.4795	1.5653	-	

Table 64: Reverse designs of 140 and 140-144 (Aurelius Caesar) from *denarii* in hoards closing up to c. 250 (n=861)								
Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Bust of Aurelius	28	11	20	16	46	244	5	**370**
Priestly impl	21	11	23	19	30	155	10	**269**
Honos	6	0	3	3	11	40	4	**67**
Juventas	18	1	9	8	25	87	7	**155**
Qty	**73**	**23**	**55**	**46**	**112**	**526**	**26**	**861**
χ^2 standardised residuals								
χ^2 = 15.563, df = 10, **p-value = 0.1128**								
Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	
Bust of Aurelius	-0.6534	0.0381	-0.9248	-0.9604	-0.2536	0.9381	-	
Priestly impl	-0.3117	1.1821	1.3298	1.2042	-0.6674	-0.6304	-	
Juventas	1.4385	-1.6236	-0.3069	-0.0848	1.2811	-0.6393	-	

Table 65: Reverse designs of 141-161 (Diva Faustina I) from *denarii* in hoards closing up to c. 250 (n=9,198)								
Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aeternitas	15	7	11	13	43	137	13	**239**
Ant & Faustina	7	7	7	4	15	80	4	**124**

Annexe 3: Antoninus Pius

Table 65: Reverse designs of 141-161 (Diva Faustina I) from *denarii* in hoards closing up to c. 250 (n=9,198)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Carpentum	1	0	0	0	0	0	0	**1**
Ceres	273	125	164	154	661	1765	124	**3266**
Eagle	2	0	2	0	3	10	0	**17**
Fortuna	17	11	12	11	33	155	8	**247**
Temple of Faust	13	6	19	15	36	134	5	**228**
Juno	101	42	46	42	159	661	28	**1079**
Peacock	26	18	14	15	66	192	8	**339**
Pietas	87	50	45	29	156	509	38	**914**
Providentia	87	47	84	47	510	701	43	**1519**
Star	0	1	2	0	3	3	0	**9**
Throne	16	11	13	7	41	164	6	**258**
Venus	18	9	7	13	42	172	8	**269**
Vesta	61	36	46	24	110	395	17	**689**
Qty	**724**	**370**	**472**	**374**	**1878**	**5078**	**302**	**9198**

χ^2 standardised residuals
χ^2 = 285.59, df = 55, **p-value < 2.2e-16**

Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**
Aeternitas	-0.7868	-0.7836	-0.2680	1.1239	-0.6808	0.6983	-
Ant & Faustina	-0.8822	0.8984	0.2654	-0.4714	-2.0523	1.3854	-
Ceres	1.0995	-0.5007	-0.1396	1.8682	-0.0850	-0.6932	-
Fortuna	-0.5511	0.3350	-0.1722	0.2903	-2.4563	1.5843	-
Temple of Faust	-1.2045	-1.0762	2.1085	1.8249	-1.6134	0.5890	-
Juno	1.6833	-0.2612	-1.2702	-0.3485	-4.2189	2.4811	-
Peacock	-0.1751	1.1395	-0.8294	0.2789	-0.4624	0.2160	-
Pietas	1.8707	2.2450	-0.1802	-1.3064	-2.1253	0.3901	-
Providentia	-3.0117	-1.8388	0.6928	-1.9320	11.2437	-4.8885	-
Throne	-0.9912	0.1592	-0.0816	-1.1125	-1.6715	1.6743	-
Venus	-0.6986	-0.5642	-1.8249	0.6010	-1.7636	1.8794	-
Vesta	0.8619	1.5207	1.7700	-0.8149	-2.6735	0.5731	-

Table 66: Reverse designs of 143-144 and 144 from *denarii* in hoards closing up to c. 250 (n=526) **No χ^2 testing: sample sizes too small*								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Honos (Aurel Caes)	5	1	3	4	15	28	2	**58**
Pax	7	3	6	4	13	23	0	**56**
Victoria	30	12	16	18	58	172	8	**314**
Virtus/Roma	2	2	5	2	13	43	1	**68**
Winged caduceus	5	1	3	0	3	18	0	**30**
Qty	**49**	**19**	**33**	**28**	**102**	**284**	**11**	**526**

Table 67: Reverse designs of 145-147 and 146-147 (Aurelius Caesar) from *denarii* in hoards closing up to c. 250 (n=896)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Fides	0	0	0	0	1	5	0	**6**
Genius Exercitus	0	0	0	0	0	0	1	**1**
Honos	62	28	23	24	103	439	24	**703**
Spes	12	6	6	21	22	81	4	**152**
Virtus	5	2	3	1	9	14	0	**34**
Qty	**79**	**36**	**32**	**46**	**135**	**539**	**29**	**896**

Annexe 3: Antoninus Pius

Table 67: Reverse designs of 145-147 and 146-147 (Aurelius Caesar) from *denarii* in hoards closing up to c. 250 (n=896) χ^2 standardised residuals χ^2 = 27.559, df = 5, **p-value = 4.438e-05**							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**
Honos	0.1595	0.0160	-0.1660	-2.1300	0.0365	0.5836	-
Spes	-0.3416	-0.0343	0.3556	4.5622	-0.0782	-1.2501	-

Table 68: Reverse designs of 145-161 from *denarii* in hoards closing up to c. 250 (n=4,366)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Aequitas (Ant)	14	7	7	8	30	110	4	**180**
Annona (Ant)	1	0	0	0	1	3	0	**5**
VOT SVS DEC III (Ant)	8	0	4	0	5	33	1	**51**
Cong *LIB IIII* (Ant)	0	0	0	0	1	0	0	**1**
Hands on cornuc (Ant)	40	28	20	18	65	243	10	**424**
Concordia (Ant)	15	2	16	13	29	126	11	**212**
Felicitas (Ant)	0	1	0	0	0	0	0	**1**
Fortuna (Ant)	0	0	0	0	0	1	0	**1**
Temple Aug & Liv(Ant)	7	4	3	5	6	39	3	**67**
Genius (Ant)	0	0	0	1	0	0	0	**1**
Liberalitas *LIB IIII* (Ant)	40	32	20	26	78	287	10	**493**
Pax (Ant)	7	3	7	7	23	85	7	**139**
Pietas (Ant)	0	0	0	0	3	0	0	**3**
Virtus (Ant)	6	4	0	2	12	27	3	**54**
Winged fulmen (Ant)	33	14	26	17	66	235	13	**404**
Ceres (FII)	0	0	0	0	0	2	0	**2**
Concordia (FII)	72	43	54	29	253	427	14	**892**
Laetitia (FII)	3	4	4	1	14	34	3	**63**
Pudicitia (FII)	24	3	15	11	40	158	8	**259**
Spes (FII)	54	26	25	6	47	201	7	**366**
Throne (FII)	0	0	2	0	1	1	0	**4**
Venus (FII)	59	44	37	20	124	424	20	**728**
	4	0	2	1	4	5	0	**16**
Qty	**387**	**215**	**242**	**165**	**802**	**2441**	**114**	**4366**

χ^2 **standardised residuals** χ^2 = 149.24, df = 45, **p-value = 4.228e-13**							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**
Aequitas (Ant)	-0.4480	-0.6380	-0.9502	0.4469	-0.5683	0.8747	-
Hands on cornuc (Ant)	0.4731	1.5419	-0.7288	0.4813	-1.5009	0.3207	-
Concordia (Ant)	-0.7116	-2.5616	1.3529	1.8608	-1.4607	0.9696	-
Liberalitas *LIB IIII* (Ant)	-0.5021	1.5306	-1.4233	1.6746	-1.3945	0.5564	-
Pax (Ant)	-1.4054	-1.4232	-0.1840	0.8288	-0.3921	1.0444	-
Winged fulmen (Ant)	-0.3472	-1.2996	0.8000	0.4677	-0.9223	0.6784	-
Concordia (FII)	-0.7573	-0.2126	0.5784	-0.8705	6.7512	-3.4650	-
Pudicitia (FII)	0.3154	-2.7215	0.1935	0.4026	-1.0828	1.1382	-
Spes (FII)	3.8449	1.8394	1.0162	-2.1258	-2.5343	-0.3777	-
Venus (FII)	-0.5619	1.3674	-0.5122	-1.4274	-0.8530	0.8374	-

Annexe 3: Antoninus Pius

Table 69: Reverse designs of 147-148 from *denarii* in hoards closing up to c. 250 (n=613)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Aequitas (Ant)	3	0	0	0	1	5	0	**9**
Annona (Ant)	20	10	15	7	39	100	7	**198**
Ant sacrificing (Ant)	3	4	3	2	14	28	0	**54**
Genius (Ant)	1	0	1	0	1	5	0	**8**
PRIMI DECENN (Ant)	1	2	0	0	1	16	0	**20**
Pax (Ant)	0	0	0	2	0	1	0	**3**
Salus (Ant)	6	4	6	4	20	85	9	**134**
Fides (Aurel Caes)	0	2	1	0	5	11	1	**20**
Minerva (Aurel Caes)	17	12	7	6	23	93	5	**163**
Vesta (Aurel Caes)	0	0	0	1	0	3	0	**4**
Qty	**51**	**34**	**33**	**22**	**104**	**347**	**22**	**613**

χ^2 standardised residuals
χ^2 = 12.722, df = 10, **p-value = 0.2396**

Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**
Annona (Ant)	0.8548	-0.2319	1.1548	0.0314	0.9625	-1.1533	-
Salus(Ant)	-1.4641	-1.1464	-0.4790	-0.2478	-0.4022	1.3489	-
Aurelius Caes	0.3386	1.1909	-0.7882	0.1737	-0.6545	0.0638	-

Table 70: Reverse designs of 148-149 from *denarii* in hoards closing up to c. 250 (n=1,831)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Aequitas (Ant)	27	12	15	22	44	130	5	**255**
Annona (Ant)	34	21	16	18	70	232	13	**404**
Ant sacrificing (Ant)	6	3	7	4	21	46	1	**88**
Bon Event (Ant)	9	5	6	1	18	70	3	**112**
Felicitas (Ant)	6	3	6	2	13	50	5	**85**
Fortuna (Ant)	13	8	7	6	31	73	7	**145**
Salus (Ant)	25	14	12	21	78	198	10	**358**
Clement (Aurel Caes)	4	4	2	3	16	41	3	**73**
Minerva (Aurel Caes)	12	12	12	10	36	102	8	**192**
Provid (Aurel Caes)	6	5	6	0	23	68	5	**113**
"Woman" (Aur Caes)	0	0	0	0	1	5	0	**6**
Qty	**142**	**87**	**89**	**87**	**351**	**1015**	**60**	**1831**

χ^2 standardised residuals
χ^2 = 29.482, df = 25, **p-value = 0.2443**

Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**
Aequitas (Ant)	1.4969	-0.1758	0.9166	2.6386	-0.7693	-1.1059	-
Annona (Ant)	0.4104	0.2824	-0.5869	-0.3927	-0.8274	0.5331	-
Bon Event (Ant)	0.0558	-0.2150	0.3676	-1.9199	-0.7631	0.9553	-
Fortuna (Ant)	0.5428	0.3906	0.1804	-0.3670	0.7136	-0.6822	-
Salus (Ant)	-0.6034	-0.8525	-1.1054	0.8174	1.1123	-0.0980	-
Aurelius Caes	-1.4329	0.5606	0.6139	-1.2952	0.3837	0.3552	-

Table 71: Reverse designs of 149-150 and 150-151 from *denarii* in hoards closing up to c. 250 (n=689)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Ant & Faustina II	0	0	1	0	0	0	0	**1**
Bonus Eventus	3	5	2	2	12	41	2	**67**
Felicitas	3	2	2	3	7	31	3	**51**
Fortuna	5	9	1	4	24	65	2	**110**

Annexe 3: Antoninus Pius

Table 71: Reverse designs of 149-150 and 150-151 from *denarii* in hoards closing up to c. 250 (n=689)

Genius	2	2	1	5	5	37	3	**55**
Pax	5	6	10	13	23	85	6	**148**
Pietas	5	6	6	5	15	38	4	**79**
Tranquillitas	10	10	7	3	21	105	7	**163**
Vesta	0	0	1	0	3	11	0	**15**
Qty	**33**	**40**	**31**	**35**	**110**	**413**	**27**	**689**

χ^2 standardised residuals

$\chi^2 = 20.291$, df = 10, **p-value = 0.02661**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Fortuna	-0.1388	0.9112	-1.7312	-0.5724	1.3899	-0.3439	-
Pax	-0.7543	-0.9279	1.4764	2.2704	-0.1606	-0.4434	-
Tranquillitas	0.8352	0.1272	0.0318	-1.6899	-1.0032	0.7092	-

Table 72: Reverse designs of 151-152 from *denarii* in hoards closing up to c. 250 (n=978)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Annona (Ant)	3	7	10	7	19	142	9	**197**
Cong *LIB VII* (Ant)	0	0	0	0	0	3	0	**3**
Fortuna (Ant)	8	6	7	6	21	70	4	**122**
Pax (Ant)	7	1	5	3	13	86	6	**121**
Pietas (Ant)	2	3	0	2	11	29	0	**47**
Roma/Virt (Ant)	1	0	0	0	0	0	0	**1**
Tranquillitas (Ant)	8	3	8	8	26	68	2	**123**
Vesta (Ant)	14	13	6	5	27	126	7	**198**
Clementia (Aurel Caes)	3	3	5	6	8	25	4	**54**
Gen Exerc (Aurel Caes)	11	5	6	7	19	60	1	**109**
Roma/Virt (Aurel Caes)	0	0	0	0	0	1	0	**1**
Virtus (Aurel Caes)	0	0	1	0	0	1	0	**2**
Qty	**57**	**41**	**48**	**44**	**144**	**611**	**33**	**978**

χ^2 standardised residuals

$\chi^2 = 41.351$, df = 25, **p-value = 0.02108**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Annona (Ant)	-2.4804	-0.2852	0.1363	-0.3598	-1.6760	1.6741	-
Fortuna (Ant)	0.3257	0.5003	0.4030	0.4309	0.8429	-0.8471	-
Pax (Ant)	0.0193	-1.7259	-0.3549	-0.8602	-0.9770	1.2102	-
Tranquillitas (Ant)	0.2546	-0.9008	0.7392	1.2496	1.9085	-1.2819	-
Vesta (Ant)	0.7237	1.8048	-1.1961	-1.1025	-0.2422	0.0561	-
Aurelius Caes	1.6575	0.1850	0.5655	1.0411	0.6315	-1.2723	-

Table 73: Reverse designs of 152-153 from *denarii* in hoards closing up to c. 250 (n=374)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Annona (Ant)	22	11	10	11	95	193	9	**351**
Fortuna (Ant)	20	9	10	8	39	97	4	**187**
Liberal *LIB VII* (Ant)	3	0	1	5	11	12	1	**33**
Salus (Ant)	1	0	0	0	0	0	0	**1**
Shrine (Ant)	0	0	0	0	0	1	0	**1**
Vesta (Ant)	40	15	13	11	86	202	7	**374**
Gen Exerc (Aurel Caes)	15	7	9	12	33	92	5	**173**
Qty	**101**	**42**	**43**	**47**	**264**	**597**	**26**	**1120**

χ^2 standardised residuals

Annexe 3: Antoninus Pius

Table 73: Reverse designs of 152-153 from *denarii* in hoards closing up to c. 250 (n=374)

χ^2 = 18.47, df = 15, **p-value = 0.2388**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Annona (Ant)	-1.6617	-0.6930	-0.9646	-0.6930	1.4800	0.3335	-
Fortuna (Ant)	0.7951	0.6495	1.0209	0.2782	-0.7079	-0.3807	-
Vesta (Ant)	1.1071	0.1202	-0.4042	-0.9287	-0.1705	-0.0138	-
Gen Exerc (Aurel Caes)	-0.0953	0.1331	0.9083	2.0711	-1.1209	-0.0581	-

Table 74: Reverse designs of 153-154 from *denarii* in hoards closing up to c. 250 (n=1,166)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Annona (Ant)	6	11	8	12	131	173	10	**351**
Cong *LIB VII* (Ant)	0	1	1	2	3	10	0	**17**
Fortuna (Ant)	12	2	9	3	81	104	4	**215**
Liberal *LIB VII* (Ant)	10	6	4	1	20	39	1	**81**
Vesta (Ant)	9	17	10	8	103	154	6	**307**
Gen Exerc (Aurel Caes)	6	6	5	2	22	49	2	**92**
Minerva (Aurel Caes)	4	7	1	5	44	35	2	**98**
Virtus (Aurel Caes)	0	1	0	0	3	1	0	**5**
Qty	**47**	**51**	**38**	**33**	**407**	**565**	**25**	**1166**

χ^2 standardised residuals

χ^2 = 25.858, df = 15, **p-value = 0.03955**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Annona (Ant)	-1.7505	-0.8894	-0.8464	0.7032	0.4978	0.3435	-
Fortuna (Ant)	1.6536	-2.3114	0.9024	-1.2440	0.3849	-0.0281	-
Vesta (Ant)	-0.5106	1.2113	0.1574	-0.2208	-0.7330	0.4288	-
Gen Exerc (Aurel Caes)	1.2418	2.0972	-0.0152	0.6452	-0.1495	-0.9677	-

Table 75: Reverse designs of 154-155 from *denarii* in hoards closing up to c. 250 (n=1,137)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Annona (Ant)	10	7	9	6	175	120	6	**333**
Felicitas (Ant)	1	0	1	0	0	0	0	**2**
Fortuna (Ant)	5	10	5	5	81	75	2	**183**
Vesta (Ant)	6	8	10	9	170	179	2	**384**
Minerva (Aurel Caes)	9	5	7	7	133	73	1	**235**
Qty	**31**	**30**	**32**	**27**	**559**	**447**	**11**	**1137**

χ^2 standardised residuals

χ^2 = 19.135, df = 10, **p-value = 0.03858**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Annona (Ant)	0.4520	0.0246	-0.0053	-0.5897	0.7182	-0.7921	-
Vesta (Ant)	-1.2969	-0.0358	-0.1640	0.0295	-1.6984	2.3059	-
Minerva (Aurel Caes)	1.1227	0.0167	0.2158	0.6595	1.3210	-2.0098	-

Table 76: Reverse designs of 155-156 from *denarii* in hoards closing up to c. 250 (n=1,115)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Annona (Ant)	29	11	17	6	70	171	7	**311**
Ceres (Ant)	7	4	3	2	11	40	0	**67**
Fortuna (Ant)	14	4	6	3	33	55	4	**119**
Pax (Ant)	20	10	13	8	40	104	7	**202**
Pietas (Ant)	6	1	1	0	4	33	1	**46**

Annexe 3: Antoninus Pius

Table 76: Reverse designs of 155-156 from *denarii* in hoards closing up to c. 250 (n=1,115)								
Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Salus (Ant)	9	5	7	1	24	52	0	**98**
Vesta (Ant)	0	0	0	0	5	2	0	**7**
Aeq (Aurel Caes)	11	5	8	10	22	70	1	**127**
Gen *P R* (Aurel Caes)	3	3	2	1	4	25	0	**38**
Provid (Aurel Caes)	2	0	0	2	2	11	0	**17**
Virtus (Aurel Caes)	6	9	6	1	19	40	2	**83**
Qty	**107**	**52**	**63**	**34**	**234**	**603**	**22**	**1115**

χ^2 standardised residuals χ^2 = 17.993, df = 20, **p-value = 0.5879**							
Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Annona (Ant)	-0.0626	-0.9581	-0.3297	-1.2618	0.3925	0.4832	-
Fortuna (Ant)	0.8709	-0.6577	-0.3660	-0.4004	1.5384	-0.9297	-
Pax (Ant)	0.2722	0.1925	0.3456	0.6295	-0.4345	-0.1662	-
Salus (Ant)	-0.1489	0.1246	0.4366	-1.2371	0.5319	-0.1544	-
Aurelius Caes	-0.6534	1.2255	0.0325	1.8379	-1.3924	0.3332	-

Table 77: reverse designs of 156-157 from *denarii* in hoards closing up to c. 250 (n=1,160)								
Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Annona (Ant)	40	15	22	5	78	215	5	**380**
Ceres (Ant)	8	6	3	3	18	59	3	**100**
Felicitas (Ant)	0	0	0	0	4	5	1	**10**
Fort Obseq (Ant)	3	0	0	0	1	2	0	**6**
Jupiter (Ant)	0	0	0	1	1	0	0	**2**
Salus (Ant)	14	10	11	7	46	140	7	**235**
Securit (Ant)	3	0	1	1	4	10	1	**20**
Victoria (Ant)	0	0	0	0	1	0	0	**1**
Felicit (Aurel Caes)	14	16	10	4	19	86	5	**154**
Securit (Aurel Caes)	1	0	0	0	5	1	1	**8**
Virtus (Aurel Caes)	25	17	11	14	57	113	7	**244**
Qty	**108**	**64**	**58**	**35**	**234**	**631**	**30**	**1160**

χ^2 standardised residuals χ^2 = 36.238, df = 20, **p-value = 0.01442**							
Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Annona (Ant)	0.8677	-1.5102	0.5224	-1.8945	0.3139	0.2288	-
Ceres (Ant)	-0.3400	0.1186	-0.9268	0.0306	-0.3335	0.5741	-
Salus (Ant)	-1.5645	-0.9375	-0.2795	0.0273	0.0343	0.9964	-
Felicit (Aurel Caes)	0.0383	2.4362	0.7794	-0.2480	-1.9948	0.2067	-
Virtus (Aurel Caes)	0.6302	0.8116	-0.4081	2.5333	1.3665	-1.7963	-

Table 78: Reverse designs of 157-158 from *denarii* in hoards closing up to c. 250 (n=853)								
Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas (Ant)	2	1	3	1	11	13	0	**31**
Annona (Ant)	54	24	30	11	80	230	5	**434**
Ant sacrif *VOTA* (Ant)	0	2	3	1	3	6	0	**15**
Felicitas (Ant)	4	0	0	0	0	0	0	**4**
Fortuna (Ant)	6	1	0	0	9	8	0	**24**
Shrine (Ant)	0	0	0	0	0	0	1	**1**
Genius (Ant)	0	0	0	2	2	3	0	**7**

Table 78: Reverse designs of 157-158 from *denarii* in hoards closing up to c. 250 (n=853)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Liberal *LIB VIII* (Ant)	3	0	1	0	6	15	0	**25**
Temp Aug & Livia (Ant)	3	0	1	1	5	8	3	**21**
Roma (Ant)	2	0	1	0	5	6	0	**14**
Felicitas (Aurel Caes)	29	12	14	11	42	132	5	**245**
Spes (Aurel Caes)	3	4	2	1	7	14	1	**32**
Qty	**106**	**44**	**55**	**28**	**170**	**435**	**15**	**853**

χ^2 standardised residuals
$\chi^2 = 2.1969$, df = 5, **p-value = 0.8213**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Annona (Ant)	0.1783	-0.1039	0.3406	-0.8246	0.1059	-0.0286	-
Aurelius Caes	-0.2243	0.1307	-0.4286	1.0374	-0.1332	0.0360	-

Table 79: Reverse designs of 158-159 from *denarii* in hoards closing up to c. 250 (n=739)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
VOT SOL/SVS DEC II/III	22	17	18	6	60	90	**16**	**229**
Felicitas (Ant)	0	0	1	0	0	0	0	**1**
Fort Obseq (Ant)	15	4	10	4	12	56	2	**103**
Temple Aug & Liv(Ant)	9	13	9	5	40	105	6	**187**
Salus (Ant)	2	2	0	1	3	1	2	**11**
Shrine (Ant)	4	0	3	2	0	20	0	**29**
Spes (Aurel Caes)	11	4	3	6	19	39	0	**82**
Virtus (Aurel Caes)	6	6	2	9	23	50	1	**97**
Qty	**69**	**46**	**46**	**33**	**157**	**361**	**27**	**739**

χ^2 standardised residuals
$\chi^2 = 39.126$, df = 15, **p-value = 0.0006137**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
VOT SOL/SVS DEC II/III	0.4615	0.8238	1.2911	-1.1342	1.6129	-1.6974	-
Fort Obseq (Ant)	1.8034	-1.0131	1.4725	-0.2367	-2.3113	0.6964	-
Temple Aug & Liv(Ant)	-1.9298	0.3391	-0.6831	-1.0802	-0.2203	1.4179	-
Aurelius Caes	0.0826	-0.4800	-1.8328	2.5083	0.1988	-0.0976	-

Table 80: Reverse designs of 159-160 and 160-161 from *denarii* in hoards closing up to c. 250 (n=1,425)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
VOT SVS DEC III (Ant)	3	0	0	3	2	79	0	**87**
Felic *FELIC SAEC* (Ant)	16	11	14	21	46	179	6	**293**
Fort (Ant)	10	12	10	4	31	78	6	**151**
Liberal *LIB VIIII* (Ant)	1	1	2	6	5	22	2	**39**
Temple Aug & Liv(Ant)	0	0	1	0	3	17	0	**21**
Pax (Ant)	19	15	13	13	53	109	5	**227**
Pietas (Ant)	3	4	3	0	7	36	1	**54**
Roma (Ant)	6	4	6	2	25	57	1	**101**
Salus (Ant)	15	19	12	9	32	117	7	**211**
Shrine (Ant)	0	0	0	1	0	1	0	**2**
Mars (Aurel Caes)	7	5	3	5	19	51	3	**93**
Minerva (Aurel Caes)	7	7	6	5	14	65	2	**106**
Pietas (Aurel Caes)	1	3	1	0	9	26	0	**40**
Qty	**88**	**81**	**71**	**69**	**246**	**837**	**33**	**1425**

χ^2 standardised residuals

Table 80: Reverse designs of 159-160 and 160-161 from *denarii* in hoards closing up to c. 250 (n=1,425)
χ^2 = 71.707, df = 30, **p-value = 2.857e-05**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
VOT SVS DEC III (Ant)	-1.1353	-2.2737	-2.1027	-0.5928	-3.4594	3.7854	-
Felic *FELIC SAEC* (Ant)	-0.6562	-1.4660	-0.1533	1.9002	-0.8105	0.6303	-
Fortuna (Ant)	0.1546	1.1528	0.9692	-1.1425	0.9402	-0.8908	-
Pax (Ant)	1.1575	0.4979	0.5114	0.6824	2.0380	-2.0090	-
Roma (Ant)	-0.2215	-0.7967	0.4072	-1.2933	1.6328	-0.3241	-
Salus (Ant)	0.4377	1.9755	0.5070	-0.2827	-0.7981	-0.3975	-
Aurelius Caes	-0.0939	0.2938	-0.5487	-0.3988	-0.0404	0.2348	-

Annexe 4: Marcus Aurelius and Lucius Verus

4.1: Results of design-level χ^2 tests on *denarii* from hoards closing up to 180

Table 1: Reverse designs of 161 and 161-162 from *denarii* in hoards closing up to 180 (n=816)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Concordia (MA)	9	0	5	49	45	18	0	**126**
Felicitas (MA)	0	0	1	2	0	0	0	**3**
Togate emperor (MA)	0	0	1	0	0	0	0	**1**
Providentia (MA)	6	0	7	56	54	21	0	**144**
Clasped hands (LV)	0	0	0	1	0	0	0	**1**
Concordia (LV)	0	0	0	3	0	0	0	**3**
Providentia (LV)	8	0	3	47	70	19	0	**147**
Divus Pius	26	0	20	103	178	64	0	**391**
Qty	**49**	**0**	**37**	**261**	**347**	**122**	**0**	**816**

χ^2 standardised residuals
$\chi^2 = 24.75$, df = 12, **p-value = 0.01605**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Concordia (MA)	0.4916	-	-0.1960	1.4645	-1.2386	-0.2349	-
Providentia (MA)	-0.9247	-	0.3053	1.5656	-0.9972	-0.1593	-
Providentia (LV)	-0.3063	-	-1.3345	0.0892	0.8647	-0.6783	-
Divus Pius	0.4699	-	0.7443	-1.8362	0.7781	0.6459	-

Table 2: Reverse designs of 161-164 (Lucilla) from *denarii* in hoards closing up to 180 (n=99)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Concordia	1	0	3	17	7	7	0	**35**
Diana	3	0	0	0	3	0	0	**6**
Juno	0	0	1	0	0	0	0	**1**
VOTA PVBLICA	2	0	0	8	2	5	0	**17**
Pietas	1	0	0	4	4	5	0	**14**
Venus	4	0	1	6	6	0	0	**17**
Vesta	2	0	1	1	1	4	0	**9**
Qty	**13**	**0**	**6**	**36**	**23**	**21**	**0**	**99**

Table 3: Reverse designs of 161-175 (Faustina II) from *denarii* in hoards closing up to 180 (n=588)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Ceres	4	0	1	0	5	1	0	**11**
Concordia	0	0	1	0	0	0	0	**1**
Cybele	1	0	1		0	1	0	**3**
Diana	1	0	3	7	14	6	0	**31**
Faustina and children	3	0	0	1	0	0	0	**4**
Fecunditas	5	0	5	52	80	30	0	**172**
Fortuna	0	0	0	0	1	0	0	**1**
Hilaritas	5	0	0	2	5	6	0	**18**
Juno	11	0	7	30	57	20	0	**125**
Laetitia	2	0	0	2	4	8	0	**16**
Pudicitia	0	0	0	0	1	1	0	**2**
Infants Comm & Ant	8	0	6	21	60	12	0	**107**

Table 3: Reverse designs of 161-175 (Faustina II) from *denarii* in hoards closing up to 180 (n=588)

Salus	3	0	1	1	49	10	0	**64**
Venus	1	0	0	8	19	4	0	**32**
Vesta	1	0	0	0	0	0	0	**1**
Qty	**45**	**0**	**25**	**124**	**295**	**99**	**0**	**588**

χ^2 standardised residuals

$\chi^2 = 32.712$, df = 12, **p-value = 0.001074**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Fecunditas	-1.6323	-	-0.9621	1.2305	-0.4227	0.7015	-
Juno	1.3116	-	0.6062	-0.3310	-0.5063	0.1865	-
Infants Comm & Ant	0.6519	-	0.5646	-1.2023	1.0832	-1.0909	-

Table 4: Reverse designs of 162-163 from *denarii* in hoards closing up to 180 (n=236)

***No χ^2 testing: sample sizes too small**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Concordia (MA)	0	0	2	22	56	13	0	**93**
Providentia (MA)	4	0	2	23	54	15	0	**98**
Providentia (LV)	2	0	0	11	25	7	0	**45**
Qty	**6**	**0**	**4**	**56**	**135**	**35**	**0**	**236**

Table 5: Reverse designs of 163 and 163-164 from *denarii* in hoards closing up to 180 (n=300)

***No χ^2 testing: sample sizes too small**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Armenia (MA)	1	0	2	23	19	13	0	**58**
Concordia (MA)	1	0	0	3	6	0	0	**10**
Felicitas (MA)	1	0	2	5	23	1	0	**32**
Mars (MA)	3	0	3	26	22	12	0	**66**
Minerva (MA)	3	0	2	3	11	2	0	**21**
Armenia (LV)	1	0	0	4	13	1	0	**19**
Mars (LV)	1	0	6	24	49	10	0	**90**
Victoria (LV)	0	0	0	0	4	0	0	**4**
Qty	**11**	**0**	**15**	**88**	**147**	**39**	**0**	**300**

Table 6: Reverse designs of 164-165 from *denarii* in hoards closing up to 180 (n=91)

***No χ^2 testing: sample sizes too small**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Annona (MA)	1	0	3	4	4	9	0	**21**
Armenia (MA)	0	0	0	5	5	2	0	**12**
Felicitas (MA)	1	0	1	2	1	6	0	**11**
Mars (MA)	0	0	0	4	4	5	0	**13**
Mars (LV)	1	0	0	8	2	3	0	**14**
Roma (LV)	0	0	0	4	7	9	0	**20**
Qty	**3**	**0**	**4**	**27**	**23**	**34**	**0**	**91**

Table 7: Reverse designs of 164-180 (Lucilla) from *denarii* in hoards closing up to 180 (n=23)

***No χ^2 testing: sample sizes too small**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Concordia	1	0	0	0	1	0	0	**2**
Fecunditas	0	0	0	0	0	1	0	**1**
Juno	0	0	1	0	3	4	0	**8**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 7: Reverse designs of 164-180 (Lucilla) from *denarii* in hoards closing up to 180 (n=23)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Pudicitia	0	0	0	0	3	1	0	**4**
Venus	0	0	3	0	1	4	0	**8**
Qty	**1**	**0**	**4**	**0**	**8**	**10**	**0**	**23**

Table 8: Reverse designs of 165 and 165-166 from *denarii* in hoards closing up to 180 (n=107)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Annona (MA)	1	0	0	0	5	0	0	**6**
LIB AVG III (MA)	0	0	0	0	2	0	0	**2**
Pax (MA)	1	0	0	2	11	2	0	**16**
Pietas (MA)	0	0	1	14	14	6	0	**35**
Roma (MA)	2	0	0	2	3	1	0	**8**
Victoria (MA)	0	0	0	2	2	0	0	**4**
Parthian (LV)	1	0	4	1	4	3	0	**13**
Pax (LV)	1	0	0	2	9	2	0	**14**
Pietas (LV)	0	0	0	0	1	1	0	**2**
Victoria (LV)	0	0	0	4	3	0	0	**7**
Qty	**6**	**0**	**5**	**27**	**54**	**15**	**0**	**107**

Table 9: Reverse designs of 166 and 166-167 from *denarii* in hoards closing up to 180 (n=225)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas (MA)	1	0	1	9	8	11	0	**30**
Pax (MA)	4	0	2	18	13	13	0	**50**
Providentia (MA)	0	0	0	9	9	6	0	**24**
Victoria (MA)	3	0	8	12	17	7	0	**47**
Aequitas (LV)	1	0	0	9	5	1	0	**16**
Pax (LV)	4	0	3	18	13	7	0	**45**
Victoria (LV)	0	0	0	8	4	1	0	**13**
Qty	**13**	**0**	**14**	**83**	**69**	**46**	**0**	**225**

Table 10: Reverse designs of 167-168 from *denarii* in hoards closing up to 180 (n=23)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas (MA)	2	0	0	1	4	1	0	**8**
Providentia (MA)	0	0	1	1	6	1	0	**9**
Aequitas (LV)	0	0	0	2	3	0	0	**5**
Victoria (LV)	0	0	0	0	0	1	0	**1**
Qty	**2**	**0**	**1**	**4**	**13**	**3**	**0**	**23**

Table 11: Reverse designs of 168 and 168-169 from *denarii* in hoards closing up to 180 (n=77)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas (MA)	6	0	1	5	8	4	0	**24**
Felicitas (MA)	0	0	0	0	1	0	0	**1**
Fortuna (MA)	2	0	0	12	3	3	0	**20**
LIB AVG V (MA)	2	0	0	1	0	1	0	**4**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 11: Reverse designs of 168 and 168-169 from *denarii* in hoards closing up to 180 (n=77)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Providentia (MA)	0	0	0	0	1	0	0	**1**
Salus (MA)	4	0	0	1	3	3	0	**11**
Aequitas (LV)	0	0	0	4	8	4	0	**16**
Qty	**14**	**0**	**1**	**23**	**24**	**15**	**0**	**77**

Table 12: Reverse designs of 169 (Divus Verus) and 169-170 from *denarii* in hoards closing up to 180 (n=26)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Diana	1	0	0	0	2	0	0	**3**
Felicitas	0	0	0	0	2	0	0	**2**
Fortuna	1	0	0	0	1	2	0	**4**
LIB AVG V	1	0	0	0	0	2	0	**3**
Minerva	1	0	0	0	0	0	0	**1**
Salus	2	0	0	1	4	1	0	**8**
Victoria	2	0	0	0	1	1	0	**4**
Divus Verus	0	0	0	0	0	1	0	**1**
Qty	**8**	**0**	**0**	**1**	**10**	**7**	**0**	**26**

Table 13: Reverse designs of 170-171 from *denarii* in hoards closing up to 180 (n=15)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Jupiter	0	0	0	0	3	0	0	**3**
PRIM DEC COS III	1	0	0	0	0	0	0	**1**
Aurelius sacrificing	0	0	0	0	1	3	0	**4**
Mars	0	0	0	0	1	1	0	**2**
Roma	1	0	0	0	2	0	0	**3**
Salus	1	0	0	0	0	0	0	**1**
Victoria	0	0	0	0	0	1	0	**1**
Qty	**3**	**0**	**0**	**0**	**7**	**5**	**0**	**15**

Table 14: Reverse designs of 171-172 from *denarii* in hoards closing up to 180 (n=13)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas	1	0	0	0	1	3	0	**5**
Aurelius sacrificing	0	0	0	0	1	0	0	**1**
Mars	2	0	0	0	2	0	0	**4**
Roma	0	0	0	0	1	2	0	**3**
Qty	**3**	**0**	**0**	**0**	**5**	**5**	**0**	**13**

Table 15: Reverse designs of 172-173 from *denarii* in hoards closing up to 180 (n=13)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
German captive	1	0	0	0	2	0	0	**3**
Aurelius sacrificing	0	0	0	0	0	1	0	**1**
Mars	0	0	0	0	0	1	0	**1**
Mercury	1	0	0	0	1	0	0	**2**
Roma	0	0	0	0	1	0	0	**1**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 15: Reverse designs of 172-173 from *denarii* in hoards closing up to 180 (n=13)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Victoria	1	0	0	0	2	2	0	**5**
Qty	**3**	**0**	**0**	**0**	**6**	**4**	**0**	**13**

Table 16: Reverse designs of 173-174 from *denarii* in hoards closing up to 180 (n=7)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
German captive	0	0	0	0	0	1	0	**1**
Aurelius sacrificing	0	0	0	0	0	1	0	**1**
Mercury	0	0	0	0	0	2	0	**2**
Victoria	0	0	0	0	2	1	0	**3**
Qty	**0**	**0**	**0**	**0**	**2**	**5**	**0**	**7**

Table 17: Reverse designs of 174 and 174-175 from *denarii* in hoards closing up to 180 (n=8)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Felicitas	0	0	0	0	1	0	0	**1**
Genius	0	0	0	0	0	1	0	**1**
Mars	0	0	0	0	1	1	0	**2**
Victoria	2	0	0	0	1	1	0	**4**
Qty	**2**	**0**	**0**	**0**	**3**	**3**	**0**	**8**

Table 18: Reverse designs of 175 and 175-176 from *denarii* in hoards closing up to 180 (n=25)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas (MA)	0	0	0	0	0	3	0	**3**
Felicitas (MA)	0	0	0	0	1	2	0	**3**
Fortuna (MA)	0	0	0	0	1	0	0	**1**
Mars (MA)	0	0	0	0	2	0	0	**2**
Roma (MA)	2	0	0	0	1	3	0	**6**
Securitas (MA)	1	0	0	0	0	1	0	**2**
Victoria (MA)	0	0	0	0	1	1	0	**2**
Commodus Caes	3	0	0	0	0	3	0	**6**
Qty	**6**	**0**	**0**	**0**	**6**	**13**	**0**	**25**

Table 19: Reverse designs of 176 and 176-177 from *denarii* in hoards closing up to 180 (n=12)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Felicitas (MA)	1	0	0	0	0	1	0	**2**
Hilaritas (MA)	1	0	0	0	0	0	0	**1**
Jupiter (MA)	1	0	0	0	0	1	0	**2**
Aurelius std (MA)	0	0	1	0	0	0	0	**1**
Pile of arms (MA)	0	0	0	0	0	1	0	**1**
Salus (MA)	0	0	0	0	0	2	0	**2**
Victoria (MA)	2	0	0	0	0	0	0	**2**
Commodus Caes	0	0	0	0	1	0	0	**1**
Qty	**5**	**0**	**1**	**0**	**1**	**5**	**0**	**12**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 20: Reverse designs of 176-180 from *denarii* in hoards closing up to 180 (n=15)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Mars (MA)	0	0	0	0	0	2	0	**2**
Minerva (MA)	1	0	0	0	0	0	0	**1**
Roma (MA)	0	0	0	0	0	1	0	**1**
Aeternitas (DivFII)	0	0	0	0	0	1	0	**1**
Funeral pyre (DivFII)	0	0	0	0	0	1	0	**1**
Peacock (DivFII)	1	0	2	0	1	2	0	**6**
Altar (DivFII)	0	0	0	0	0	2	0	**2**
Throne (DivFII)	0	0	0	0	0	1	0	**1**
Qty	**2**	**0**	**2**	**0**	**1**	**10**	**0**	**15**

Table 21: Reverse designs of 177 and 177-178 from *denarii* in hoards closing up to 180 (n=6)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Commodus Aug	3	0	0	0	0	3	0	**6**
Qty	**3**	**0**	**0**	**0**	**0**	**3**	**0**	**6**

Table 22: Reverse designs of 178-179 and 179-180 from *denarii* in hoards closing up to 180 (n=5)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Fortuna (MA)	1	0	0	0	0	1	0	**2**
Salus (MA)	0	0	0	0	0	2	0	**2**
Victoria (MA)	0	0	0	0	0	1	0	**1**
Qty	**1**	**0**	**0**	**0**	**0**	**4**	**0**	**5**

4.2: Results of design-level χ^2 tests on *denarii* from hoards closing up to 192

Table 23: Reverse designs of 161 and 161-162 from *denarii* in hoards closing up to 192 (n=1,088)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Concordia (MA)	13	0	7	50	57	35	0	**162**
Felicitas (MA)	0	0	1	2	0	0	0	**3**
Togate emperor (MA)	0	0	1	0	0	0	0	**1**
Providentia (MA)	12	0	10	57	75	26	0	**180**
Clasped hands (LV)	0	0	0	1	0	0	0	**1**
Concordia (LV)	0	0	1	3	1	0	0	**5**
Providentia (LV)	17	0	5	49	83	34	0	**188**
Divus Pius	43	0	27	106	274	98	0	**548**
Qty	**85**	**0**	**52**	**268**	**490**	**193**	**0**	**1088**

χ^2 standardised residuals
χ^2 = 24.75, df = 12, **p-value = 0.01605**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Concordia (MA)	0.0633	-	-0.1340	1.6936	-1.9232	1.1134	-
Providentia (MA)	-0.5821	-	0.6356	2.0036	-0.7361	-1.0968	-
Providentia (LV)	0.5652	-	-1.2128	0.4894	-0.2469	0.0588	-
Divus Pius	-0.0319	-	0.4189	-2.3558	1.6121	-0.0112	-

Table 24: Reverse designs of 161-164 (Lucilla) from *denarii* in hoards closing up to 192 (n=159) **No χ^2 testing: sample sizes too small*								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Concordia	3	0	3	18	18	10	0	**52**
Diana	4	0	0	1	4	2	0	**11**
Juno	1	0	1	0	1	0	0	**3**
VOTA PVBLICA	3	0	0	8	4	7	0	**22**
Pietas	1	0	0	4	8	6	0	**19**
Venus	8	0	1	6	11	1	0	**27**
Vesta	7	0	3	1	4	10	0	**25**
Qty	**27**	**0**	**8**	**38**	**50**	**36**	**0**	**159**

Table 25: Reverse designs of 161-175 (Faustina II) from *denarii* in hoards closing up to 192 (n=906)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Ceres	7	0	1	3	7	6	0	**24**
Concordia	0	0	1	0	0	0	0	**1**
Cybele	4	0	1	0	0	2	0	**7**
Diana	4	0	4	7	17	6	0	**38**
Faustina and children	3	0	0	1	1	1	0	**6**
Fecunditas	13	0	5	56	143	43	0	**260**
Fortuna	2	0	0	0	2	0	0	**4**
Hilaritas	15	0	1	4	9	9	0	**38**
Juno	19	0	11	30	136	42	0	**238**
Laetitia	3	0	0	2	4	13	0	**22**
Pudicitia	0	0	0	0	1	1	0	**2**
Infants Comm & Ant	11	0	9	22	68	19	0	**129**
Salus	5	0	1	1	57	16	0	**80**
Venus	2	0	1	9	23	13	0	**48**
Vesta	3	0	1	0	3	2	0	**9**
Qty	**91**	**0**	**36**	**135**	**471**	**173**	**0**	**906**

χ^2 standardised residuals χ^2 = 32.712, df = 12, **p-value = 0.001074**							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**
Fecunditas	-1.1073	-	-1.4752	2.5137	-0.4571	-0.1701	-
Juno	0.7069	-	0.7597	-1.1049	0.0000	0.2524	-
Infants Comm & Ant	0.7575	-	1.9540	0.4735	-0.6656	-0.6188	-
Salus	-0.1851	-	-1.1322	-3.2272	1.6692	0.6571	-

Table 26: Reverse designs of 162-163 from *denarii* in hoards closing up to 192 (n=284) **No χ^2 testing: sample sizes too small*								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Concordia (MA)	6	0	2	22	51	29	0	**110**
Providentia (MA)	9	0	3	24	66	19	0	**121**
Providentia (LV)	2	0	0	11	31	9	0	**53**
Qty	**17**	**0**	**5**	**57**	**148**	**57**	**0**	**284**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 27: Reverse designs of 163 and 163-164 from *denarii* in hoards closing up to 192 (n=426)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Armenia (MA)	6	0	2	23	43	17	0	**91**
Concordia (MA)	1	0	0	5	6	0	0	**12**
Felicitas (MA)	1	0	2	5	32	3	0	**43**
Mars (MA)	4	0	4	26	46	15	0	**95**
Minerva (MA)	3	0	2	3	14	2	0	**24**
Armenia (LV)	5	0	2	4	14	5	0	**30**
Mars (LV)	6	0	6	24	70	20	0	**126**
Victoria (LV)	0	0	0	0	4	1	0	**5**
Qty	**26**	**0**	**18**	**90**	**229**	**63**	**0**	**426**

χ^2 standardised residuals
χ^2 = 4.5174, df = 8, **p-value = 0.8077**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Armenia (MA)	0.6172	-	-0.8018	0.3702	-0.4956	0.4708	-
Mars (MA)	-0.3950	-	0.1811	0.8002	-0.3469	-0.2094	-
Mars (LV)	-0.1816	-	0.5241	-1.0094	0.7224	-0.2182	-

Table 28: Reverse designs of 164-165 from *denarii* in hoards closing up to 192 (n=117)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Annona (MA)	1	0	3	5	5	12	0	**26**
Armenia (MA)	0	0	0	5	7	3	0	**15**
Felicitas (MA)	1	0	1	2	4	6	0	**14**
Mars (MA)	3	0	0	4	5	5	0	**17**
Mars (LV)	1	0	0	8	4	5	0	**18**
Roma (LV)	2	0	1	4	8	12	0	**27**
Qty	**8**	**0**	**5**	**28**	**33**	**43**	**0**	**117**

Table 29: Reverse designs of 164-180 (Lucilla) from *denarii* in hoards closing up to 192 (n=78)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Concordia	3	0	0	1	5	3	0	**12**
Fecunditas	0	0	0	0	0	2	0	**2**
Hilaritas	2	0	0	0	2	1	0	**5**
Juno	2	0	1	0	6	7	0	**16**
Laetitia	0	0	0	0	2	0	0	**2**
Pudicitia	3	0	0	0	3	7	0	**13**
Venus	5	0	4	2	5	12	0	**28**
Qty	**15**	**0**	**5**	**3**	**23**	**32**	**0**	**78**

Table 30: Reverse designs of 165 and 165-166 from *denarii* in hoards closing up to 192 (n=164)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Annona (MA)	2	0	0	1	15	1	0	**19**
Felicitas (MA)	0	0	0	0	3	0	0	**3**
LIB AVG III (MA)	0	0	0	0	3	0	0	**3**
Pax (MA)	1	0	0	2	12	5	0	**20**
Pietas (MA)	2	0	2	14	26	7	0	**51**
Roma (MA)	2	0	1	2	6	3	0	**14**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 30: Reverse designs of 165 and 165-166 from *denarii* in hoards closing up to 192 (n=164)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Victoria (MA)	1	0	0	2	2	0	0	**5**
Parthian (LV)	1	0	4	2	11	5	0	**23**
Pax (LV)	2	0	0	2	9	2	0	**15**
Pietas (LV)	0	0	0	0	1	1	0	**2**
Victoria (LV)	1	0	0	4	4	0	0	**9**
Qty	**12**	**0**	**7**	**29**	**92**	**24**	**0**	**164**

Table 31: Reverse designs of 166 and 166-167 from *denarii* in hoards closing up to 192 (n=347)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas (MA)	3	0	1	9	17	17	0	**47**
Pax (MA)	11	0	2	18	24	14	0	**69**
Providentia (MA)	2	0	0	10	21	8	0	**41**
Victoria (MA)	6	0	9	14	44	9	0	**82**
Aequitas (LV)	3	0	0	9	12	2	0	**26**
Pax (LV)	7	0	4	20	19	10	0	**60**
Victoria (LV)	1	0	0	8	10	3	0	**22**
Qty	**33**	**0**	**16**	**88**	**147**	**63**	**0**	**347**

χ^2 standardised residuals
χ^2 = 16.956, df = 8, **p-value = 0.03057**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Aequitas (MA)	1.1250	-	-1.3117	0.2414	-0.8343	0.9767	-
Victoria (MA)	-1.0894	-	1.3132	-1.3811	1.7524	-1.0680	-
Pax (LV)	0.0671	-	-0.1285	1.3557	-1.1539	0.2011	-

Table 32: Reverse designs of 167-168 from *denarii* in hoards closing up to 192 (n=88)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas (MA)	2	0	0	2	31	2	0	**37**
Providentia (MA)	0	0	1	1	24	1	0	**27**
Aequitas (LV)	0	0	0	2	20	1	0	**23**
Victoria (LV)	0	0	0	0	0	1	0	**1**
Qty	**2**	**0**	**1**	**5**	**75**	**5**	**0**	**88**

Table 33: Reverse designs of 168 and 168-169 from *denarii* in hoards closing up to 192 (n=185)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas (MA)	9	0	1	5	32	8	0	**55**
Felicitas (MA)	3	0	0	0	2	2	0	**7**
Fortuna (MA)	6	0	0	13	14	5	0	**38**
LIB AVG V (MA)	7	0	0	1	3	1	0	**12**
Minerva (MA)	0	0	0	0	0	3	0	**3**
Providentia (MA)	1	0	1	0	1	0	0	**3**
Salus (MA)	8	0	0	1	5	8	0	**22**
Aequitas (LV)	2	0	0	6	21	8	0	**37**
Fortuna (LV)	1	0	1	1	4	0	0	**7**
Victoria (LV)	0	0	0	0	1	0	0	**1**
Qty	**37**	**0**	**3**	**27**	**83**	**35**	**0**	**185**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 33: Reverse designs of 168 and 168-169 from *denarii* in hoards closing up to 192 (n=185)
No χ^2 testing: sample sizes too small
χ^2 standardised residuals
χ^2 = 13.352, df = 6, **p-value = 0.03778**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Aequitas (MA)	0.7061	-	-	-1.5921	0.7465	-0.2667	-
Fortuna (MA)	0.4434	-	-	2.2303	-1.2912	-0.4769	-
Aequitas (LV)	-1.3024	-	-	-0.3368	0.4067	0.8054	-

Table 34: Reverse designs of 169 (Divus Verus) and 169-170 from *denarii* in hoards closing up to 192 (n=72)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Diana	3	0	0	0	4	2	0	**9**
Felicitas	0	0	0	0	5	0	0	**5**
Fortuna	2	0	0	0	2	4	0	**8**
LIB AVG V	2	0	0	0	1	2	0	**5**
Minerva	3	0	2	0	1	0	0	**6**
Roma	0	0	0	0	1	0	0	**1**
Salus	4	0	0	1	9	3	0	**17**
Victoria	4	0	0	0	5	2	0	**11**
Divus Verus	1	0	0	1	4	4	0	**10**
Qty	**19**	**0**	**2**	**2**	**32**	**17**	**0**	**72**

Table 35: Reverse designs of 170-171 from *denarii* in hoards closing up to 192 (n=35)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Diana	0	0	1	0	0	0	0	**1**
Jupiter	3	0	0	1	3	2	0	**9**
PRIM DEC COS III	1	0	0	0	0	2	0	**3**
Aurelius sacrificing	1	0	0	0	3	3	0	**7**
Mars	0	0	0	1	1	2	0	**4**
Roma	2	0	0	0	3	1	0	**6**
Salus	1	0	0	0	1	1	0	**3**
Victoria	0	0	0	0	0	2	0	**2**
Qty	**8**	**0**	**1**	**2**	**11**	**13**	**0**	**35**

Table 36: Reverse designs of 171-172 from *denarii* in hoards closing up to 192 (n=34)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas	3	0	0	0	4	5	0	**12**
Aurelius sacrificing	0	0	0	0	1	1	0	**2**
Mars	3	0	0	0	5	2	0	**10**
Roma	1	0	1	1	3	2	0	**8**
Victoria	1	0	0	0	0	1	0	**2**
Qty	**8**	**0**	**1**	**1**	**13**	**11**	**0**	**34**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 37: Reverse designs of 172-173 from *denarii* in hoards closing up to 192 (n=21)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
German captive	2	0	0	0	3	0	0	**5**
Aurelius sacrificing	0	0	0	0	1	2	0	**3**
Mars	1	0	0	0	1	0	0	**2**
Mercury	1	0	0	0	1	1	0	**3**
Roma	0	0	0	0	2	0	0	**2**
Victoria	1	0	0	0	3	2	0	**6**
Qty	**5**	**0**	**0**	**0**	**11**	**5**	**0**	**21**

Table 38: Reverse designs of 173-174 from *denarii* in hoards closing up to 180 (n=18)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Felicitas	0	0	0	0	1	0	0	**1**
German captive	1	0	0	0	0	1	0	**2**
Aurelius sacrificing	2	0	0	0	2	1	0	**5**
Mercury	1	0	0	0	1	3	0	**5**
Victoria	0	0	0	0	3	2	0	**5**
Qty	**4**	**0**	**0**	**0**	**7**	**7**	**0**	**18**

Table 39: Reverse designs of 174 and 174-175 from *denarii* in hoards closing up to 192 (n=25)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Felicitas	1	0	1	1	2	0	0	**5**
Genius	0	0	0	0	0	1	0	**1**
German captive	0	0	0	0	2	1	0	**3**
Aurelius sacrificing	1	0	0	0	0	0	0	**1**
Mars	2	0	0	0	2	3	0	**7**
Roma	1	0	0	0	2	0	0	**3**
Victoria	3	0	0	0	1	1	0	**5**
Qty	**8**	**0**	**1**	**1**	**9**	**6**	**0**	**25**

Table 40: Reverse designs of 175 and 175-176 from *denarii* in hoards closing up to 192 (n=64)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas (MA)	0	0	0	0	2	3	0	**5**
Bust of Comm (MA)	0	0	0	0	0	1	0	**1**
Felicitas (MA)	2	0	0	0	4	5	0	**11**
Fortuna (MA)	0	0	0	0	2	0	0	**2**
Genius (MA)	1	0	1	0	0	1	0	**3**
Mars (MA)	2	0	0	0	3	0	0	**5**
Altar *FOR RED* (MA)	0	0	0	1	0	0	0	**1**
Roma (MA)	2	0	0	1	4	4	0	**11**
Securitas (MA)	1	0	0	0	2	3	0	**6**
Captives (MA)	0	0	0	0	1	0	0	**1**
Victoria (MA)	0	0	0	0	1	1	0	**2**
Commodus Caes	6	0	0	1	3	6	0	**16**
Qty	**14**	**0**	**1**	**3**	**22**	**24**	**0**	**64**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 41: Reverse designs of 176 and 176-177 from *denarii* in hoards closing up to 192 (n=39)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Felicitas (MA)	2	0	1	0	6	1	0	**10**
Fides (MA)	0	0	0	0	3	0	0	**3**
Hilaritas (MA)	2	0	0	0	0	1	0	**3**
Jupiter (MA)	1	0	0	0	0	1	0	**2**
Aurelius std (MA)	0	0	1	0	0	0	0	**1**
Pax (MA)	0	0	0	0	2	0	0	**2**
Pile of arms (MA)	0	0	0	1	1	1	0	**3**
Salus (MA)	0	0	0	1	2	3	0	**6**
Victoria (MA)	2	0	0	0	4	2	0	**8**
Commodus Caes	1	0	0	0	0	0	0	**1**
Qty	**8**	**0**	**2**	**2**	**18**	**9**	**0**	**39**

Table 42: Reverse designs of 176-180 from *denarii* in hoards closing up to 192 (n=55)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Mars (MA)	1	0	0	0	1	2	0	**4**
Minerva (MA)	1	0	0	1	0	0	0	**2**
Roma (MA)	0	0	0	0	0	1	0	**1**
Aeternitas (DivFII)	0	0	0	0	0	5	0	**5**
Cresc & stars (DivFII)	0	0	0	0	0	2	0	**2**
FII seated (DivFII)	0	0	0	0	1	0	0	**1**
Funeral pyre (DivFII)	0	0	0	0	0	2	0	**2**
Peacock (DivFII)	3	0	3	0	6	12	0	**24**
Altar (DivFII)	2	0	0	0	1	6	0	**9**
Throne (DivFII)	2	0	1	0	0	2	0	**5**
Qty	**9**	**0**	**4**	**1**	**9**	**32**	**0**	**55**

Table 43: Reverse designs of 177 and 177-178 from *denarii* in hoards closing up to 192 (n=23)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Annona (MA)	1	0	0	0	0	0	0	**1**
Mars (MA)	1	0	0	0	1	1	0	**3**
Minerva (MA)	1	0	0	0	0	1	0	**2**
Roma (MA)	0	0	0	1	0	0	0	**1**
Commodus Aug	4	0	0	0	7	5	0	**16**
Qty	**7**	**0**	**0**	**1**	**8**	**7**	**0**	**23**

Table 44: Reverse designs of 178-179 and 179-180 from *denarii* in hoards closing up to 192 (n=27)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Fortuna (MA)	1	0	0	0	2	5	0	**8**
Mars (MA)	0	0	0	0	1	1	0	**2**
Salus (MA)	0	0	0	1	1	2	0	**4**
Victoria (MA)	0	0	0	0	1	2	0	**3**
Commodus Aug	3	0	0	0	2	5	0	**10**
Qty	**4**	**0**	**0**	**1**	**7**	**15**	**0**	**27**

4.3: Results of design-level χ^2 tests on *denarii* from hoards closing up to 211

Table 45: Reverse designs of 161 and 161-162 from *denarii* in hoards closing up to 211 (n=1,331)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Clasped hands (MA)	1	0	0	0	0	0	0	**1**
Concordia (MA)	21	43	12	0	65	50	0	**191**
Felicitas (MA)	0	1	1	0	0	0	0	**2**
Togate emperor (MA)	0	0	1	0	0	0	0	**1**
Providentia (MA)	21	39	16	0	82	54	0	**212**
Concordia (LV)	0	0	1	0	1	0	0	**2**
Togate emperor (LV)	0	0	1	0	0	0	0	**1**
Providentia (LV)	22	33	10	0	91	56	0	**212**
Divus Pius	68	115	46	0	294	186	0	**709**
Qty	**133**	**231**	**88**	**0**	**533**	**346**	**0**	**1331**

χ^2 standardised residuals
χ^2 = 8.3562, df = 12, **p-value = 0.7567**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Concordia (MA)	0.4486	1.7048	-0.0338	-	-1.3408	0.0122	-
Providentia (MA)	-0.0296	0.3579	0.6953	-	-0.3450	-0.1883	-
Providentia (LV)	0.1879	-0.6308	-0.9408	-	0.6301	0.0804	-
Divus Pius	-0.3195	-0.7357	0.1518	-	0.5400	0.0527	-

Table 46: Reverse designs of 161-164 (Lucilla) from *denarii* in hoards closing up to 211 (n=239)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Concordia	6	18	5	0	20	18	0	**67**
Diana	7	6	1	0	6	5	0	**25**
Juno	4	3	1	0	2	1	0	**11**
VOTA PVBLICA	4	3	0	0	4	9	0	**20**
Pietas	2	3	2	0	8	6	0	**21**
Venus	11	14	4	0	12	10	0	**51**
Vesta	9	9	5	0	4	17	0	**44**
Qty	**43**	**56**	**18**	**0**	**56**	**66**	**0**	**239**

χ^2 standardised residuals
χ^2 = 18.619, df = 8, **p-value = 0.01703**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Concordia	-1.7072	-0.1716	1.6102	-	0.8733	-0.5669	-
Venus	1.2435	0.5935	-1.3791	-	0.4657	-0.8600	-
Vesta	0.9633	-0.4076	-0.6865	-	-1.6790	1.6903	-

Table 47: Reverse designs of 161-175 (Faustina II) from *denarii* in hoards closing up to 211 (n=1,353)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Ceres	12	19	6	0	11	20	0	**68**
Concordia	0	0	1	0	1	0	0	**2**
Cybele	5	4	4	0	0	4	0	**17**
Diana	7	8	6	0	17	15	0	**53**
Faustina and children	3	0	0	0	2	4	0	**9**
Fecunditas	20	45	19	0	151	94	0	**329**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 47: Reverse designs of 161-175 (Faustina II) from *denarii* in hoards closing up to 211 (n=1,353)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Fortuna	2	8	2	0	3	3	0	**18**
Hilaritas	19	23	7	0	10	23	0	**82**
Juno	32	59	24	0	143	97	0	**355**
Laetitia	5	4	0	0	6	19	0	**34**
Pudicitia	0	0	1	0	2	1	0	**4**
Infants Comm & Ant	14	24	16	0	68	35	0	**157**
Salus	9	15	5	0	61	29	0	**119**
Venus	7	18	6	0	25	23	0	**79**
Vesta	4	7	5	0	4	7	0	**27**
Qty	**139**	**234**	**102**	**0**	**504**	**374**	**0**	**1353**

χ^2 standardised residuals
χ^2 = 85.784, df = 28, **p-value = 8.911e-08**

Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**
Ceres	2.1184	2.1912	0.5106	-	-3.0259	0.3739	-
Diana	0.8304	-0.3346	1.1300	-	-0.8211	0.1748	-
Fecunditas	-2.0907	-1.4570	-0.9424	-	1.9619	0.5295	-
Hilaritas	3.9355	2.4299	0.4637	-	-3.8992	0.1733	-
Juno	-0.3926	-0.1687	-0.2853	-	0.3468	0.0981	-
Infants Comm & Ant	-0.3002	-0.5174	1.4160	-	0.8376	-1.1467	-
Salus	-0.7366	-1.1602	-1.2079	-	2.1153	-0.5628	-
Venus	-0.2291	1.2499	0.1425	-	-1.0635	0.3522	-

Table 48: Reverse designs of 162-163 from *denarii* in hoards closing up to 211 (n=326)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Concordia (MA)	8	12	6	0	65	32	0	**123**
Providentia (MA)	14	22	3	0	69	26	0	**134**
Providentia (LV)	6	8	2	0	33	20	0	**69**
Qty	**28**	**42**	**11**	**0**	**167**	**78**	**0**	**326**

χ^2 standardised residuals
χ^2 = 7.1963, df = 8, **p-value = 0.5156**

Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**
Ceres	-0.7890	-0.9663	0.9079	-	0.2508	0.4738	-
Diana	0.7342	1.1399	-0.7155	-	0.0429	-1.0705	-
Fecunditas	0.0302	-0.2984	-0.2151	-	-0.3947	0.8591	-

Table 49: Reverse designs of 163 and 163-164 from *denarii* in hoards closing up to 211 (n=501)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Armenia (MA)	8	18	2	0	45	33	0	**106**
Concordia (MA)	3	3	0	0	6	0	0	**12**
Felicitas (MA)	1	2	2	0	9	32	0	**46**
Mars (MA)	8	17	7	0	48	28	0	**108**
Minerva (MA)	4	6	2	0	15	10	0	**37**
Armenia (LV)	9	5	3	0	14	9	0	**40**
Mars (LV)	12	18	9	0	72	36	0	**147**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 49: Reverse designs of 163 and 163-164 from *denarii* in hoards closing up to 211 (n=501)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Victoria (LV)	0	0	0	0	4	1	0	**5**
Qty	**45**	**69**	**25**	**0**	**213**	**149**	**0**	**501**

χ^2 standardised residuals $\chi^2 = 5.7103$, df = 8, **p-value = 0.6796**							
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**
Armenia (MA)	-0.0773	0.6179	-1.4290	-	-0.4955	0.8466	-
Mars (MA)	-0.1302	0.2873	0.6959	-	-0.1940	-0.1892	-
Mars (LV)	0.1772	-0.7710	0.6170	-	0.5870	-0.5567	-

Table 50: Reverse designs of 164-165 from *denarii* in hoards closing up to 211 (n=148) ***No χ^2 testing: sample sizes too small**								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Annona (MA)	1	8	4	0	7	17	0	**37**
Armenia (MA)	2	3	1	0	8	7	0	**21**
Felicitas (MA)	1	3	3	0	4	9	0	**20**
Mars (MA)	6	4	0	0	5	6	0	**21**
Mars (LV)	1	3	1	0	5	7	0	**17**
Roma (LV)	4	5	1	0	8	14	0	**32**
Qty	**15**	**26**	**10**	**0**	**37**	**60**	**0**	**148**

Table 51: Reverse designs of 164-180 (Lucilla) from *denarii* in hoards closing up to 211 (n=216) ***No χ^2 testing: sample sizes too small**								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Concordia	5	11	1	0	8	4	0	**29**
Fecunditas	0	4	1	0	0	2	0	**7**
Hilaritas	2	4	0	0	2	5	0	**13**
Juno	3	6	3	0	7	14	0	**33**
Laetitia	0	0	0	0	2	2	0	**4**
Pudicitia	3	18	3	0	3	13	0	**40**
Venus	15	33	7	0	5	30	0	**90**
Qty	**28**	**76**	**15**	**0**	**27**	**70**	**0**	**216**

Table 52: Reverse designs of 165 and 165-166 from *denarii* in hoards closing up to 211 (n=224) ***No χ^2 testing: sample sizes too small**								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Annona (MA)	3	4	1	0	16	9	0	**33**
Felicitas (MA)	0	0	0	0	3	0	0	**3**
LIB AVG III (MA)	0	1	0	0	3	3	0	**7**
Pax (MA)	1	2	1	0	14	8	0	**26**
Pietas (MA)	2	9	3	0	28	10	0	**52**
Roma (MA)	2	8	1	0	7	6	0	**24**
Victoria (MA)	1	2	0	0	4	1	0	**8**
LIB AVG III (LV)	1	2	0	0	0	2	0	**5**
Parthian (LV)	3	6	5	0	11	9	0	**34**
Pax (LV)	3	2	2	0	10	4	0	**21**
Pietas (LV)	1	0	0	0	1	3	0	**5**
Victoria (LV)	1	1	0	0	4	0	0	**6**
Qty	**18**	**37**	**13**	**0**	**101**	**55**	**0**	**224**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 53: Reverse designs of 166 and 166-167 from *denarii* in hoards closing up to 211 (n=474)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas (MA)	8	14	3	0	19	29	0	**73**
Pax (MA)	14	17	9	0	27	26	0	**93**
Providentia (MA)	4	9	3	0	23	15	0	**54**
Victoria (MA)	11	23	14	0	47	21	0	**116**
Aequitas (LV)	3	5	2	0	13	7	0	**30**
Pax (LV)	13	15	7	0	21	22	0	**78**
Victoria (LV)	2	6	2	0	12	8	0	**30**
Qty	**55**	**89**	**40**	**0**	**162**	**128**	**0**	**474**

χ^2 standardised residuals
χ^2 = 21.601, df = 16, **p-value = 0.1566**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Aequitas (MA)	-0.2750	0.0664	-1.3288	-	-1.0492	2.0330	-
Pax (MA)	0.8260	-0.1246	0.3211	-	-0.6805	0.1223	-
Providentia (MA)	-0.9875	-0.3680	-0.7825	-	1.2137	0.0679	-
Victoria (MA)	-0.8041	0.2449	1.2321	-	1.3902	-1.8948	-
Pax (LV)	1.1663	0.0794	0.0835	-	-0.9471	0.1539	-

Table 54: Reverse designs of 167-168 from *denarii* in hoards closing up to 211 (n=112)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas (MA)	3	4	1	0	32	5	0	**45**
Providentia (MA)	2	2	1	0	25	4	0	**34**
Aequitas (LV)	0	3	1	0	21	7	0	**32**
Victoria (LV)	0	0	0	0	0	1	0	**1**
Qty	**5**	**9**	**3**	**0**	**78**	**17**	**0**	**112**

Table 55: Reverse designs of 168 and 168-169 from *denarii* in hoards closing up to 211 (n=380)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas (MA)	14	26	5	0	36	21	0	**102**
Felicitas (MA)	6	10	2	0	2	11	0	**31**
Fortuna (MA)	6	26	7	0	16	13	0	**68**
LIB AVG V (MA)	10	18	1	0	3	8	0	**40**
Minerva (MA)	0	0	0	0	0	3	0	**3**
Providentia (MA)	1	0	1	0	1	1	0	**4**
Salus (MA)	11	15	2	0	7	17	0	**52**
Aequitas (LV)	5	21	1	0	22	18	0	**67**
Fortuna (LV)	3	1	2	0	4	0	0	**10**
Victoria (LV)	1	1	0	0	1	0	0	**3**
Qty	**57**	**118**	**21**	**0**	**92**	**92**	**0**	**380**

χ^2 standardised residuals
χ^2 = 37.592, df = 20, **p-value = 0.00993**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Aequitas (MA)	-0.0692	-1.1972	0.0177	-	1.9512	-0.5879	-
Fortuna (MA)	-1.1376	0.8741	2.0308	-	-0.3268	-0.7307	-
LIB AVG V (MA)	1.8636	1.4241	-0.6778	-	-2.2570	-0.4450	-
Salus (MA)	1.3831	-0.4285	-0.3326	-	-1.7226	1.3845	-
Aequitas (LV)	-1.4271	-0.1263	-1.2511	-	1.1832	0.5857	-

Annexe 4: Marcus Aurelius and Lucius Verus

Table 56: Reverse designs of 169 (Divus Verus) and 169-170 from *denarii* in hoards closing up to 211 (n=214)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Diana	4	7	2	0	4	9	0	**26**
Felicitas	1	5	0	0	6	3	0	**15**
Fortuna	2	12	0	0	2	6	0	**22**
LIB AVG V	4	4	1	0	1	3	0	**13**
Minerva	4	4	5	0	1	0	0	**14**
Roma	1	0	0	0	1	0	0	**2**
Salus	9	31	4	0	13	12	0	**69**
Victoria	8	6	0	0	6	5	0	**25**
Divus Verus	6	6	3	0	4	9	0	**28**
Qty	**39**	**75**	**15**	**0**	**38**	**47**	**0**	**214**

Table 57: Reverse designs of 170-171 from *denarii* in hoards closing up to 211 (n=133)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Diana	0	1	1	0	1	1	0	**4**
Jupiter	5	9	4	0	4	11	0	**33**
PRIM DEC COS III	1	4	0	0	0	2	0	**7**
Aurelius sacrificing	2	13	4	0	5	6	0	**30**
Mars	2	6	1	0	1	4	0	**14**
Minerva	0	1	0	0	0	0	0	**1**
Roma	3	9	0	0	6	5	0	**23**
Salus	2	2	0	0	3	3	0	**10**
Victoria	0	4	2	0	1	4	0	**11**
Qty	**15**	**49**	**12**	**0**	**21**	**36**	**0**	**133**

Table 58: Reverse designs of 171-172 from *denarii* in hoards closing up to 211 (n=121)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas	4	11	2	0	7	13	0	**37**
Aurelius sacrificing	0	0	0	0	1	1	0	**2**
Mars	6	12	4	0	5	9	0	**36**
Roma	3	19	3	0	9	6	0	**40**
Victoria	1	4	0	0	0	1	0	**6**
Qty	**14**	**46**	**9**	**0**	**22**	**30**	**0**	**121**

Table 59: Reverse designs of 172-173 from *denarii* in hoards closing up to 211 (n=70)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas	1	2	0	0	1	0	0	**4**
German captive	5	9	2	0	3	5	0	**24**
Aurelius sacrificing	1	5	1	0	3	2	0	**12**
Mars	1	1	0	0	1	1	0	**4**
Mercury	1	2	0	0	2	5	0	**10**
Roma	0	0	0	0	2	0	0	**2**
Victoria	1	5	0	0	5	3	0	**14**
Qty	**10**	**24**	**3**	**0**	**17**	**16**	**0**	**70**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 60: Reverse designs of 173-174 from *denarii* in hoards closing up to 211 (n=66)
No χ² testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Felicitas	0	0	1	0	1	0	0	**2**
German captive	3	5	2	0	2	3	0	**15**
Aurelius sacrificing	3	10	1	0	3	1	0	**18**
Mars	0	2	1	0	0	0	0	**3**
Mercury	2	3	1	0	3	3	0	**12**
Victoria	0	8	0	0	4	4	0	**16**
Qty	**8**	**28**	**6**	**0**	**13**	**11**	**0**	**66**

Table 61: Reverse designs of 174 and 174-175 from *denarii* in hoards closing up to 211 (n=95)
No χ² testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Felicitas	2	7	3	0	4	6	0	**22**
Genius	0	4	2	0	1	6	0	**13**
German captive	0	0	0	0	2	1	0	**3**
LIB AVG VI	0	2	0	0	0	1	0	**3**
Aurelius sacrificing	3	0	0	0	0	0	0	**3**
Mars	4	3	2	0	2	7	0	**18**
Roma	1	2	1	0	4	3	0	**11**
Victoria	4	9	2	0	1	6	0	**22**
Qty	**14**	**27**	**10**	**0**	**14**	**30**	**0**	**95**

Table 62: Reverse designs of 175 and 175-176 from *denarii* in hoards closing up to 211 (n=175)
No χ² testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas (MA)	0	10	0	0	2	6	0	**18**
Bust of Comm (MA)	0	1	0	0	0	1	0	**2**
Felicitas (MA)	3	11	1	0	5	9	0	**29**
Fortuna (MA)	0	4	0	0	3	0	0	**7**
Genius (MA)	3	6	1	0	1	2	0	**13**
Mars (MA)	3	7	0	0	3	2	0	**15**
Pax (MA)	1	0	1	0	0	0	0	**2**
Altar FOR RED (MA)	0	0	0	0	0	1	0	**1**
Roma (MA)	3	11	3	0	4	12	0	**33**
Securitas (MA)	1	2	0	0	3	5	0	**11**
Captives (MA)	0	2	0	0	1	0	0	**3**
Victoria (MA)	1	1	0	0	1	2	0	**5**
Commodus Caes	9	11	1	0	5	10	0	**36**
Qty	**24**	**66**	**7**	**0**	**28**	**50**	**0**	**175**

Table 63: Reverse designs of 176 and 176-177 from *denarii* in hoards closing up to 211 (n=88)
No χ² testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Annona (MA)	0	3	0	0	0	0	0	**3**
Felicitas (MA)	2	1	2	0	6	2	0	**13**
Fides (MA)	0	1	0	0	4	0	0	**5**
Hilaritas (MA)	2	2	1	0	1	1	0	**7**
Jupiter (MA)	1	0	0	0	0	1	0	**2**
Aurelius std (MA)	0	0	1	0	0	0	0	**1**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 63: Reverse designs of 176 and 176-177 from *denarii* in hoards closing up to 211 (n=88)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Pax (MA)	0	6	0	0	2	1	0	**9**
Pile of arms (MA)	0	3	1	0	1	1	0	**6**
Salus (MA)	1	10	0	0	2	6	0	**19**
Victoria (MA)	2	9	0	0	5	4	0	**20**
Commodus Caes	1	1	0	0	0	1	0	**3**
Qty	**9**	**36**	**5**	**0**	**21**	**17**	**0**	**88**

Table 64: Reverse designs of 176-180 from *denarii* in hoards closing up to 211 (n=211)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Annona (MA)	0	5	2	0	1	0	0	**8**
Mars (MA)	5	10	1	0	3	4	0	**23**
Minerva (MA)	1	3	0	0	0	3	0	**7**
Roma (MA)	0	3	1	0	1	1	0	**6**
Salus (MA)	0	4	0	0	0	0	0	**4**
Aeternitas (DivFII)	2	4	3	0	0	7	0	**16**
Cresc & stars (DivFII)	0	2	0	0	0	2	0	**4**
FII seated (DivFII)	0	1	0	0	1	0	0	**2**
Funeral pyre (DivFII)	0	0	2	0	0	1	0	**3**
Peacock (DivFII)	13	24	7	0	7	21	0	**72**
Pietas (DivFII)	0	1	0	0	1	3	0	**5**
Altar (DivFII)	6	15	3	0	2	12	0	**38**
Throne (DivFII)	2	10	2	0	4	5	0	**23**
Qty	**29**	**82**	**21**	**0**	**20**	**59**	**0**	**211**

Table 65: Reverse designs of 177 and 177-178 from *denarii* in hoards closing up to 211 (n=107)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Annona (MA)	1	2	0	0	0	0	0	**3**
Mars (MA)	1	7	0	0	1	2	0	**11**
Minerva (MA)	1	2	0	0	0	1	0	**4**
Pietas (MA)	0	1	0	0	0	0	0	**1**
Roma (MA)	1	1	0	0	0	0	0	**2**
Salus (MA)	1	12	0	0	0	1	0	**14**
Commodus Aug	7	38	1	0	9	17	0	**72**
Qty	**12**	**63**	**1**	**0**	**10**	**21**	**0**	**107**

Table 66: Reverse designs of 178-179 and 179-180 from *denarii* in hoards closing up to 211 (n=162)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Fortuna (MA)	4	19	1	0	5	7	0	**36**
Justitia (MA)	1	2	0	0	0	0	0	**3**
Mars (MA)	3	16	1	0	3	2	0	**25**
Salus (MA)	1	11	1	0	3	5	0	**21**
Victoria (MA)	0	4	0	0	1	2	0	**7**
Commodus Aug	5	40	2	0	6	17	0	**70**
Qty	**14**	**92**	**5**	**0**	**18**	**33**	**0**	**162**

4.4: Results of design-level χ^2 tests on *denarii* from hoards closing up to *c.* 250

Table 67: Reverse designs of 161 and 161-162 from *denarii* in hoards closing up to *c.* 250 (n=4,138)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Clasped hands (MA)	1	0	0	0	0	1	0	**2**
Concordia (MA)	33	43	25	54	103	351	17	**626**
Felicitas (MA)	0	1	1	2	1	12	2	**19**
Togate emperor (MA)	1	0	1	0	0	2	1	**5**
Providentia (MA)	30	39	30	59	108	372	18	**656**
Clasped hands (LV)	0	0	0	1	0	0	0	**1**
Concordia (LV)	1	0	1	5	3	15	1	**26**
Togate emperor (LV)	0	0	2	0	0	2	0	**4**
Providentia (LV)	28	33	17	53	133	340	17	**621**
Divus Pius	112	115	84	129	384	1300	54	**2178**
Qty	**206**	**231**	**161**	**303**	**732**	**2395**	**110**	**4138**

χ^2 standardised residuals
χ^2 = 25.857, df = 15, **p-value = 0.03956**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Concordia (MA)	0.3405	1.3076	0.2249	1.3095	-0.8082	-0.5797	-
Providentia (MA)	-0.4524	0.3430	0.9915	1.6933	-0.8184	-0.3732	-
Providentia (LV)	-0.5124	-0.3296	-1.3770	1.2210	2.1279	-1.0057	-
Divus Pius	0.3388	-0.7124	0.0704	-2.2804	-0.2535	1.0513	-

Table 68: Reverse designs of 161-164 (Lucilla) from *denarii* in hoards closing up to *c.* 250 (n=925)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Concordia	12	18	8	19	32	130	8	**227**
Diana	8	6	4	3	7	68	4	**100**
Juno	5	3	2	1	3	40	0	**54**
VOTA PVBLICA	5	3	3	9	5	67	1	**93**
Pietas	5	3	2	4	11	32	0	**57**
Venus	11	14	9	7	23	142	3	**209**
Vesta	12	9	7	2	15	131	9	**185**
Qty	**58**	**56**	**35**	**45**	**96**	**610**	**25**	**925**

χ^2 standardised residuals
χ^2 = 25.236, df = 15, **p-value = 0.04687**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Concordia	-0.4110	0.8412	-0.2689	2.9669	1.5871	-1.4788	-
Diana	0.8537	-0.1861	0.0731	-0.6145	-1.1071	0.3883	-
Venus	-0.4793	0.0293	0.2519	-0.7143	0.0508	0.2369	-
Vesta	0.3466	-0.8325	-0.0264	-2.0830	-1.0077	1.1065	-

Table 69: Reverse designs of 161-175 (Faustina II) from *denarii* in hoards closing up to *c.* 250 (n=4,273)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Ceres	19	19	13	4	35	167	12	**269**
Concordia	0	0	1	1	1	1	0	**4**
Cybele	7	4	7	0	5	37	3	**63**
Diana	11	8	10	8	32	84	6	**159**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 69: Reverse designs of 161-175 (Faustina II) from *denarii* in hoards closing up to *c.* 250 (n=4,273)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Faustina and children	3	0	0	1	4	14	0	**22**
Fecunditas	41	45	42	69	194	536	29	**956**
Fortuna	3	8	3	0	7	36	0	**57**
Hilaritas	24	23	16	6	45	247	13	**374**
Juno	62	59	41	45	206	663	35	**1111**
Laetitia	7	4	1	3	6	63	3	**87**
Pudicitia	0	0	2	1	2	1	1	**7**
Infants Comm & Ant	22	24	21	24	95	270	19	**475**
Salus	17	15	8	1	84	166	8	**299**
Venus	16	18	18	11	45	163	10	**281**
Vesta	4	7	10	0	8	76	4	**109**
Qty	**236**	**234**	**193**	**174**	**769**	**2524**	**143**	**4273**

χ^2 standardised residuals
χ^2 = 96.2, df = 35, **p-value = 1.286e-07**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Ceres	1.2220	1.2428	0.4569	-2.1889	-2.1071	0.9131	-
Diana	0.8364	-0.1760	1.2182	0.4692	0.4228	-0.8976	-
Fecunditas	-1.5038	-0.9164	0.1067	4.3583	1.0494	-1.0673	-
Hilaritas	0.8498	0.6499	-0.0222	-2.4989	-2.9947	1.9223	-
Juno	0.2377	-0.1127	-1.0043	-0.3868	-0.1968	0.4505	-
Infants Comm & Ant	-0.6919	-0.2727	0.1502	0.8449	0.6902	-0.3672	-
Salus	0.1812	-0.2963	-1.3798	-3.3121	3.6617	-0.7681	-
Venus	0.2182	0.7521	1.7041	-0.2904	-1.0478	-0.0848	-

Table 70: Reverse designs of 162-163 from *denarii* in hoards closing up to *c.* 250 (n=972)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Concordia (MA)	13	12	9	22	80	218	7	**361**
Providentia (MA)	22	22	6	26	83	211	7	**377**
Providentia (LV)	11	8	7	12	43	144	9	**234**
Qty	**46**	**42**	**22**	**60**	**206**	**573**	**23**	**972**

χ^2 standardised residuals
χ^2 = 9.3922, df = 10, **p-value = 0.4953**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Ceres	-1.0040	-0.9264	0.2770	-0.0806	0.3601	0.2912	-
Diana	0.9600	1.3900	-0.8801	0.5390	0.2995	-0.8299	-
Fecunditas	0.0284	-0.6204	0.7811	-0.5901	-0.8358	0.6989	-

Table 71: Reverse designs of 163 and 163-164 from *denarii* in hoards closing up to *c.* 250 (n=1,410)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Armenia (MA)	14	18	7	28	53	187	1	**308**
Concordia (MA)	3	3	0	5	7	17	2	**37**
Felicitas (MA)	2	3	3	5	36	45	1	**95**
Mars (MA)	14	17	9	29	72	198	10	**349**
Minerva (MA)	6	6	2	4	25	51	2	**96**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 71: Reverse designs of 163 and 163-164 from *denarii* in hoards closing up to *c.* 250 (n=1,410)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Armenia (LV)	13	6	6	5	17	54	1	**102**
Mars (LV)	21	18	16	26	87	233	9	**410**
Victoria (LV)	0	0	0	0	4	9	0	**13**
Qty	**73**	**71**	**43**	**102**	**301**	**794**	**26**	**1410**

χ^2 standardised residuals
χ^2 = 22.897, df = 15, **p-value = 0.08634**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Armenia (MA)	-0.6336	0.5594	-0.9919	0.9208	-1.0529	0.5440	-
Mars (MA)	-1.0069	-0.1012	-0.6631	0.5912	0.5323	-0.0312	-
Armenia (LV)	3.2307	0.3552	1.4530	-0.9855	-0.7012	-0.6661	-
Mars (LV)	-0.1411	-0.5747	0.7484	-0.8547	0.7837	-0.1130	-

Table 72: Reverse designs of 164-165 from *denarii* in hoards closing up to *c.* 250 (n=485)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Annona (MA)	3	8	8	5	12	72	2	**110**
Armenia (MA)	5	3	2	5	11	46	0	**72**
Felicitas (MA)	3	3	7	4	6	52	2	**77**
Mars (MA)	8	4	1	5	13	49	3	**83**
Mars (LV)	3	3	2	8	12	43	0	**71**
Roma (LV)	6	5	4	4	11	41	1	**72**
Qty	**28**	**26**	**24**	**31**	**65**	**303**	**8**	**485**

Table 73: Reverse designs of 164-180 (Lucilla) from *denarii* in hoards closing up to *c.* 250 (n=888)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Concordia	8	11	4	1	14	82	2	**122**
Fecunditas	0	4	1	1	0	15	0	**21**
Hilaritas	3	4	1	0	2	31	3	**44**
Juno	10	6	5	0	16	114	2	**153**
Laetitia	0	0	1	0	2	12	0	**15**
Pudicitia	10	18	9	3	12	109	11	**172**
Venus	21	33	14	5	31	244	13	**361**
Qty	**52**	**76**	**35**	**10**	**77**	**607**	**31**	**888**

χ^2 standardised residuals
χ^2 = 9.007, df = 12, **p-value = 0.7023**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Concordia	0.1589	0.1557	-0.4225	-	0.8141	-0.2972	-
Juno	0.1302	-2.0052	-0.5062	-	0.4504	0.6248	-
Pudicitia	-0.0131	1.0889	0.9537	-	-0.7652	-0.3305	-
Venus	-0.1711	0.4997	-0.0626	-	-0.2590	-0.0152	-

Table 74: Reverse designs of 165 and 165-166 from *denarii* in hoards closing up to *c.* 250 (n=769)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Annona (MA)	4	4	2	2	23	79	3	**117**
Felicitas (MA)	0	0	0	0	4	0	0	**4**
LIB AVG III (MA)	1	1	0	0	3	11	0	**16**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 74: Reverse designs of 165 and 165-166 from *denarii* in hoards closing up to *c.* 250 (n=769)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Pax (MA)	3	2	5	3	31	43	7	**94**
Pietas (MA)	3	9	6	14	36	74	3	**145**
Roma (MA)	4	8	8	3	14	78	0	**115**
Victoria (MA)	1	2	0	2	6	20	1	**32**
LIB AVG III (LV)	1	2	1	0	0	3	0	**7**
Parthian (LV)	6	6	8	3	14	81	7	**125**
Pax (LV)	4	2	6	2	14	45	1	**74**
Pietas (LV)	1	0	0	0	3	4	0	**8**
Victoria (LV)	2	1	0	7	4	18	0	**32**
Qty	**30**	**37**	**36**	**36**	**152**	**456**	**22**	**769**

Table 75: Reverse designs of 166 and 166-167 from *denarii* in hoards closing up to *c.* 250 (n=1,426)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas (MA)	17	14	10	11	37	52	6	**147**
Pax (MA)	17	17	17	20	45	199	7	**322**
Providentia (MA)	7	9	6	11	28	81	4	**146**
Victoria (MA)	18	23	23	17	66	161	9	**317**
Aequitas (LV)	6	5	3	10	25	76	7	**132**
Pax (LV)	13	15	10	22	31	143	3	**237**
Victoria (LV)	4	6	6	8	17	80	4	**125**
Qty	**82**	**89**	**75**	**99**	**249**	**792**	**40**	**1426**

χ^2 standardised residuals
χ^2 = 56.321, df = 30, **p-value = 0.002508**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Aequitas (MA)	2.9977	1.6437	0.8581	0.2926	2.3185	-3.1830	-
Pax (MA)	-0.3791	-0.7176	-0.0110	-0.5270	-1.5408	1.4162	-
Providentia (MA)	-0.4834	-0.0392	-0.6075	0.2691	0.4928	-0.0159	-
Victoria (MA)	-0.0521	0.7245	1.5513	-1.0660	1.4340	-1.1307	-
Aequitas (LV)	-0.5131	-1.0683	-1.4473	0.3586	0.5367	0.5409	-
Pax (LV)	-0.2269	-0.0067	-0.7482	1.2929	-1.7026	0.8030	-
Victoria (LV)	-1.1806	-0.6349	-0.2140	-0.2187	-1.0162	1.3057	-

Table 76: Reverse designs of 167-168 from *denarii* in hoards closing up to *c.* 250 (n=301)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas (MA)	5	4	2	3	40	96	2	**152**
Fortuna (MA)	0	0	0	0	0	1	0	**1**
Providentia (MA)	2	2	2	1	36	38	0	**81**
Aequitas (LV)	0	3	2	3	26	28	0	**62**
Victoria (LV)	2	0	0	0	2	1	0	**5**
Qty	**9**	**9**	**6**	**7**	**104**	**164**	**2**	**301**

Table 77: Reverse designs of 168 and 168-169 from *denarii* in hoards closing up to *c.* 250 (n=1,461)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas (MA)	19	26	8	7	64	194	5	**323**
Felicitas (MA)	6	10	4	0	12	77	6	**115**
Fortuna (MA)	8	26	14	16	38	165	6	**273**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 77: Reverse designs of 168 and 168-169 from *denarii* in hoards closing up to *c.* 250 (n=1,461)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
LIB AVG V (MA)	14	18	6	3	21	125	7	**194**
Minerva (MA)	0	0	0	0	0	5	0	**5**
Providentia (MA)	2	0	1	1	3	1	0	**8**
Salus (MA)	16	15	4	3	28	161	9	**236**
Victoria (MA)	0	0	1	1	0	3	0	**5**
Aequitas (LV)	8	21	7	8	33	145	11	**233**
Fortuna (LV)	6	1	2	2	7	31	2	**51**
Victoria (LV)	2	1	1	0	2	12	0	**18**
Qty	**81**	**118**	**48**	**41**	**208**	**919**	**46**	**1461**

χ^2 standardised residuals

χ^2 = 37.592, df = 20, **p-value = 0.00993**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Aequitas (MA)	0.5034	-0.3058	-0.6769	-0.8493	2.3227	-0.8191	-
Fortuna (MA)	-1.6482	0.5859	1.8737	2.7805	-0.3525	-0.5898	-
LIB AVG V (MA)	1.2820	0.4382	0.0111	-1.1202	-1.3526	0.3645	-
Salus (MA)	1.1264	-1.0603	-1.2072	-1.4789	-1.0614	1.1658	-
Aequitas (LV)	-1.1107	0.3934	-0.0341	0.4907	-0.0786	0.1138	-

Table 78: Reverse designs of 169 (Divus Verus) and 169-170 from *denarii* in hoards closing up to *c.* 250 (n=941)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Diana	5	7	6	0	11	61	4	**94**
Felicitas	1	5	0	0	10	41	2	**59**
Fortuna	4	12	3	0	14	58	3	**94**
LIB AVG V	6	4	4	0	3	33	2	**52**
Minerva	6	4	8	2	6	63	2	**91**
Roma	1	0	0	0	2	4	0	**7**
Salus	15	31	11	2	42	193	7	**301**
Victoria	9	6	3	0	16	86	7	**127**
Divus Verus	9	6	6	1	7	86	1	**116**
Qty	**56**	**75**	**41**	**5**	**111**	**625**	**28**	**941**

χ^2 standardised residuals

χ^2 = 26.804, df = 20, **p-value = 0.1409**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Diana	-0.1890	-0.1759	0.8819	-	0.0359	-0.1273	-
Fortuna	-0.6401	1.6128	-0.6024	-	0.9037	-0.5925	-
Minerva	0.3229	-1.2018	1.9597	-	-1.3933	0.3958	-
Salus	-0.6313	1.3656	-0.7068	-	1.1268	-0.5756	-
Victoria	0.6481	-1.2585	-1.0961	-	0.3915	0.3662	-
Divus Verus	0.8031	-1.1292	0.2984	-	-1.8271	0.8422	-

Table 79: Reverse designs of 170-171 from *denarii* in hoards closing up to *c.* 250 (n=640)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Diana	1	1	1	0	1	9	1	**14**
Jupiter	7	9	8	2	15	90	1	**132**
PRIM DEC COS III	1	4	1	0	0	33	2	**41**
Aurelius sacrificing	4	13	6	1	19	95	6	**144**
Mars	3	6	5	2	10	70	5	**101**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 79: Reverse designs of 170-171 from *denarii* in hoards closing up to *c.* 250 (n=640)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Minerva	0	1	0	0	0	11	1	**13**
Roma	3	9	4	0	10	65	4	**95**
Salus	3	2	2	0	8	26	0	**41**
Victoria	3	4	5	0	8	36	3	**59**
Qty	**25**	**49**	**32**	**5**	**71**	**435**	**23**	**640**

χ^2 standardised residuals
χ^2 = 3.2813, df = 8, **p-value = 0.9155**

Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**
Jupiter	0.8855	-0.3262	0.4567	-	-0.1931	-0.1438	-
Aurelius sacrificing	-0.5752	0.7182	-0.4576	-	0.5512	-0.2073	-
Mars	-0.3429	-0.4849	0.0175	-	-0.4393	0.4187	-

Table 80: Reverse designs of 171-172 from *denarii* in hoards closing up to *c.* 250 (n=583)								
Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Aequitas	4	11	4	2	25	125	4	**175**
LIB AVG V	0	0	1	0	0	1	1	**3**
Aurelius sacrificing	0	0	0	0	1	4	0	**5**
Mars	7	12	9	2	21	117	2	**170**
Roma	5	19	5	3	21	133	3	**189**
Victoria	2	4	1	0	5	27	2	**41**
Qty	**18**	**46**	**20**	**7**	**73**	**407**	**12**	**583**

χ^2 standardised residuals
χ^2 = 6.5076, df = 8, **p-value = 0.5906**

Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**
Aequitas	-0.5340	-0.7301	-0.7727	-	0.6718	0.2400	-
Mars	0.8270	-0.3978	1.3456	-	-0.1017	-0.2895	-
Roma	-0.2745	1.0805	-0.5389	-	-0.5488	0.0451	-

Table 81: Reverse designs of 172-173 from *denarii* in hoards closing up to *c.* 250 (n=369)
No χ^2 testing: sample sizes too small

Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Aequitas	3	2	1	0	4	15	2	**27**
German captive	6	9	4	2	9	50	3	**83**
LIB AVG V	0	0	0	0	3	0	0	**3**
Aurelius sacrificing	2	5	2	1	12	60	4	**86**
Mars	1	1	0	0	2	16	3	**23**
Mercury	5	2	0	1	5	29	3	**45**
Roma	0	0	2	0	3	9	2	**16**
Victoria	2	5	1	2	12	61	3	**86**
Qty	**19**	**24**	**10**	**6**	**50**	**240**	**20**	**369**

Table 82: Reverse designs of 173-174 from *denarii* in hoards closing up to *c.* 250 (n=313)
No χ^2 testing: sample sizes too small

Design	**Britain**	**Spain & W Med**	**Rhine**	**Italy & Adriatic**	**Western Danube**	**Eastern Danube**	**Eastern Med**	**Qty**
Felicitas	0	0	1	0	1	3	0	**5**
German captive	6	5	6	0	10	66	4	**97**
Aurelius sacrificing	4	10	4	0	10	49	2	**79**

Annexe 4: Marcus Aurelius and Lucius Verus

Table 82: Reverse designs of 173-174 from *denarii* in hoards closing up to *c.* 250 (n=313)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Mars	1	2	1	1	3	14	1	**23**
Mercury	3	3	4	0	5	30	0	**45**
Victoria	1	8	1	0	15	37	2	**64**
Qty	**15**	**28**	**17**	**1**	**44**	**199**	**9**	**313**

Table 83: Reverse designs of 174 and 174-175 from *denarii* in hoards closing up to *c.* 250 (n=351)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Felicitas	2	7	3	1	11	44	2	**70**
Genius	0	4	3	2	2	33	0	**44**
German captive	0	0	0	0	3	5	0	**8**
LIB AVG VI	0	2	2	0	1	8	0	**13**
Aurelius sacrificing	3	0	1	0	0	5	0	**9**
Mars	5	3	2	0	4	23	2	**39**
Mercury	0	0	0	0	1	1	1	**3**
Roma	2	2	1	0	12	49	3	**69**
Victoria	5	9	6	0	5	69	2	**96**
Qty	**17**	**27**	**18**	**3**	**39**	**237**	**10**	**351**

Table 84: Reverse designs of 175 and 175-176 from *denarii* in hoards closing up to *c.* 250 (n=708)

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Aequitas (MA)	0	10	1	0	8	54	3	**76**
Bust of Comm (MA)	0	1	0	0	0	1	0	**2**
Felicitas (MA)	3	11	3	0	22	76	4	**119**
Fortuna (MA)	0	4	0	0	5	15	3	**27**
Genius (MA)	3	6	2	0	6	38	2	**57**
Mars (MA)	5	7	0	1	9	50	1	**73**
Pax (MA)	3	0	1	0	9	21	1	**35**
Pile of arms (MA)	1	0	0	0	0	0	0	**1**
Altar *FOR RED* (MA)	0	0	0	1	0	1	0	**2**
Roma (MA)	3	11	7	1	10	78	7	**117**
Securitas (MA)	1	2	3	0	10	31	0	**47**
Captives (MA)	0	2	0	0	1	6	0	**9**
Victoria (MA)	1	1	0	0	2	11	0	**15**
Commodus Caes	11	11	6	1	14	80	5	**128**
Qty	**31**	**66**	**23**	**4**	**96**	**462**	**26**	**708**

χ^2 standardised residuals
χ^2 = 13.331, df = 8, **p-value = 0.1009**

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med
Felicitas (MA)	-1.1150	0.0096	-1.0051	-	1.7163	-0.2012	-
Roma (MA)	-1.0178	0.1873	0.8728	-	-1.1798	0.4989	-
Commodus Caes	2.0446	-0.1864	0.1509	-	-0.5511	-0.2762	-

Annexe 4: Marcus Aurelius and Lucius Verus

Table 85: Reverse designs of 176 and 176-177 from *denarii* in hoards closing up to *c.* 250 (n=365)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Annona (MA)	0	3	0	0	1	5	0	**9**
Felicitas (MA)	2	1	4	0	8	39	1	**55**
Fides (MA)	1	1	1	0	6	3	0	**12**
Hilaritas (MA)	2	2	1	1	4	11	1	**22**
Jupiter (MA)	1	0	0	0	0	6	0	**7**
Aurelius std (MA)	0	0	1	0	0	6	0	**7**
Pax (MA)	1	6	2	0	9	26	1	**45**
Pile of arms (MA)	1	3	2	1	1	31	1	**40**
Salus (MA)	5	10	2	3	5	31	2	**58**
Captives (MA)	0	0	0	0	0	1	0	**1**
Victoria (MA)	5	9	4	2	13	65	4	**102**
Commodus Caes	1	1	0	0	1	4	0	**7**
Qty	**19**	**36**	**17**	**7**	**48**	**228**	**10**	**365**

Table 86: Reverse designs of 176-180 from *denarii* in hoards closing up to *c.* 250 (n=979)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Annona (MA)	2	5	3	0	3	20	3	**36**
Mars (MA)	5	10	1	0	9	63	0	**88**
Minerva (MA)	2	3	0	2	0	22	0	**29**
Roma (MA)	0	3	4	1	6	17	1	**32**
Salus (MA)	0	4	1	0	4	16	0	**25**
Aeternitas (DivFII)	5	4	7	0	5	62	3	**86**
Cresc & stars (DivFII)	0	2	1	0	0	14	0	**17**
FII seated (DivFII)	1	1	1	0	1	5	0	**9**
Funeral pyre (DivFII)	2	0	1	1	0	8	1	**13**
Peacock (DivFII)	24	24	15	2	22	255	6	**348**
Pietas (DivFII)	0	1	0	0	1	6	0	**8**
Altar (DivFII)	7	15	9	1	12	120	4	**168**
Throne (DivFII)	6	10	4	2	9	83	6	**120**
Qty	**54**	**82**	**47**	**9**	**72**	**691**	**24**	**979**

Table 87: Reverse designs of 177 and 177-178 from *denarii* in hoards closing up to *c.* 250 (n=470)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Annona (MA)	1	2	0	0	2	11	2	**18**
Jupiter (MA)	0	0	0	0	1	1	0	**2**
Mars (MA)	3	7	0	0	6	32	3	**51**
Minerva (MA)	1	2	1	1	2	9	1	**17**
Pietas (MA)	0	1	0	0	0	5	0	**6**
Roma (MA)	1	1	0	1	0	5	1	**9**
Salus (MA)	1	12	3	0	1	60	4	**81**
Woman' (MA)	0	0	1	0	0	2	0	**3**
Commodus Aug	17	38	7	0	21	189	11	**283**
Qty	**24**	**63**	**12**	**2**	**33**	**314**	**22**	**470**

Table 88: Reverse designs of 178-179 and 179-180 from *denarii* in hoards closing up to *c.* 250 (n=605)
No χ^2 testing: sample sizes too small

Design	Britain	Spain & W Med	Rhine	Italy & Adriatic	Western Danube	Eastern Danube	Eastern Med	Qty
Fortuna (MA)	7	19	5	0	11	76	3	**121**
Justitia (MA)	3	2	0	0	0	6	0	**11**
Mars (MA)	4	16	4	1	12	75	5	**117**
Salus (MA)	3	11	4	2	10	71	1	**102**
Victoria (MA)	2	4	1	0	7	30	1	**45**
Commodus Aug	9	40	9	2	24	119	6	**209**
Qty	**28**	**92**	**23**	**5**	**64**	**377**	**16**	**605**

Annexe 5: Commodus

Table 1: Proportions (%) at which *denarii* struck under Antoninus, Aurelius, and Commodus occur in hoards closing *c.* 180-260										
CHRE no.	**Hoard**	**Country**	***tpq***	**Hoard total**	**Total coins of Antoninus**	**Antoninus as % of hoard total**	**Total coins of Aurelius**	**Aurelius as % of hoard total**	**Total coins of Comm**	**Comm as % of hoard total**
16323	Pocreaca	Romania	180	100	9	**9.00**	6	**6.00**	0	-
2781	Grocka	Serbia	180	149	56	**37.58**	17	**11.41**	0	-
9850	Balloo 1839	Netherlands	180	350	46	**13.14**	0	-	1	**0.29**
2612	Gîrla Mare	Romania	180	320	98	**30.63**	38	**11.88**	0	-
8038	Gura Ialomiţei 1	Romania	180	186	11	**5.91**	20	**10.75**	1	**0.54**
1662	Ollerton	England	180	427	69	**16.16**	32	**7.49**	1	**0.23**
16312	Bălăneşti 1958	Romania	181	103	22	**21.36**	15	**14.56**	1	**0.97**
13318	Feulen	Luxembourg	181-182	20	2	**10.00**	4	**20.00**	1	**5.00**
2610	Dumbrăvioara	Romania	180-183	300	111	**37.00**	55	**18.33**	1	**0.33**
16255	Parava 1937	Romania	183-184	270	83	**30.74**	43	**15.93**	5	**1.85**
15473	Unterammergau 1908	Germany	184	106	10	**9.43**	3	**2.83**	1	**0.94**
2613	Alba Iulia 1867	Romania	184-185	612	76	**12.42**	99	**16.18**	7	**1.14**
16318	Gherăieştii Noi	Romania	184-185	271	37	**13.65**	15	**5.54**	3	**1.11**
2614	Desa 1988	Romania	185	222	43	**19.37**	26	**11.71**	10	**4.50**
16319	lunguleţu	Romania	185	27	12	**44.44**	7	**25.93**	2	**7.41**
5265	Briglands	Scotland	186-187	180	53	**29.44**	43	**23.89**	9	**5.00**
5264	Prelasko	Slovenia	178-191	700	190	**27.14**	136	**19.43**	26	**3.71**
49	Bletchley 1987	England	178-191	627	148	**23.60**	46	**7.34**	3	**0.48**
126	Barway	England	178-191	471	136	**28.87**	56	**11.89**	3	**0.64**
2806	Bela reka	Serbia	178-191	322	96	**29.81**	47	**14.60**	8	**2.48**
16736	Radalj	Serbia	178-191	250	70	**28.00**	40	**16.00**	2	**0.80**
5267	Sascut	Romania	178-191	1000	149	**14.90**	168	**16.80**	11	**1.10**
5260	Butoieşti	Romania	178-191	550	30	**5.45**	47	**8.55**	0	-
5268	Barger Compascuum	Netherlands	178-191	312	103	**33.01**	39	**12.50**	11	**3.53**
16146	Bugojno	Bos-Herz	178-191	70	19	**27.14**	17	**24.29**	2	**2.86**
213	Knutsford Area	England	190-191	104	24	**23.08**	16	**15.38**	10	**9.62**
17266	Ostfriesland I	Germany	190-191	27	10	**37.04**	6	**22.22**	4	**14.81**
16320	Peştera Igliţa	Romania	190-191	28	9	**32.14**	14	**50.00**	5	**17.86**
9826	Dura Europos 21	Syria	177-192	18	2	**11.11**	0	-	1	**5.56**
13869	Gualdo Tadino	Italy	180-192	99	25	**25.25**	35	**35.35**	3	**3.03**

Annexe 5: Commodus

Table 1: Proportions (%) at which *denarii* struck under Antoninus, Aurelius, and Commodus occur in hoards closing *c.* 180-260										
CHRE no.	**Hoard**	**Country**	***tpq***	**Hoard total**	**Total coins of Antoninus**	**Antoninus as % of hoard total**	**Total coins of Aurelius**	**Aurelius as % of hoard total**	**Total coins of Comm**	**Comm as % of hoard total**
12460	Mirosaljci	Serbia	187-192	726	146	**20.11**	434	**59.78**	6	**0.83**
1487	Postwick	England	191-192	310	107	**34.52**	67	**21.61**	21	**6.77**
2165	South Shields 1878	England	191-192	100	26	**26.00**	12	**12.00**	8	**8.00**
16325	Săhăteni 1900	Romania	191-192	257	76	**29.57**	41	**15.95**	6	**2.33**
2489	Ugthorpe 1998	England	192	72	21	**29.17**	14	**19.44**	3	**4.17**
16342	Ghindăuani	Romania	193	38	10	**26.32**	12	**31.58**	0	**-**
1322	Littleborough 1994	England	193	76	13	**17.11**	17	**22.37**	7	**9.21**
6995	Bréval	France	193	122	0	**-**	0	**-**	14	**11.48**
16342	Ghindăuani	Romania	193	38	0	**-**	0	**-**	7	**18.42**
2941	Făurei	Romania	193-194	42	13	**30.95**	8	**19.05**	0	**-**
2954	Itești	Romania	193-194	272	47	**17.28**	27	**9.93**	5	**1.84**
16346	Mircești	Romania	193-194	918	224	**24.40**	94	**10.24**	14	**1.53**
9379	Prăjești	Romania	193-194	183	33	**18.03**	18	**9.84**	1	**0.55**
9893	Finkum	Netherlands	194	26	10	**38.46**	10	**38.46**	3	**11.54**
3037	Villach	Austria	193-195	165	1	**0.61**	1	**0.61**	0	**-**
2615	Lujerdiu	Romania	194-195	278	58	**20.86**	110	**39.57**	94	**33.81**
17475	Gnotzheim	Germany	194-195	47	12	**25.53**	6	**12.77**	3	**6.38**
16348	Racova-Chetriș	Romania	195	300	86	**28.67**	50	**16.67**	12	**4.00**
16347	Oboroceni	Romania	195	735	189	**25.71**	109	**14.83**	31	**4.22**
1305	Owston Ferry	England	196	120	1	**0.83**	0	**-**	0	**-**
5275	Măgura	Romania	196-197	2830	617	**21.80**	341	**12.05**	74	**2.61**
13139	Kristendorf 1 1908	Austria	196-197	432	121	**28.01**	168	**38.89**	15	**3.47**
2944	Flonheim	Germany	193-200	400	91	**22.75**	76	**19.00**	100	**25.00**
5490	Diepenveen	Netherlands	201	372	122	**32.80**	135	**36.29**	15	**4.03**
8010	Mastacăn	Romania	202	344	85	**24.71**	48	**13.95**	25	**7.27**
2808	Mór-Felsődobos	Hungary	203	72	10	**13.89**	2	**2.78**	0	**-**
9991	Passewaaij 2000	Netherlands	205	27	9	**33.33**	3	**11.11**	0	**-**
3019	Sveti Petar Mrežnički	Croatia	205	1200	0	**-**	1	**0.08**	0	**-**
17391	Solin	Croatia	205	73	6	**8.22**	0	**-**	4	**5.48**
2616	Sarmizegetusa 1993	Romania	201-206	21	6	**28.57**	4	**19.05**	0	**-**
2911	Abergele 1842 b	Wales	201-206	800	73	**9.13**	23	**2.88**	8	**1.00**
13315	Thamusida - Northern Hoard	Morocco	201-206	33	6	**18.18**	3	**9.09**	5	**15.15**
2918	Arborfield	England	203-206	41	10	**24.39**	4	**9.76**	3	**7.32**

Annexe 5: Commodus

Table 1: Proportions (%) at which *denarii* struck under Antoninus, Aurelius, and Commodus occur in hoards closing *c.* 180-260											
CHRE no.	**Hoard**	**Country**	***tpq***	**Hoard total**	**Total coins of Antoninus**	**Antoninus as % of hoard total**	**Total coins of Aurelius**	**Aurelius as % of hoard total**	**Total coins of Comm**	**Comm as % of hoard total**
5277	Vidin	Bulgaria	201-207	340	100	**29.41**	36	**10.59**	3	**0.88**
2209	Kenilworth I	England	207	65	14	**21.54**	5	**7.69**	0	-
238	Bristol (Rochester Road)	England	208	1480	247	**16.69**	135	**9.12**	60	**4.05**
16337	Ardeoani	Romania	201-210	96	16	**16.67**	4	**4.17**	1	**1.04**
12824	Llíria 1999	Spain	209	5990	1387	**23.16**	1469	**24.52**	1952	**32.59**
13314	Thamusida - Southern Hoard	Morocco	206-210	34	6	**17.65**	3	**8.82**	3	**8.82**
17038	Seligenstadt	Germany	208-210	495	97	**19.60**	5	**1.01**	1	**0.20**
9911	Hargen	Netherlands	210	23	2	**8.70**	0	-	1	**4.35**
5272	Puriceni	Romania	193-211	1170	267	**22.82**	166	**14.19**	35	**2.99**
2807	Mendé	Hungary	193-211	115	30	**26.09**	31	**26.96**	14	**12.17**
533	Handley	England	194-211	639	140	**21.91**	100	**15.65**	39	**6.10**
2965	Lashorst 1899	Germany	197-211	220	48	**21.82**	43	**19.55**	14	**6.36**
17403	Požarevac (Surroundings) 1982	Serbia	197-211	458	107	**23.36**	63	**13.76**	4	**0.87**
755	Muswell Hill	England	209-211	654	64	**9.79**	51	**7.80**	24	**3.67**
16999	Marköbel 1983	Germany	209-211	74	9	**12.16**	3	**4.05**	6	**8.11**
16532	Čortanovci	Serbia	210-213	2459	527	**21.43**	308	**12.53**	112	**4.55**
2522	Darfield 1948	England	213	500	105	**21.00**	53	**10.60**	7	**1.40**
5281	Kecel I	Hungary	214	2596	858	**33.05**	733	**28.24**	303	**11.67**
15419	Libya 1923 - Unknown Findspot	Libya	214	261	22	**8.43**	9	**3.45**	19	**7.28**
3045	Zadar	Croatia	215	273	60	**21.98**	46	**16.85**	17	**6.23**
13116	Carnuntum 2012	Austria	215	104	1	**0.96**	1	**0.96**	7	**6.73**
12902	Castrillo de Cabrera	Spain	211-217	53	13	**24.53**	1	**1.89**	0	-
566	Chadwell St Mary	England	213-217	100	10	**10.00**	1	**1.00**	5	**5.00**
2976	Mainz 1952	Germany	217-218	53	1	**1.89**	7	**13.21**	5	**9.43**
9800	Dura Europos 3 and 4	Syria	217-218	402	57	**14.18**	0	-	13	**3.23**
2617	Frânceşti	Romania	219	1365	249	**18.24**	184	**13.48**	97	**7.11**
5436	Kiziltepe	Turkey	219	424	4	**0.94**	5	**1.18**	9	**2.12**
58	Prestwood A	England	220	113	15	**13.27**	3	**2.65**	5	**4.42**
2990	Obererbach	Germany	218-222	867	245	**28.26**	180	**20.76**	176	**20.30**
2961	Kervian	France	218-222	413	0	-	0	-	22	**5.33**
12493	Trichiana 1967	Italy	218-222	42	5	**11.90**	3	**7.14**	4	**9.52**
9846	Anloo 2008-2009	Netherlands	218-222	115	37	**32.17**	24	**20.87**	1	**0.87**
9824	Dura Europos 19	Syria	218-222	299	0	-	1	**0.33**	1	**0.33**

Annexe 5: Commodus

Table 1: Proportions (%) at which *denarii* struck under Antoninus, Aurelius, and Commodus occur in hoards closing *c.* 180-260										
CHRE no.	**Hoard**	**Country**	***tpq***	**Hoard total**	**Total coins of Antoninus**	**Antoninus as % of hoard total**	**Total coins of Aurelius**	**Aurelius as % of hoard total**	**Total coins of Comm**	**Comm as % of hoard total**
1975	Akenham	England	220-222	118	17	**14.41**	6	**5.08**	5	**4.24**
2924	Blăgești	Romania	222	46	6	**13.04**	2	**4.35**	4	**8.70**
8878	Denarius Hoard (Erimtan Coll)	Turkey	221-222	246	23	**9.35**	18	**7.32**	31	**12.60**
3058	Câmpulung-Muscel	Romania	223	49	2	**4.08**	1	**2.04**	6	**12.24**
5282	Tell Kalak	Jordan	222-225	2350	470	**20.00**	377	**16.04**	141	**6.00**
5503	Bäretswil ZH 1993	Switzerland	226	658	67	**10.18**	38	**5.78**	34	**5.17**
8039	Nireș	Romania	227	30	0	**-**	4	**13.33**	1	**3.33**
3083	Kempten-Lindenberg 1958	Germany	222-228	640	108	**16.88**	112	**17.50**	53	**8.28**
3093	Mainz 1950	Germany	222-228	186	25	**13.44**	25	**13.44**	8	**4.30**
16633	Sigmaringen	Germany	222-228	44	1	**2.27**	1	**2.27**	1	**2.27**
16360	Muntenești	Romania	228	775	237	**30.58**	122	**15.74**	82	**10.58**
2620	Dănești	Romania	228	1337	249	**18.62**	136	**10.17**	129	**9.65**
2869	Spodnja Hajdina	Slovenia	229	66	1	**1.52**	0	**-**	2	**3.03**
13267	Mauer bei Amstetten	Austria	230	68	7	**10.29**	2	**2.94**	2	**2.94**
3085	Kirchmatting	Germany	222-231	1169	30	**2.57**	9	**0.77**	56	**4.79**
3082	Kempten/Spinnerei	Germany	226-231	27	4	**14.81**	0	**-**	1	**3.70**
16362	Târpești	Romania	228-231	137	38	**27.74**	18	**13.14**	0	**-**
16258	Moigrad-Porolissum 2004	Romania	228-231	35	6	**17.14**	0	**-**	2	**5.71**
2622	Turda 1981-1982	Romania	228-231	1982	0	**-**	0	**-**	2	**0.10**
580	East of England	England	231	3124	329	**10.53**	172	**5.51**	1	**0.03**
5285	Ercsi	Hungary	231	386	3	**0.78**	6	**1.55**	5	**1.30**
3132	Wiggensbach	Germany	233	401	8	**2.00**	1	**0.25**	5	**1.25**
7713	Carmel Coast 1990 A	Israel	222-235	162	0	**-**	2	**1.23**	0	**-**
3072	Falkirk	Scotland	222-235	1925	389	**20.21**	182	**9.45**	48	**2.49**
12486	Vicenza 1908 - Surroundings	Italy	222-235	110	8	**7.27**	17	**15.45**	7	**6.36**
3130	Welzheim	Germany	222-235	670	71	**10.60**	10	**1.49**	31	**4.63**
16479	Iezer	Romania	222-235	45	7	**15.56**	9	**20.00**	3	**6.67**
3050	Baden-Baden 1824	Germany	222-235	562	57	**10.14**	51	**9.07**	21	**3.74**
792	Standish 1926	England	228-235	137	8	**5.84**	2	**1.46**	4	**2.92**
3095	Marnbach	Germany	228-235	165	2	**1.21**	0	**-**	2	**1.21**
16650	Rembrechts	Germany	230-235	88	3	**3.41**	2	**2.27**	4	**4.55**
7483	Börgönd	Hungary	231-235	566	7	**1.24**	5	**0.88**	7	**1.24**
16370	Kučevo	Serbia	231-235	207	2	**0.97**	0	**-**	1	**0.48**

Annexe 5: Commodus

Table 1: Proportions (%) at which *denarii* struck under Antoninus, Aurelius, and Commodus occur in hoards closing *c.* 180-260										
CHRE no.	**Hoard**	**Country**	***tpq***	**Hoard total**	**Total coins of Antoninus**	**Antoninus as % of hoard total**	**Total coins of Aurelius**	**Aurelius as % of hoard total**	**Total coins of Comm**	**Comm as % of hoard total**
13270	Pottenbrunn 1985	Austria	233-235	21	1	**4.76**	0	-	0	-
3091	Leskovec	Slovenia	235	1200	9	**0.75**	1	**0.08**	3	**0.25**
13265	Linsberg	Austria	235	286	15	**5.24**	11	**3.85**	4	**1.40**
12482	Oulches 1850-1900	France	235-236	33	0	-	0	-	1	**3.03**
5288	Niederaschau	Germany	235-238	800	9	**1.13**	4	**0.50**	10	**1.25**
2784	Ravna	Serbia	235-238	187	2	**1.07**	5	**2.67**	6	**3.21**
2520	Cadeby 1912	England	235-238	28	1	**3.57**	3	**10.71**	1	**3.57**
2523	Darfield 1947	England	235-238	481	42	**8.73**	24	**4.99**	1	**0.21**
3120	Sulakyurt	Turkey	236-238	429	1	**0.23**	0	-	0	-
5289	Köln Gertrudenstraße 1909	Germany	236-238	22500	386	**1.72**	258	**1.15**	121	**0.54**
16530	Supska 1995	Serbia	236-238	935	85	**9.09**	52	**5.56**	71	**7.59**
3096	Mehovine	Serbia	236-238	2000	11	**0.55**	6	**0.30**	15	**0.75**
8848	Postojna	Slovenia	236-238	338	11	**3.25**	7	**2.07**	7	**2.07**
2627	Ţaga	Romania	239	1013	58	**5.73**	65	**6.42**	96	**9.48**
16197	Verona 1891 - Ponte Postumio	Italy	240	475	119	**25.05**	77	**16.21**	23	**4.84**
1435	Dereham, Near	England	241	1100	18	**1.64**	16	**1.45**	15	**1.36**
17396	Vis	Croatia	241-243	78	1	**1.28**	1	**1.28**	1	**1.28**
3517	Yatağan	Turkey	243	243	3	**1.23**	1	**0.41**	1	**0.41**
3280	Jeledinţi	Romania	238-244	27	0	-	2	**7.41**	0	-
3446	Stellata	Italy	238-244	1800	12	**0.67**	14	**0.78**	19	**1.06**
2633	Cristeşti 1963	Romania	243-244	118	0	-	2	**1.69**	4	**3.39**
9304	Timişoara 1958	Romania	244-247	66	5	**7.58**	17	**25.76**	1	**1.52**
2639	Galicea mare	Romania	246-247	800	5	**0.63**	7	**0.88**	10	**1.25**
5507	Köngen	Germany	246-248	651	1	**0.15**	0	-	5	**0.77**
16541	Mezul 1966 2	Serbia	247-248	1267	8	**0.63**	1	**0.08**	16	**1.26**
7744	Bârca 1962	Romania	244-249	1931	17	**0.88**	18	**0.93**	32	**1.66**
24	Timsbury 2011	England	244-229	20	1	**5.00**	0	-	0	-
7502	Bakonyszombathely-Páskum	Hungary	247-249	1865	56	**3.00**	41	**2.20**	31	**1.66**
2785	Sikirica 1952	Serbia	247-249	292	1	**0.34**	1	**0.34**	3	**1.03**
4788	Skopje	N Maced	248-249	1022	24	**2.35**	19	**1.86**	16	**1.57**
2799	Jablanica	Serbia	249	2211	1	**0.05**	1	**0.05**	3	**0.14**
3406	Reka Devnia 1929	Bulgaria	243-251	101096	13717	**13.57**	11989	**11.86**	3743	**3.70**
5292	Russe 1916	Bulgaria	249-251	1602	23	**1.44**	122	**7.62**	112	**6.99**

Annexe 5: Commodus

Table 1: Proportions (%) at which *denarii* struck under Antoninus, Aurelius, and Commodus occur in hoards closing *c.* 180-260										
CHRE no.	**Hoard**	**Country**	***tpq***	**Hoard total**	**Total coins of Antoninus**	**Antoninus as % of hoard total**	**Total coins of Aurelius**	**Aurelius as % of hoard total**	**Total coins of Comm**	**Comm as % of hoard total**
4843	Eastern Turkey	Turkey	249-251	2711	87	**3.21**	72	**2.66**	15	**0.55**
4846	Bârca 1937	Romania	249-251	67	0	-	0	-	1	**1.49**
3305	Ladenburg 1877/82	Germany	249-251	68	4	**5.88**	0	-	0	-
2656	Bârca 1963	Romania	250-251	127	0	-	0	-	1	**0.79**
2657	Bocşa Română	Romania	251	119	13	**10.92**	2	**1.68**	3	**2.52**
3133	Abrud	Romania	251-252	2060	33	**1.60**	26	**1.26**	73	**3.54**
13037	Courcelles-sur-Nied 2005	France	251-253	191	3	**1.57**	2	**1.05**	0	-
7501	Péliföldszentkereszt II	Hungary	251-253	244	5	**2.05**	5	**2.05**	4	**1.64**
6113	Le Sablon	France	251-253	444	2	**0.45**	3	**0.68**	5	**1.13**
5299	Wiesbach Mangelhausen	Germany	251-253	402	2	**0.50**	1	**0.25**	6	**1.49**
5300	Gračič	Slovenia	253	431	0	-	0	-	2	**0.46**
3198	Clavier III	Belgium	254	1679	0	-	0	-	1	**0.06**
2663	Stăneşti	Romania	254-255	1119	2	**0.18**	3	**0.27**	6	**0.54**
2875	Balozsameggyes	Hungary	255	337	3	**0.89**	2	**0.59**	18	**5.34**
2876	Bušetina	Croatia	257	30	3	**10.00**	0	-	0	-
9746	Slatina 1	Bulgaria	257	37	1	**2.70**	1	**2.70**	0	-
7431	Xanten	Germany	257-258	14	1	**7.14**	0	-	0	-
13260	Gösseling	Austria	257-258	1361	18	**1.32**	15	**1.10**	15	**1.10**
8090	Krog	Slovenia	259	2290	0	-	0	-	1	**0.04**
9792	Dura Europos 5	Syria	253-260	29	0	-	3	**10.34**	2	**6.90**
5418	Banasa - House of Fonteius	Morocco	257-260	51	0	-	1	**1.96**	0	-
6543	Baden	Switzerland	258-260	1872	6	**0.32**	8	**0.43**	1	**0.05**
					Total: 2573	**Average: 14.44%**	**Total: 20840**	**Average: 10.60%**	**Total: 8800**	**Average: 4.62%**