Bimetallism, Coinage, and Empire in Persian Anatolia

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1. Introduction

When Cyrus the Great conquered Asia Minor in the 540s he inherited a bimetallic currency system from the vanquished Lydian king Croesus which endured until 334/3, when the Persians themselves were swept from Asia Minor by Alexander the Great, and which then survived into the Hellenistic period. The fact that Persia operated a bimetallic currency system is not in itself unusual: Rome did likewise from Caesar's dictatorship onwards, and bimetallic currency systems have operated in many societies since.[1] Where the Persian case differs from these historical parallels is in the insistence by Greek numismatists that the Persians maintained an immutable 13.33:1 silver/gold exchange rate in Asia Minor from the 540s down to the 330s despite significant changes in the silver/gold ratio in neighbouring parts of Greece in the late 5th and 4th centuries.[2] This has been driven by a belief that the Persian Empire continued to mint gold darics and silver sigloi in parallel throughout these two centuries and thus that the 13.33:1 exchange rate which this pairing of denominations embodies remained constant. Despite the fact that Ian Carradice decisively challenged this assumption about the continued production of sigloi in the 4th century over three decades ago, the idea that the Persians managed to maintain an immutable silver/gold exchange rate has remained largely unchallenged in the scholarship.[3] If correct, this would suggest that the Persian Empire had found a way to insulate itself from market forces and impose the use of an exchange rate which was favourable to itself irrespective of the relative price of silver and gold. Given that, so far as economic historians are concerned, no state has ever achieved such a feat, this would be a quite remarkable finding.

As we shall argue, however, a careful re-examination of the evidence does not support this view and instead suggests that the silver/gold exchange rate in Persian-controlled Asia Minor repeatedly fluctuated downwards in the late 5th and 4th centuries in response to changes in the supply of gold and silver in neighbouring Greece.[4] This reconstruction of the history of the

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[1] Rome: Butcher, Ponting 2014. Medieval, early modern, and modern: Redish 2000.

[2] For the conventional view see Le Rider 2001: 163-4 who, in setting out this scenario, exercises due caution as to its verifiability.

[3] Carradice 1987.

[4] Various aspects of this reconstruction have been foreshadowed in earlier work. Johnston 1932 saw that the 13.33:1 ratio broke down but thought that sigloi were replaced with Kyzikene electrum. Guépin 1962 suggested that sigloi production ended *ca.* 425 which, as Carradice 1987 subsequently demonstrated, is correct albeit a quarter of a century too early. However, Guépin failed to connect this demonetization of the sigloi to a change in the silver/gold ratio. Figueira 1998: 496-527 provides the most complete survey of the evidence for a changing ratio in Greece at the end of the Peloponnesian War but leaves aside the question of what impact this might have had on Asia Minor. As discussed in Section 3.3 below, both Carradice 1987 and Hardwick 1996 had the evidence before them for a break in the 13.33:1 ratio in Asia Minor in the last decade of the 5th century but did not make

silver/gold exchange rate in Persian-controlled Asia Minor in turn has consequences for how we use coinage to write the economic and political history of this region in the 4th century and for how we understand the character of the Persian Empire in the century before it was swept away by Alexander.

2. Bimetallism

2.1 A Brief Introduction to Bimetallism

Herodotus states in Book 1 of the *Histories* that the Lydian kingdom in western Asia Minor was the first state to mint gold and silver coins (presumably as opposed to an electrum alloy coinage which had of course existed for some time before Croesus).[5] Although this assertion has often been questioned, finds from the excavations at Sardis have recently validated Herodotus' claim, and we now know that bimetallic coinage was in fact first introduced in the second quarter of the 6th century under the Lydian king Croesus.[6] In bimetallic currency systems, the value of a coin is determined by an exchange rate between two metals which is fixed by the state. In the case of the bimetallic coinage of Croesus, he fixed a silver/gold exchange rate of 13.33:1. He then minted silver staters to a theoretical weight of 10.75g and gold croesids to a theoretical weight of 8.06g. When we apply the 13.33:1 exchange rate, this produces a neat equivalency whereby 10 silver staters = 1 gold croesid.[7]

Although the Lydian kingdom under Croesus was the first state to introduce bimetallic coinage, the concept of bimetallism is already attested in the accounts from the Artemision deposit at Ephesos (late 7th/early 6th century) and no doubt goes back long before this.[8] The accounts record revenue from various sources in terms of pure gold (καθαρὸς χρυσός) and fine silver (ἄργυρος), and for the overall total the silver in the accounts is converted into gold (here at a silver/gold exchange rate of 11.66:1).[9] These accounts illustrate how gold was used as the metal of account in a bimetallic system by which all other metals (e.g. silver, electrum) were valued at whatever fixed exchange rate the state had decided upon. As later epigraphic and numismatic evidence shows, gold remained the metal of account in Asia Minor right down to the Hellenistic period.[10]

It is important to emphasize that, in this accounting convention, references to gold in our texts can as easily be references to *value* ('I have 10 darics worth of silver') as to actual *metal* ('I have 10 darics'). By accounting only in gold, the Persians were able to maintain price and revenue stability, even while the relative value of silver was shifting. Hence, in a bimetallic

this connection. More recently, the realization that sigloi were a satrapal rather than a royal coinage (see n. 153 below) makes it politically conceivable for the Greeks of Asia Minor to have taken on the job of producing silver coinage for this region of the Persian Empire when sigloi production ceased.

[5] Hdt. 1.94.1: πρῶτοι δὲ ἀνθρώπων τῶν ἡμεῖς ἴδμεν νόμισμα χρυσοῦ καὶ ἀργύρου κοψάμενοι ἐχρήσαντο ('[The Lydians] were the first men whom we know to use coinage struck from gold and silver').

[6] Cahill, Kroll 2005.

[7] The formula is: (gold coin weight x exchange rate) / silver coin weight = number of silver coins which equal one gold coin. Thus, for the bimetallic coinage of Croesus: (8.06g x 13.33) / 10.75g = 9.99 staters. Note that, because in general we are rounding the weights of the silver coins to the nearest 0.1g, the figure for the number of coins will often be off by 0.1. Variation within this margin of error is therefore not significant.

[8] Kroll 2008: 20-1, Kroll 2020, Bresson 2020a.

[9] *I. Ephesos* 1 with Kroll 2020.

[10] See in general Callataÿ 2008 and for Miletos in the 3rd/2nd century Sosin 2001: 166-75.

currency system, it becomes a good rule of thumb to assume that any change in the silver standard or denominational structure of a coinage is probably driven by a change in the relationship of silver to gold. By contrast, the Greek world outside the sphere of Persian control operated a monometallic currency system with silver as the metal of account and gold coinages usually reserved for emergencies. In this system, changes to silver specie can more straightforwardly be read as an index of prosperity or impoverishment in a way which, if applied to a bimetallic currency, can be deeply misleading.[11]

In understanding how a bimetallic currency system functions, we need to pay attention to three important ratios. How each of these ratios worked can be conveniently illustrated using the well-documented example of Athens in the second half of the 5th century:

1) The silver/gold exchange rate on the open market – This exchange rate will be highly sensitive to fluctuations in the relative scarcity/abundance of silver/gold and so will change continually. For example, David Lewis used epigraphic evidence from Athens for the amount of silver spent on honorific crowns and the amount of gold which this bought to establish how the market exchange rate fluctuated at Athens 434/4 – 348/7.[12] Between 434/3 and 420/19, we see fluctuations between 13.5:1 and 16.66:1 at a time when, by contrast, the state exchange rate remained fixed at 14:1.[13]

2) The silver/gold exchange rate the state would prefer to use – The state sets its own exchange rate in order to insulate itself from market volatility. Up to a point, the power and legal authority of the state allows it to enforce the use of this preferred exchange rate. For example, Wesley Thompson used the accounts for the building of the Parthenon to establish that in both 440/39 (a purchase of gold by the state) and in 434/3 (a sale of gold by the state) the Athenian state's preferred exchange rate remained 14:1.[14] By contrast, Lewis' evidence for the market exchange rate attests a more volatile and less favourable market rate at this time: 16.66:1 pre-434/3 and 15:1 in 434/3 itself.[15]

3) The ratio of gold to silver coins – One way the state could use its power and legal authority to guarantee the use of a favourable exchange rate was to mint coins whose weights and denominations produced neat equivalencies which thus 'baked in' the state's preferred exchange rate. For example, we have already seen with the bimetallic coinage of Croesus that 10 silver staters = 1 gold croesid at the Lydian state's preferred exchange rate of 13.33:1. At Athens at the beginning of the Peloponnesian War, the 14:1 exchange rate worked out at 27 Attic drachms = 1 gold daric.[16] The attractiveness of this pricing structure may have been that, when paying soldiers and sailors, it worked out as roughly a drachm a day. Significantly, when it became impossible to maintain the 14:1 exchange rate on which this equivalency was based during the Ionian War (413-404) and the first half of the 4th century, states chose to alter the weight standard and/or denominations of the silver coins to accommodate a lower exchange rate rather than jettison this 27 silver coins = 1 daric pricing structure (Section 3.3 below).

[11] See below the concluding remarks in Section 6.

[12] Lewis 1968, now to be supplemented with Figueira 1998: 513 (updated figures for 434/3-398/7) and 522-4 (some criticism of Lewis' methodology).

[13] Lewis 1968: 107, nos. 1-12.

[14] Thompson 1964: 103 discussing *IG* I^3 458.15-17 (440/39) and 449.389-91 (434/3).

[15] Lewis 1968: 107, nos. 1-2.

[16] (8.35g x 14) / 4.33g = 26.99.

2.2 The Problem of Persian Bimetallism

The bimetallic currency system of the Persian Empire was a subject of considerable perplexity to economists in the first half of the 20th century. The failures of bimetallic currency systems in France and the United States in particular during the second half of the 19th century had illustrated just how difficult it was to maintain the state's preferred silver/gold exchange rate when ratios in neighbouring regions changed.[17] Yet, according to Greek numismatists, this is precisely what Persia had achieved in its far western territories for a period of over two centuries. The orthodoxy was (and largely remains) that the silver/gold exchange rate of 13.33:1, first introduced by Croesus in the second quarter of the 6th century, was maintained by Persia right down to Alexander the Great's conquest of Anatolia in 334/3. This claim is somewhat surprising given that in neighbouring Greece there were downward fluctuations in the state exchange rate from 14:1 at the beginning of the Peloponnesian War, to 12:1 by the war's end, and finally to 10:1 by the time Philip II issued his gold coinage in the 350s.

This apparent paradox even caught the attention of John Maynard Keynes. In a letter to the Irish economist Joe Johnston in response to a paper Johnston had published on Persian bimetallism in the Irish Classics journal *Hermathena*, Keynes wrote:

> 'I have the impression that the bi-metallic system of the Persian Empire worked efficiently for a long period of years, without either metal driving the other out of circulation, in spite of moderate disparities from the Persian ratio on the adjoining Greek territories, and have often wondered how this could have been achieved. I suspect that the Temple hoards operated to preserve the official ratio, much as a Central Bank with very large reserves might do today. We know what enormous figures the Temple hoards had reached by the time of Alexander, and if the Temples always rigorously observed the official ratio, this might well have produced the necessary stabilising effect'.[18]

In referring to the Persian bimetallic system working well, 'without either metal driving the other out of circulation, in spite of moderate disparities from the Persian ratio on the adjoining Greek territories', Keynes is wondering how Persia managed to avoid the problem of speculation or arbitrage destabilizing this bimetallic currency system, since this had played such an instrumental role in disrupting bimetallic systems in the second half of the 19th century.[19]

Arbitrage is the practice of taking advantage of price disparities between two or more markets, in this case the markets for gold and silver in Greece and Asia Minor, in order to make a profit. For example, we shall see below (Section 3.2) a scenario in which silver became scarcer in Greece in the late 5th century, its value consequently went up, and the silver/gold exchange rate therefore went down, in this case from 14:1 to 12:1, because the same amount of gold now bought less silver. In these circumstances, if Persia maintained the exchange rate in Asia Minor at 13.33:1, then this would create an opportunity for arbitrage: gold could now be bought 'cheap' in Greece (relative to the price in Asia Minor) and then used to buy 'cheap' silver in

[17] Redish 2000: 167-206 (France), 209-39 (United States).

[18] Letter dated 11/4/1933 and quoted in Johnston 2003: 55-6. The paper prompting this exchange is Johnston 1932.

[19] Gold arbitrage is, for example, central to the plot of Émile Zola's *L'Argent* (1891) which explores the world of the Paris Bourse in the period 1864-1869. For further discussion of bimetallism in 19th century France see Thuillier 1962, Thuillier 1983, Boyer-Xambeu *et al*. 1994, and Flandreau 2004.

Asia Minor (relative to the price in Greece) in order to make a profit. This would result in gold disappearing from circulation in Greece as it was melted down and exported to Asia Minor, and the same happening to silver in Asia Minor, thus injecting further instability into the silver/gold exchange rate in response to these changes in the relative scarcity/abundance of these metals.[20]

It is worth underlining that this is precisely the outcome predicted by Gresham's Law, namely the principle that 'bad' money (coinage where the commodity value of the metal is considerably below the face value of the coins) drives 'good' money (coinage where commodity value and face value are much the same) out of circulation.[21] This places a hard limit on the state's ability to set an exchange rate favourable to itself irrespective of market conditions. If the Persian state insisted on keeping the exchange rate fixed at 13.33:1 rather than altering it to accommodate these significant changes in the market rate, this would only create further opportunities for arbitrage and thus for this arbitrage-driven cycle to continue.[22]

Indeed, we have a contemporary example of what could go wrong if a state did not heed this lesson. Dionysios I of Syracuse (reigned 405-367) tried to maintain a 15:1 silver/gold ratio.[23] To some extent, Sicily was insulated by distance from developments in the eastern Mediterranean, and this may have given Dionysios more leeway. Nevertheless, it is striking that Syracusan production of silver coinage apart from decadrachms appears to have already come to a halt by *ca.* 400-390 (and it is unlikely the decadrachms continued much longer thereafter),[24] and did not restart until the reign of Timoleon (343-337), who issued silver coinage reflecting a 12:1 rate.[25] This is particularly notable given the city's long history of producing silver coinage prior to this point and the windfall of silver which it had received from defeating the Athenian expedition in 413. In accordance with Gresham's Law, we should see Sicilians saving their old silver coinage rather than spending it at an unfavourable 15:1 ratio. This is the same phenomenon that led to hoarding of old Roman silver in the third century AD when debased coins were introduced. Gresham's Law affects why hoards are buried, but not why hoards are abandoned, hence we need to be a bit cautious, but the sheer extent of

[20] The fact that there is no evidence for gold arbitrage is an argument in favor of shifting ratios. We know that gold was an important medium for the storage of wealth for rich Athenians. It was held not as coins but as plate that was weighed and exchangeable as a commodity. See Vickers 1990 for the literary and physical evidence as well as a good argument for why we see limited survival. While the gold mines on Thasos and Siphnos stopped producing by the Classical period (Hdt. 6.46 and 3.57) there is no reason not to think that the gold they produced was still in circulation. In addition, gold mining was still active in Thrace at the time Brasidas seized Amphipolis as we learn from Thucydides, himself a gold miner (Thuc. 4.105).

[21] https://eh.net/encyclopedia/greshams-law/.

[22] Redish 2000: 184-5.

[23] Interestingly, the ratio in Sicily was increased to 15:1 just before Dionysios came to power. When gold coins were first introduced to Sicily probably less than a decade earlier, they were at a 13:1 ratio. The increase in ratio probably reflects the fact that Sicily was experiencing the reverse of what was happening within the collapsing Athenian Empire and saw an influx of silver rather than a depletion. The increase in ratio may have been a reasonable short-term correction, but, as discussed above, was unsustainable. See Fischer-Bossert 2017: 34.

[24] Boehringer 1979, Boehringer 2006, Fischer-Bossert 2012: 150-1, Fischer-Bossert 2017: 18-20. Syracuse perhaps resembles France of the late 1850s, which tried to maintain a silver/gold ratio of 15.5:1 while abroad the price of gold was falling. As a result, silver coins disappeared from circulation and silver exports soared: Redish 2000: 181-5.

[25] It should be noted that this shift to 12:1 (implied from the coins: 1 AV 10 litra (2.15g) = 3 AR staters (8.6g) happened at a time when Macedonia and western Anatolia were shifting to 10:1 (see Section 4.5 below). Once again, distance from the Aegean appears to have insulated Sicily to some extent from changes occurring there.

recovered silver hoards from Sicily in this period points to Dionysios' policy having a tangible impact. Faced with this situation, Dionysios decided to experiment with using a bronze coinage in place of silver, and a number of the anecdotes in Book 2 of Pseudo-Aristotle's *Oeconomica* appear to reflect his machinations in sustaining this system.[26]

It could, of course, be argued that arbitrage is an anachronistic notion to introduce into the economic history of the ancient world, and consequently that the long-term stability of Persia's silver/gold exchange rate only appeared to be a problem to Keynes and Johnston because they were imposing inappropriate modern parallels on the ancient evidence. However, it is worth emphasizing that the difference between how arbitrage operated in antiquity and how it worked in 19th century Europe is one of scale rather than of being a qualitatively different phenomenon. After all, all trade is fundamentally a form of arbitrage – of taking a good from an area where its value is less to an area where it is more highly valued. For the Greek world, there is no better example of this than the grain trade. Xenophon's description in *Oeconomicus* 20.27-28 is worth quoting:

> You mean, Ischomachos, that your father naturally loved farming as intensely as merchants love grain. So deep is their love of grain that on receiving reports that it is abundant anywhere, merchants will voyage in quest of it: they will cross the Aegean, the Euxine, the Sicilian sea, and when they have got as much as possible, they carry it over the sea and actually stow it in the very ship in which they themselves sail. And when they need money they don't unload the grain just anywhere, but they carry it to the place where they hear that grain is most valued and the people prize it most highly, and deliver it to them there. Yes, your father's love of farming seems to be something like that.[27]

In order for arbitrage to occur, three basic pre-conditions need to be met:

1) Knowledge of price disparities – We can be certain that every city which minted precious metal coinage will have known the price of these commodities at the time it minted these coins. If the city had precious metal mines in its territory, then it was almost certainly exporting these metals and thus aware of their market value. If instead the city had no mines in its territory and had to purchase the metal on the open market, then it would discover the metal's price in this way. Alternatively, even if the city was melting down precious metals it already possessed (e.g. in the form of bullion or old/foreign coinage), it would be doing so to meet a cash expenditure and would thus need to establish what the buying power of this metal was before minting the coins. In all three scenarios, the state clearly had an incentive to find out where these precious metals could be bought or sold for the best price. This is not to say that a Greek state did not have a fixed need for silver based upon the need for the coinage. The fact that a city's troops were expecting 10 T in pay was not going to change based on daily fluctuations in relative commodity prices. What would be potentially impacted is how the city chose to procure that silver for that need. Given how preternaturally well-networked the Aegean basin was, it is hard to imagine that knowledge of price disparities between Greece and Asia Minor did not become

[26] Ps-Arist. *Oec.* 2.2.20 = 1349a15-1350a7, esp. 1349b34-7 (during a period of silver scarcity Dionysios persuades the Syracusan assembly to vote that his tin coinage should be considered silver – on the identity of these δραχμαὶ καττιτέρου see Boehringer 1979: 26-9), 1349b19-33 (Dionysios tricks the Rhegians and Syracusans into revealing their hoarded silver).

[27] We can see a similar practice today in the way tankers are used to store oil at sea when there is an expectation that prices will rise. Compare, too, the similar description of the grain trade in Lysias 22.14-15 as well as the measures the Athenians took to defeat this speculation. We thank Thomas Figueira for drawing this parallel to our attention.

known in short order not only to states, but, just as importantly for the operation of arbitrage, to private individuals.

2) The ability to make good on price disparities – The means by which knowledge of price disparities was disseminated (i.e. the dense networks of maritime trade which criss-crossed the Aegean) was also the means by which individuals could make good on these price disparities between Greece and Asia Minor and thus set Gresham's Law in motion. While the task of transporting precious metals between Greece and Asia Minor imposed transaction costs on the business of arbitrage, if the profit margin exceeded these costs then the task of transporting the metals was not by itself prohibitively difficult or expensive.

3) The possibility of exogenous shocks to the market for precious metals – Possibilities for arbitrage are at their greatest when a sudden scarcity or abundance of a precious metal dramatically alters the market exchange rate (e.g. as the California Gold Rush did in 1848, with dire consequences for the excessively rigid bimetallic systems of both the United States and France).[28] Just within the Classical period, we have three examples of this kind of exogenous shock from the Aegean basin: **i)** the abundance of silver precipitated by the discovery of the 'third contact' at Laurion in the 510s/500s and subsequently by the enormous silver coinage of Athens in the 5th century (Section 3.1); **ii)** the scarcity of silver which stemmed from a variety of causes in the last decade of the Peloponnesian War (Section 3.2); **iii)** the abundance of gold which resulted from Philip II opening the Krenides mines in the mid-350s and from his subsequent coinage, and to which the looting of gold from sanctuaries in mainland Greece at this time may also have contributed (Section 4.2).[29]

3. The Fifth Century

3.1 The Impact of the Opening of the Laurion Mines

Although in what follows in this section our focus will primarily be on events from the end of the 5th century, it is worth noting an episode from the very beginning of the 5th century which already shows the Persian authorities actively managing their bimetallic coinage in order to accommodate fluctuations in the silver/gold exchange rate.

It has often been observed that, if we assume the use of a 13.33:1 exchange rate in Persia, then the introduction of the heavier gold daric under Darius (8.35g rather than the croesid stater's 8.06g) would have 'broken' the 1 gold coin = 10 or 20 silver coins equivalency which the Persians had inherited from the Lydian kingdom. This was then 'fixed' when a heavier silver siglos was introduced in the 480s under Xerxes (Carradice Type 3b – 5.55g rather than 5.4g).

[28] For further discussion of this episode see the introduction to Section 4.3 below.

[29] For the looting of sanctuaries see Davies 2007, esp. pp. 81-4 where he notes that the size of Philip II's coinage suggests that the volume of gold coming out of Krenides dwarfed the 325 T which the Phokians seized from Delphi. This influx of gold seized from the sanctuary would have had an impact on central Greece, but to explain the changes we see in the rest of the Greek world we need to look to Krenides. As an aside, one should keep in mind that, with the exception of Athens that turned its coinage into a commodity, most mine production would not have been coined by the miner. The notion that large denomination Thracian and Macedonian coins were struck for tribute has long been discounted (Wartenberg 2015); that would have been paid as bullion. There is no reason to think Philip's new gold coinage would have had an advantageous international market in its early phases and that his gold coinage would reflect a substantial part of the discovery. In fact, the earlier history of Greek gold discoveries did not result in any gold coinage. The evidence of Diod. 16.8.6-7 speaks only to gold discoveries. The easiest explanation for Philip's large silver coinage is that at least some of the silver was purchased with gold (which would of course put pressure on the ratio).

On the assumption that the 13.33:1 exchange rate was immutable, some scholars have considered this simply to have been an error on the part of Darius' government which was soon put right by his successor.[30] However, if we allow that the silver/gold exchange rate could change (as we will see it repeatedly do in the late 5th century and throughout the 4th century) and posit that it had dropped to 13:1 in the last decade of the 6th century, then Darius' reform would in fact have served to *maintain* the 1:20 ratio between gold and silver coins.[31]

We would speculate that the fall in the value of silver reflected by the return to the 13.33:1 rate under Xerxes reflects the large amount of silver which was emanating from the Greek world at this time. In particular, following the discovery of the 'third contact' at Laurion in the 510s/500s, in the 490s and 480s Athens had begun to mint silver coinage both continuously and at previously unparallelled levels of production. This abundance of silver was probably responsible for first establishing the 14:1 rate at Athens which subsequently remained unchanged until the late 410s. If that is correct, then we may infer from the rapid return to 13.33:1 in Persia and the stability of this rate until the 410s that opportunities for arbitrage existed when Persia was at 13:1 and Athens at 14:1 which apparently did not exist when Persia was at 13.33:1 (i.e. within a 5% differential). The importance of this modest adjustment is in how it shows that, long before the more dramatic shifts in the exchange rate of the late 5th and 4th centuries, the Persians were aware that their bimetallic coinage had to be managed to reflect changing supply and demand even if the triggering event happened beyond their borders.

Table 1. Summary of the Lydian and Persian bimetallic coinages in the 6th and 5th centuries.

Lydian/Persian Coinages	Gold Coin	Silver Coin	Silver/Gold Exchange Rate	Ratio of Gold to Silver Coins
Croesids (Croesus, Cyrus, Cambyses)	8.06g (stater)	10.75g (stater)	13.33:1	(8.06g x 13.33) / 10.75g = 10
Carradice Type 1 (Darius)	-	5.4g (siglos)	13.33:1	(8.06g x 13.33) / 5.4g = 20
Carradice Types 2-3a (Darius – *ca.* 500)	8.35g (daric)	5.4g (siglos)	13:1	(8.35g x 13) / 5.4g = 20
Carradice Types 3b-4 (Xerxes – 480s)	8.35g (daric)	5.55g (siglos)	13.33:1	(8.35g x 13.33) / 5.55g = 20

3.2 Silver Scarcity at Athens in the Ionian War

As just discussed, in the decades prior to the Peloponnesian War, both the 14:1 silver/gold state exchange rate at Athens and the 13.33:1 state exchange rate in Asia Minor remained stable. We may infer from this stability that a disparity of up to 5% in the state exchange rate between neighbouring territories was insufficiently great to encourage arbitrage. Presumably, in cases where the disparity between exchange rates was this small there was no incentive to arbitrage the difference because any potential profit would be swallowed up by the transaction costs of taking advantage of this opportunity. It was only in the course of the Ionian War (413-404) that the disparity between Greece and Asia Minor became sufficiently great to encourage arbitrage and thus precipitate volatility in the state exchange rate.

There is both epigraphic and numismatic evidence for this volatility in the exchange rate at Athens. As Wesley Thompson pointed out, the accounts of the Hellenotamiai for 409/8 attest two different rates being used in different parts of this document: either 13:1 or 10:1 at one

[30] See e.g. Karwiese 1993, Alram 2012: 64, 66-7.

[31] In the context of tribute collection Hdt. 3.95.1 attests a 13:1 ratio for the reign of Darius, albeit in a passage where his maths has been heavily criticized: Asheri *et al.* 2007: 493-4.

point, and either 12:1 or 11:1 at another.[32] Moreover, the weight and denominations of the gold coinage which Athens minted 407-404 implies a state exchange rate of 12:1 being employed by this point.[33] Unfortunately, Lewis was only able to find evidence for the market rate relating to before and after the period we are interested in (i.e. 415/14, 414/13, and 402/1).[34] Nevertheless, the rates attested for these years suggest that there was an appreciable and permanent drop in the market rate in the decade between our data points: whereas the rates for 415-413 are around 14:1, those for 402/1 are around 11:1 (the lowest point the market rate reaches until 348/7), and throughout the first half of the 4th century it remains in the range 13:1-12:1.[35] At this 12:1 exchange rate, there would now only be 24 Attic drachms = 1 daric.[36] In terms of gold, therefore, it was costing the Athenian state more to buy the same services (i.e. a soldier or sailor's labour for a day).

The cause of this volatility in the state exchange rate appears to be the silver scarcity which Athens experienced during the Ionian War.[37] Throughout the 5th century, and in particular from the 450s onwards, Athens produced unprecedented volumes of silver coinage.[38] While part of the silver for this coinage clearly came from the mines of Laurion, the majority must have come from the tribute payments and taxes which the Athenian Empire collected.[39] Most of this new silver coinage which Athens created did not remain in the Aegean basin, but ended up disappearing into the economies of Egypt, the Levant, and beyond. This loss of silver from the Aegean basin was a result of the trade deficit which the Greek world ran with these Near Eastern economies: for example, Greeks bought many Egyptian goods with their silver (above all grain), but Egyptians did not do likewise with Greek goods, resulting in a net loss of silver for the Greek world.[40]

So long as Athens continued to have access to the Laurion mines and to collect silver from its empire through tribute and taxes, this net loss of silver could be offset from what was received through these sources. However, a concatenation of setbacks in the years 413-411 produced a situation in which Athens lost its entire silver reserves at precisely the moment when it was both receiving dramatically less silver and spending a great deal more of it than it had done in the past. Before embarking on the Sicilian Expedition in 415, the Athenian state had still had considerable silver reserves, as evidenced by the 3,000 talents which were set aside for the expedition in March 415.[41] However, with the Peloponnesian fortification of Dekeleia in summer 413, the Athenian state now lost access to silver from the Laurion mines and in turn

[32] Thompson 1964: 105-11 and Lewis 1968: 106 discussing *IG* I^3 376.54 (13:1 or 10:1), 114-16 (11:1 or 12:1).

[33] Thompson 1964: 111-13.

[34] Lewis 1968: 108, nos. 16-19.

[35] Lewis 1968: 108, nos. 20-44 with Figueira 1998: 513 for updated figures on 415/14 and 414/13.

[36] (8.6 x 12) / 4.33 = 24 Attic drachms.

[37] For discussion on this point and of the opposing hypothesis that an influx of Persian gold at this time was instead responsible see Thompson 1964: 120-3 and Figueira 1998: 514-17. For evidence of the increased use of gold coins in general in Greece at this time see the Spartan War Fund inscription from the Ionian War (*OR* 151, with discussion of the dating problem at pp. 298-301) and for the early 4th century see Nicolet-Pierre 1996 200-7.

[38] Kroll 2009: 195-9.

[39] Van Alfen 2012: 93.

[40] Van Alfen 2012: 94.

[41] Samons 2000: 236-40, Kallet 2001: 193-5.

the revenue to be derived from exporting silver coinage.[42] Moreover, now that it was impossible to harvest crops from much of rural Attica, Athenians could no longer bring in silver through exporting cash crops and also needed to spend more silver on importing food stuffs. The unusually absolute nature of the Athenian defeat in Sicily in September 413 then meant that the considerable quantities of silver which Athens had spent on the expedition were entirely lost to it in a distant theatre. The wide-scale revolt in late 413 in response to the news from Sicily cut into tribute and tax revenue, the other of Athens' two main sources of silver, and was particularly damaging because it involved such a high number of the largest tribute-payers. The process of rapidly rebuilding the Athenian fleet and then dealing with the allies in revolt over the course of 413-411 represented a further major expenditure of silver. This cycle was only further exacerbated by the loss of Euboia in 411 which had been a major source of grain for Athens, thus compelling the Athenians to spend even more silver on importing food stuffs. While the victory at Kyzikos in 410 should have provided an opportunity to start rebuilding silver reserves through tribute collection, this did not come to pass. Half the biggest tribute-payers still remained in revolt and, insofar as tribute was collected by commanders in the field, they tended to spend it there and then rather than send it back to Athens.[43]

This combination of factors created a perfect storm: not only was Athens no longer offsetting the loss of silver from the Aegean basin through various means (e.g. the Laurion mines, tribute and tax collection, exports), it was now speeding this process up through a collapse in its exports, an increase in its imports (above all of food stuffs from areas beyond the Aegean basin), and the expenditure of the silver it did collect in theatres far from Athens. This dramatic contraction in the supply of silver in the Aegean will have rapidly resulted in the price of silver going up, the very last development which the Athenian state needed at this juncture. Moreover, opportunities for arbitrage (which would further disrupt the silver supply) now existed: silver in private hands could be used to buy 'cheap' gold in Greece which could then be taken to Asia Minor to buy 'cheap' silver there. The accounts of the treasury of Athena from 410/9 show that in the first prytany of 410 the city's silver reserves finally gave out and expenditure now began to be taken out of income.[44] In 409/8, the Hellenotamiai sold gold in an attempt to raise silver as ready cash. However, with the silver/gold exchange rate against them, the gold which they sold was now buying them considerably less silver than it would have done only a few years earlier.[45] This shortage of silver with which to meet expenditure is likewise reflected first in the accounts of 409/8, where Athens resorts to making large payments in difficult to value electrum and non-Attic silver, and then in the introduction of gold coinage in 407/6 and bronze coinage in 406/5 in place of silver.[46]

3.3 The Impact on Asia Minor

[42] For the fortification of Dekeleia see Thuc. 6.91.6-7, 7.19.1-2, 7.27-28. For the mass desertion of slaves being the main factor in halting production see Thuc. 7.27.5 with Hornblower 1991-2008 1: pp. 327-8 and 3: pp. 591-2 and Xen. *Por.* 4.25 with Gauthier 1976: 157-9.

[43] On all this see Thompson 1964: 115-18. For collected revenue being spent in the field see the 'book' payments from Eretria and Samos in *OR* 180.16-17, 20-1, and 34-7 (in this case rents from Athena's properties rather than tribute).

[44] *OR* 180.2-3.

[45] See n. 32 above.

[46] Electrum and non-Attic silver in the accounts of 409/8: *IG* I^3 376 with Thompson 1964 113. Gold and bronze coinages in 407-404: Thompson 1966, Thompson 1970, Kroll 1976, Kroll 1993: 7-8, 24-6, Kroll 1996, van Alfen 2012: 94-5.

The evidence we have looked at so far relates only to Athens. However, given the out-sized role which the Athenian Empire played in the economy of the Aegean, it would be highly surprising if these dramatic changes to the silver supply did not have an effect far beyond Attica.[47] Indeed, there is evidence that these changes had already had an impact on the silver/gold exchange rate in western Asia Minor by summer 411. In the context of the Spartan commander Mindaros resupplying his fleet at Chios, Thucydides says that he received from the Chians 'three Chian fortieths for each man'.[48] The identity of this denomination is obscure. There is no such coin as a 'Chian fortieth' and no silver coin which another silver coin could stand in this relationship to. These coins must be a fortieth of something gold, and logically this must be a daric given that we are in the vicinity of Persian-controlled Asia Minor and Mindaros has just been negotiating pay for his troops first with Tissaphernes and now with Pharnabazos.[49] Nicholas Hardwick has therefore suggested that the coins in question were in fact Chian third staters: these had been minted in large quantities *ca.* 435-410 and were still in circulation as late as *ca.* 400.[50]

This finding is important for three reasons. Firstly, this episode represents our earliest attestation of a bimetallic accounting system being used for pay in Thucydides. The implication would appear to be that, as soon as cities in western Asia Minor left the Athenian Empire, they immediately reverted to this system. Secondly, it suggests that the Chian state was operating a notional silver/gold exchange rate of 12.46:1 (assuming a 2.6g third stater and a 15.6g tetradrachm). This suggests that the official figure had probably been adjusted from the previously existing 13.33:1 down to 12.5:1. This 6% reduction indicates that the value of silver quickly appreciated in response to the silver scarcity created by the Ionian War. Thirdly, Persian minting had previously reflected the old exchange rate in a neat equivalency of 20 silver sigloi = 1 daric ratio. However, at the new 12.5:1 exchange rate, a daric was now only worth 18.6 sigloi.

If this 20 sigloi = 1 daric equivalency really had broken by 411, then this may explain two unexpected findings from Ian Carradice's analysis of the hoard evidence for Persian darics and sigloi. Carradice found that siglos production mostly ended in the late 5th century, whereas daric production actually increased from the late 5th century onwards.[51] The explanation may

[47] While the Persians may have been sitting on lots of bullion in Persepolis, it is clear from the negotiations between the Asia Minor satraps and the Great King that the satraps' access to silver was limited. It is important not to underestimate the demand for silver (as bullion) that existed in the Persian Empire outside Asia Minor. Jursa's pioneering work has shown that Babylonia was a monetized economy with everyday transactions done in silver. While the 5th century information is far scarcer than the 6th century, the fact that we see dramatically rising interest rates for borrowing silver in that period raises questions about the metal's relative availability: Jursa 2010: 774.

[48] Thuc. 8.101.1: ὁ δὲ Μίνδαρος ἐν τούτῳ καὶ ἐκ τῆς Χίου τῶν Πελοποννησίων αἱ νῆες ἐπισιτισάμεναι δυοῖν ἡμέραιν καὶ λαβόντες παρὰ τῶν Χίων τρεῖς τεσσαρακοστὰς ἕκαστος Χίας ('Meanwhile, Mindaros and the Peloponnesian fleet at Chios spent two days in provisioning and received from the Chians three Chian fortieths for each man').

[49] Thuc. 8.99

[50] Hardwick 1996. Hardwick 2013: 117 provides the most recent figures for the size of the series: n (specimens) = 189, d (obverse dies observed) = 60, n/d (X > 3 is a representative sample) = 3.15. Applying the formula for estimating the original number of dies proposed in Esty 2011 we get D = 88 ±12. For these coins still circulating *ca.* 400 see *IGCH* 1203 (Chian portion: 1 stater, 81 third staters) with Hardwick 2010: 225-6 for the dating of this hoard to *ca.* 400 rather than *ca.* 380 as stated in *IGCH*.

[51] Carradice 1987. The important findings from Carradice's hoard analysis are that, "the vast majority of the surviving sigloi seem to date from the fifth century" and that the last stylistic version of the sigloi (Type IV) "was introduced by about *c.* 450" (p. 92). Carradice did not consider a shift in the silver/gold ratio as a reason for the

be that, at this new silver/gold exchange rate of 12.5:1, a neat equivalency could not be created between any number of sigloi and a daric. As a result, the siglos denomination fell out of the bimetallic system and the sigloi in circulation were effectively demonetized.[52] This would explain why, when the silver coins with which soldiers and sailors are being paid are specified in Thucydides Books 7-8 and in Xenophon's *Anabasis* and *Hellenica*, they are always drachm-denominated coinages (either Attic or Aeginetan) and never sigloi. Based on the number of 5th century sigloi found in 4th century hoards, it appears that they were never formally removed from circulation, nor did they lose their bullion value. They were, however, subject to extensive countermarking, demonstrating that these coins needed to be re-validated, most likely by a money changer, in order to facilitate exchange.

An interesting piece of contemporary evidence shows how the sigloi had lost their value by the end of the 5th century. In the context of the Ten Thousand marching along the course of the Euphrates into Babylonia in 401, Xenophon on one occasion mentions sigloi as a price for grain (and, crucially, not as a coin) which was being offered in the Lydian market attached to Cyrus' non-Greek army. Here he values one siglos at 7.5 Attic obols.[53] This is surprisingly low and gives us a siglos of only 5.4g – 0.2g lighter than the 5.6g 'heavy' siglos which Xerxes had introduced in the late 480s and which, on the 13.33:1 exchange rate, was valued at 1/20th of a daric. Presumably, now that sigloi were known to have lost their nominal face value in exchange with darics, prices would no longer have been expressed in sigloi. This lower valuation of them relative to another silver coinage acknowledges that they were no longer easy to exchange and thus more akin to bullion.[54]

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halting of the sigloi, but, if our analysis is right, then sigloi production probably ended *ca*. 415-410. What complicates the picture is that Carradice isolated a small group of sigloi that he labels Type IV.C that, based on hoards, seem to be from the third quarter of the 4th century or later. These can be distinguished by slightly lower weights and other stylistic variations from other Type IV sigloi and Carradice suggested the possibility of another mint (p. 90, perhaps more eastern). As will be seen below, at some point after 400 when the silver/gold ratio was at 12:1, Persian-weight coins had a new life based upon 9 staters or 18 sigloi to a daric. What we would propose is a break of some 20-40 years between the vast Type IV sigloi and this much smaller Group C. While this is consistent with Carradice's observations, the catalogue of his plate illustrations (pp. 94-5) at the end of his article show date ranges that imply a continuity of sigloi production from the late 5th through the middle of the 4th century, thus giving a misleading impression of his own evidence. Importantly, the other major minter of sigloi denominated coins, Aspendos, also sees its issues (the so-called Mopsus sigloi) come to an end at a similar time while stater production is continuing robustly. The mint of Aspendos was an important source of coinage for Persian military operations. As Tekin 2000: 161 notes, 'The Aspendos boar group ends around the beginning of the 4th century BC.' The new South Anatolia hoard may raise these dates slightly.

[52] A version of this view was first expressed by Guépin 1962: 16: 'I take it therefore that this and other fourth-century hoards, like for instance the bullion hoard from Babylon dated *c*. 385 … prove that after 425 the siglos lost its fiduciary character'.

[53] Xen. *Anab.* 1.5.6: τὸ δὲ στράτευμα ὁ σῖτος ἐπέλιπε, καὶ πρίασθαι οὐκ ἦν εἰ μὴ ἐν τῇ Λυδίᾳ ἀγορᾷ ἐν τῷ Κύρου βαρβαρικῷ, τὴν καπίθην ἀλεύρων ἢ ἀλφίτων τεττάρων σίγλων. ὁ δὲ σίγλος δύναται ἑπτὰ ὀβολοὺς καὶ ἡμιωβέλιον Ἀττικούς· ἡ δὲ καπίθη δύο χοίνικας Ἀττικὰς ἐχώρει ('As for the army, their grain gave out, and it was not possible to buy it except in the Lydian market attached to the barbarian army of Cyrus at the price of four sigloi for a capith of wheat flour or of barley meal. The siglos is worth 7.5 Attic obols. The capith contains two Attic choinikes').

[54] It is suggestive that the lexicographer Hesychius (σ 585-6) refers to an exchange rate of 8 Attic obols to the siglos. This is what one would expect if the exchange was taking place in the Persian Empire before the shift in the silver ratio, since this would have been almost exact when Athens was at a 14:1 silver/gold ratio. With both 27 Attic drachms and 20 sigloi worth 1 daric, 27 Attic drachms (i.e. 162 obols) = 20 sigloi and therefore 1 siglos = 8.1 Attic obols. However, it is equally possible Hesychius is simply incorrect since he makes a number of errors which show lack of familiarity with the original sources (e.g. wrongly claiming that the Xenophon passage is from *Anabasis* Book 6).

Finally, we may note that the change in the silver/gold exchange rate also ended the easy exchangeability between the daric and the Aeginetan coins in which Peloponnesian forces were often paid.[55] At the 13.33:1 exchange rate, there were 18 Aeginetan drachms (6.1g) or 9 staters (12.3g) to a daric, whereas once the rate had dropped to 12.5:1 this equivalency no longer worked (a daric would now be worth 17 drachms and 8.5 staters).[56] The fact that, by the end of the 5th century, Aeginetan silver could no longer be easily exchanged with the bimetallic currency system in Asia Minor based on the daric may explain the disappearance of this weight standard outside of central Greece and the Peloponnese at this time, and might also in part explain why long-circulating Aeginetan turtles were frequently countermarked.[57]

If soldiers and sailors were not being paid in sigloi or in Aeginetan-weight coins since neither now exchanged easily with the daric, then this raises the question of which silver coins they were being paid with instead. For 411 and 407 we have references to Spartan and Peloponnesian commanders wanting their troops to be paid one Attic drachm (4.33g) a day or a daric a month from Persian sources of funding, with the Persians themselves instead only wanting to pay a rate of three or four obols a day.[58] The rate of one drachm a day was what these troops would have been familiar with from earlier in the Peloponnesian War when the 14:1 silver/gold exchange rate made 27 Attic drachms equivalent to 1 daric, or roughly one drachm a day over the course of a month. However, at the 12.5:1 exchange rate attested by the Chian fortieths for 411, it would only be possible to get 24 Attic drachms to 1 daric. As a result, the Persians were now having to pay over the odds to provide the Peloponnesian troops with the one drachm a day which they expected as pay. The Persian desire to bargain the Greeks down to a rate of 3-4 obols a day may therefore reflect, at least in part, their appreciation that the price of silver had gone up and that a rate of one Attic drachm a day had therefore now had become too rich.[59]

The adoption of the Chian weight standard (3.8g drachm / 15.35g tetradrachm), the dating of which will be discussed in a moment, resolved this problem. At the 12.5:1 exchange rate, 27 Chian drachms = 1 daric.[60] A reduction in the weight of the drachms by about 10% therefore made it possible to accommodate the higher price of silver while leaving the price paid for services unaltered. States could now pay their troops 27 drachms for a month's wage without having to pay over the odds to do so, and so long as the lighter coins maintained the buying power of a drachm (as is possible in a bimetallic system when the silver/gold exchange rate alters), then the troops would not object to being paid in coins with about 10% less silver. What therefore makes the adoption of the Chian standard so revolutionary, and what accounts for its

[55] For example, in the contributions to the Spartan war fund (*OR* 151, *ca.* 427-412) darics and Aeginetan silver are the only coins mentioned.

[56] (8.35 x 13.33) / 12.3 = 9.05 Aeginetan staters.

[57] Nicolet-Pierre, Gjongecaj 1995: 324-8 have made a persuasive argument that the countermarking of turtles probably happened well after their original minting and that the purpose (aside from obvious test cuts determining purity) was to facilitate exchange and accounting, most likely in private contexts. They believe that most of the countermarking did not start until the second half of the 5th century. We are not arguing that all the countermarking began after the change in the gold ratio, since Aeginetan coins were probably already becoming awkward in areas dominated by the Attic standard. Rather, the phenomenon that led to the countermarking of turtles must be similar to that which caused the similar countermarking of sigloi.

[58] Thuc. 8.29.1-2 (Tissaphernes), 8.45.2 (Alcibiades and Tissaphernes), Xen. *Hell.* 1.5.1-7 (Lysander and Cyrus).

[59] The discussion in Hornblower 1991-2008 3: p. 837 nicely captures the atmosphere of horse-trading at Thuc. 8.29.2.

[60] (8.35 x 12.5) / 3.84 = 27.2 Chian drachms.

extraordinarily rapid adoption, was that in western Asia Minor it was able to replace *both* the Attic drachm *and* the Persian siglos in one fell swoop. It replaced the Attic drachm by providing a means of maintaining the drachm-denominated pricing structure of the period of Athenian domination, and it replaced the Persian siglos by providing a silver coinage which could replace the discontinued sigloi and interact with the daric in the bimetallic world of Persian-controlled Asia Minor.

There has been considerable debate as to when exactly the Chian standard became widely adopted beyond Chios itself, with dates ranging from the late 400s to the early 380s.[61] The foregoing argument makes a date at the beginning of this range much more likely. The longer that states waited to alter the weight standard and/or denominations of their silver coins in order to accommodate the higher price of silver, the longer they would find themselves paying over the odds for the largest expenditure a state had to deal with in the ancient world – war. The 13.33:1 silver/gold exchange rate had probably already become untenable in the course of 412 and was down to 12.5:1 by 411. The various Persian attempts to avoid paying Peloponnesian troops over the odds by halving pay in 411 and 407 were only partly successful and caused dangerous levels of resentment among Peloponnesian troops. The adoption of the Chian weight standard as a drachm-denominated coinage was an elegant solution which was right before their eyes, since Spartan commanders such as Mindaros, Kallikratidas, and Lysander all found themselves in regular discussion with the Chians on matters of minting and finance in these years.[62] In such a context, it makes sense to date the so-called ΣYN coinages, thought to be the first series to adopt the Chian weight standard beyond Chios, to 405/4 and the context of Lysander's campaigns in western Asia Minor.[63] By contrast, it becomes increasingly hard to explain why states would have continued paying over the odds on military expenditure by waiting until the 390s or 380s to implement this simple solution.

3.4 Eteonikos in Thrace

At the very end of the Peloponnesian War (perhaps *ca.* 405), the last three mints active in Thrace – Abdera, Maroneia, and Mende – all began to strike a new silver coinage on a hitherto unattested weight standard based on a stater of 12.9g.[64] Since these three mints had in the past used different weight standards from one another, the sudden shift to the same rather unusual standard at all three cities would appear to reflect outside influence. As it happens, Xenophon relates that, following the Spartan victory at Aigospotamoi in 405, '[Lysander] sent Eteonikos with ten triremes to the Thraceward region who brought all those parts over to the side of the

[61] Karwiese 1980, Ashton *et al.* 2002a: 136-9, Meadows 2011.

[62] Ellis-Evans 2016: 14-16.

[63] See most recently Meadows 2011 and Ellis-Evans 2016, where it is argued that the Chian standard was used to finance the Spartan fleet in 406/5 before the ΣYN coinage was introduced. Psoma (this volume) argues that the ΣYN coinage is a slightly later Spartan-led phenomenon that took place under Agesilaos. Should her interpretation be accepted, the ΣYN coinage could no longer be viewed as the earliest expansion of the weight standard after the fall of Athens. However, this would not in itself change the argument presented here, since it can be independently demonstrated on other evidence that the Chian standard was quickly adopted after 405. The 15 mints that adopted the Attic-standard after the revolt of Mytilene for their fractional coinage (Ellis-Evans 2019: 189-96) abandoned that standard for the Chian in a fashion that can be described as rushed and likely simultaneous as evidenced by shared dies between the different standards and subtle changes of type. This smacks of having taken place at the moment of liberation from Athens not almost a decade later. The evidence of weight standard changes in Thrace and the introduction of the Chian standard in the Cyclades where Sparta restored populations and/or oligarchs is surely the work of Lysander. See Kagan 2022.

[64] Kagan 2014: 19-23. This was also the standard used for the fractional coinage of the re-founded Skione. See Kagan 2022: 10-11.

Lakedaimonians'.[65] It is thus tempting to connect this expedition with this change in the coinage of these cities. Our suggestion is therefore that Eteonikos, having spent several years commanding Spartan forces in Ionia and having just witnessed Lysander's coinage reform in western Asia Minor with reference to a bimetallic system, decided to do the same in the Thraceward region.[66] If we assume that Eteonikos extended the use of gold as the metal of account from Spartan-controlled Asia Minor (where this had long been the case) to Spartan-controlled Thrace (where it had not), then we believe it is possible to make sense of the otherwise inexplicable 12.9g staters.

At the 12.5:1 exchange rate attested by the ΣΥΝ coinage for 405/4, 1 gold daric = 8 staters at 12.9g.[67] By contrast, there were no such possibilities for easy convertibility with the daric offered by the Milesian standard (14.3g staters), the weight standard which had been adopted by Akanthos and the Chalkidian League and which as a result was now dominant in the region. Indeed, when Philip II later used the Milesian standard for his silver coinage he paired it with heavier Attic weight gold staters to achieve easy exchangeability. Faced with a monetary environment in which the main weight standard for silver coinage could not operate within a bimetallic system, Eteonikos effected a 10% debasement of these Milesian staters (from 14.3g to 12.9g) in order to create the 1:8 equivalency between gold and silver coins (compare Lysander's 10% debasement by adopting the Chian standard). However, since the independent Chalkidians did not adopt this reform it did not survive long in western Thrace. It did, however, last for several decades at Abdera and Maroneia until it was replaced *ca*. 380 by staters at Abdera that can be described as either Chian tridrachms or double sigloi and at Maroneia by drachms equivalent to half sigloi.[68]

Table 2. Summary of the evidence for change in the silver/gold exchange rate during the Peloponnesian War.

Date	**Silver/Gold Ratio**	**Source**	**Ratio of Gold to Silver Coins** (1 daric = *n* silver coins)
430s (Athens)	14:1	Inscribed Athenian accounts (Thompson 1964)	1:27 Attic drachms (4.33g)
411 (Chios)	12.5:1	Chian 'fortieths' (Hardwick 1996)	1:18.4 sigloi (5.55g) (13.33:1 silver/gold ratio gave 1:20 sigloi)
409/8 (Athens)	10:1 – 13:1	Inscribed Athenian accounts (Thompson 1964)	1:19 – 1:25 Attic drachms (implied 1:15 – 1:19 sigloi)
407 (Athens)	12:1	Athenian gold coins	1:23 Attic drachms (implied 1:18 sigloi)
405 (Thrace)	12.5:1	Inferred from the coins	1:8 staters (12.9g)
405/4 (W. Anatolia)	12.5:1	ΣΥΝ coinage (Meadows 2011)	1:27 Chian drachms (3.8g) 1:9 Chian tridrachms (11.4g)

4. The Fourth Century: The Numismatic Evidence

4.1 The Chian Standard (*ca*. 405 – *ca.* 350)

Following the end of the Peloponnesian War, the specific factors which had precipitated a sudden contraction in the supply of silver during the Ionian War were to some extent alleviated

[65] Xen. *Hell.* 2.2.5: [Λύσανδρος] εἰς δὲ τὰ ἐπὶ Θρᾴκης χωρία ἔπεμψε δέκα τριήρεις ἔχοντα Ἐτεόνικον, ὃς τὰ ἐκεῖ πάντα πρὸς Λακεδαιμονίους μετέστησεν.

[66] Eteonikos in Asia Minor: Ellis-Evans 2016: 13-14.

[67] (8.35 x 12.5) / 12.9 = 8.09 staters.

[68] See Psoma *et al.* 2008: 170 and Chryssanthaki-Nagle 2007: 148. Interestingly, this change coincides with the revival of the double sigloi in Asia Minor (see below).

(Section 3.2). Nevertheless, the available evidence points to continued downward pressure on the silver/gold exchange rate during the first half of the 4th century, and indeed the ratio had probably already decreased to 12:1 by *ca.* 400. Whereas for Athens we at least have Lewis' evidence of the price paid for gold crowns to establish the market rate, for Asia Minor we appear to have no relevant epigraphic evidence. However, we do have one important piece of literary evidence. Xenophon recounts in Book 1 of the *Anabasis* how Cyrus promised the Greek seer Silanos a payment of 10 talents if he was right about there not being a battle for ten days and, when the period had passed uneventfully, Cyrus gave him 3,000 darics.[69] This took place in 401 just before the Battle of Cunaxa near Babylon. The talents which Cyrus offered are unlikely to have been Attic ones, as many commentators have assumed, since this would produce a 10.3:1 exchange rate which is both unattested and unrealistic at this date. At the same time, it will not do to dismiss this simply as a literary trope, since Xenophon is meticulous with such figures.[70] Rather, the solution must be that they were Babylonian talents. The Babylonian talent consisted of 60 minas each made up of sixty shekels. Hence, there were 3,600 shekels in a talent. The weight of the Daric is thought to be theoretically equal to the old Mesopotamian shekel.[71] So, 10 T would have been 36,000 shekels.[72] Dividing by 12 produces exactly 3,000 Darics. The Babylonian talent is also described by Herodotus as being worth 70 Euboic minas.[73]

Beyond these relatively meagre literary and epigraphic references, the coins themselves can provide evidence of how the state exchange rate in Asia Minor changed over the course of this period provided they can be precisely enough dated. This is possible as a result of two factors already discussed in Section 2.1: **1)** states used their choice of weight standard and denominations to 'bake in' their preferred exchange rate; **2)** states sought out neat equivalencies between coins in the two metals for reasons of practicality. It needs to be stressed that none of the equivalencies which we cite below require a combination of different denominations in order to work. Modern metrologists have often been compelled to argue for

[69] Xen. *Anab.* 1.7.18: ἐνταῦθα Κῦρος Σιλανὸν καλέσας τὸν Ἀμπρακιώτην μάντιν ἔδωκεν αὐτῷ δαρεικοὺς τρισχιλίους, ὅτι τῇ ἑνδεκάτῃ ἀπ᾽ ἐκείνης ἡμέρᾳ πρότερον θυόμενος εἶπεν αὐτῷ ὅτι βασιλεὺς οὐ μαχεῖται δέκα ἡμερῶν, Κῦρος δ᾽ εἶπεν· οὐκ ἄρα ἔτι μαχεῖται, εἰ ἐν ταύταις οὐ μαχεῖται ταῖς ἡμέραις· ἐὰν δ᾽ ἀληθεύσῃς, ὑπισχνοῦμαί σοι δέκα τάλαντα. τοῦτο τὸ χρυσίον τότε ἀπέδωκεν, ἐπεὶ παρῆλθον αἱ δέκα ἡμέραι ('Then Cyrus, having summoned Silanos the Ambraciot soothsayer, gave him 3,000 darics, because on the eleventh day before this, while sacrificing, he had told Cyrus that the King would not fight within ten days, and Cyrus had said: "Then he will not fight at all, if he will not fight within ten days; but if your prediction proves true, I promise you ten talents". This gold, then, he paid over, because the ten days had passed').

[70] *Pace* Melville-Jones 1993-2007 2: 331-2. For Xenophon's meticulous recording of distances in parasangs and the role this plays in the *Anabasis* see Rood 2010.

[71] Alram 2012.

[72] Le Rider 2001: 157-60 tries to interpret this passage in a way that can maintain the 13.33:1 ratio by postulating the existence of a Persic talent consisting of 6000 sigloi. However, given that such a talent is otherwise unknown, and taking into account the other evidence we have for the fall in the ratio, the above explanation seems more reasonable.

[73] Hdt. 3.89.2 (discussing Persian tribute collection under Darius): τοῖσι μὲν αὐτῶν ἀργύριον ἀπαγινέουσι εἴρητο Βαβυλώνιον σταθμὸν τάλαντον ἀπαγινέειν, τοῖσι δὲ χρυσίον ἀπαγινέουσι Εὐβοϊκόν. τὸ δὲ Βαβυλώνιον τάλαντον δύναται Εὐβοΐδας ἑβδομήκοντα μνέας ('Those that paid in silver were required to render the weight of a Babylonian talent [c. 30 kg]; those that paid in gold, of a Euboic talent [25.98g]. The Babylonian talent is worth 70 Euboic minas'). For the argument against Reizke's emendation <ὀκτὼ καὶ> before ἑβδομήκοντα (making a Babylonian talent worth 78 Euboic minas) and a further intervention at 3.95.1 see How, Wells 1912 1: pp. 281-2, 287, Hemmerdinger 1988: 52-6, Develin 1990: 35, Asheri *et al.* 2007: 482 and 493-4, and Wilson 2015: 61. At 70 minas based on a drachm of 4.33g, this would give a weight of 30,310g for ten talents that at 12:1 would be 3,025 darics at 8.35g. Cyrus was probably thinking solely in Near Eastern equivalents and not converting back.

overly complicated solutions of this kind because they have been working with preconceived assumptions such as the immutability of the Persian silver/gold exchange rate. Our working assumption is instead that Greeks sought out exchange values which were simple and obvious. Once it is admitted that the Persian exchange rate changed over time, such easy to use equivalencies are not difficult to find.[74]

Teos, Ionia (*ca.* 405-387) – In the early 4th century, Teos minted a coinage of gold hemidrachms (1.86g) and trihemiobols (0.96g) and silver diobols on the Chian standard.[75] Since both the gold and silver coinage is on the same weight standard, we should assume that the exchange rate between them was a round number. As Philip Kinns has noted, at the 12:1 exchange rate attested elsewhere at this time 1 gold hemidrachm = 6 silver drachms and 1 gold trihemiobol = 3 silver drachms.[76] Kinns also noted that this divisibility by three is a feature of the ΣΥΝ coinages where 1 daric = 9 tridrachms or 27 drachms.[77]

Thasos (*ca.* 404 – 390-385) – At the very beginning of the 4th century, Thasos issued gold drachms (3.95g) and silver tetradrachms, drachms, and trihemiobols on the Chian standard.[78] As we noted with Teos, when a mint produces gold and silver coins on the same weight standard, we should expect a whole number exchange rate. In this case, a 12:1 ratio produces a 1 gold drachm = 3 silver tetradrachms equivalency.[79]

Maroneia (ca. 400-390) – Two gold coins with the horse forepart obverse and vine in square reverse weighing 3.30g and 3.14g survive from Period VI (the 12.9g standard issue at the mint).

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[74] For a survey of Greek gold coins before Alexander see Melville-Jones 1999. Almost all the issues he discusses are rare. We have not discussed those issues where the question of date or the corresponding silver issue makes it hard to discern the ratio, though we have found nothing that suggests a different pattern. One issue Melville-Jones fails to discuss is that of Thebes. The issue had been considered electrum not gold because until recently all known examples were Aeginetan hemidrachms and obols that look adulterated. The appearance in trade of a pure Aeginetan gold drachm in 2006 indicates that this is indeed a gold issue. The use of the same standard for the gold and silver coins implies a whole number silver/gold ratio of either 12:1 or 10:1 depending when the coins are dated. As with underweight silver fractions, the adulteration of the small gold coins implies that they would have been used locally where conversion into the pure drachms would have been respected. The use of Thebes' ethnic and the *drakonopnigon* design would most easily lead one to a 405 date contemporary with the use of that type by Lysander before the Boiotians turned against Sparta (this would make them contemporary with the Athenian gold and on the same ratio), but other dates are certainly possible. Gartland 2013 is unwilling to accept the implications of the gold drachm and instead tries to connect the choice of electrum with Boiotian naval ambitions in the 360s, seeing the issue's purpose as being to conduct trade with the Black Sea region. This seems unlikely. The great electrum coinages of western Asia Minor were carefully and consistently alloyed and were capable of being valued. A new entrant striking small denominations would surely have seen their coins valued at a discount to whatever intrinsic value they had. Gartland's argument is not helped by his use of the old reading for the exchange ratio of the Olbia inscription and the lack of any find spots in that region.

[75] Kinns 1980 1: 166-7 (commentary), 2: 502-3 (catalogue). The second example of the AV trihemiobol which Kinns 1989: 187 n. 28 notes as first appearing in 1986 subsequently appeared in Vinchon (24/11/1994) 144 and most recently in Sincona 10 (May 2013) 150.

[76] (1.86 x 12) / 3.8 = 5.9 Chian drachms.

[77] Kinns 1980 1: pp. 165-7, Kinns 1989: 187.

[78] For overviews of the 4th century coinage of Thasos see Le Rider 1967: 187-8 and Picard 2000: 306-9. For weights see West 1929: 15-16. The date adopted here is inferred from the evidence of the Hecatomnus Hoard (*CH* 9.387, TAQ *ca.* 380) and the Pixodarus Hoard (*CH* 9.421, TAQ *ca.* 390-385): see Meadows in Ashton *et al.* 2002a: 97 and 2002b: 161-6.

[79] (3.95 x 12) / 15.3 = 3.09 Chian tetradrachms.

A 12:1 exchange rate, using the midpoint in weight, produces an exact 3:1 equivalency with a silver tetradrachm.[80]

Siphnos (ca. 394) – One gold coin of Attic weight (4.29g) survives in Berlin. It coincides with a change in standard from Chian/Aeginetan weights introduced by the pro-Spartan oligarchy that was put in place after the fall of Athens and expelled ca. 394. This gold coin reuses dies associated with the earlier issue and probably represents a special issue connected with the overthrow of the oligarchy as reported by Isocrates. The use of the Attic standard would suggest an even exchangeability with Attic silver coins which would be 12:1 at this date.[81]

Klazomenai, Ionia (*ca.* 380) – In the late 380s/early 370s, Klazomenai minted a coinage of gold octobols and silver tetradrachms, didrachms, drachms, hemidrachms, and diobols on the Attic weight standard.[82] We would expect a round number for the silver/gold exchange rate given the shared weight standard, and indeed 1 gold octobol = 4 silver tetradrachms on a 12:1 exchange rate.[83]

Pamphylia and Cilicia (380s-360s) – There are ten mints in Pamphylia and Cilicia which primarily produced high value silver coinage on the Persic standard (double sigloi at 11.2g) and a modest amount of fractional silver to accompany this (a mixture of tetrobols at 3.6g, obols at 0.9g, and hemiobols at 0.4g). As François de Callataÿ has shown, the chronology of these mints must now be revised, resulting in the dating of almost all of them to various points within a much tighter timeframe of the 380s-360s.[84] At the 12:1 exchange rate we have seen attested at Teos, Thasos, and Klazomenai in the period immediately before this, 1 daric = 9 double sigloi or 27 tetrobols.[85] Interestingly, these mints in Pamphylia and Cilicia did not change their weight standard to accommodate the new silver/gold exchange rate as we have seen in the previous three cases, but rather their choice of denominations (double sigloi and tetrobols instead of sigloi). Finally, these mints are of particular interest because, as de Callataÿ argues, their production was being directed not by the cities themselves, but rather by the

[80] Psoma *et al.* 2008: 175. A single gold coin of 3.98g from ca. 360 also exists. It has a head of Dionysos and should be tied to the light Attic-weight tetradrachms that also have the head of Dionysos as a type. These range in weight from 16-17g. At the low end of that range, using a 12:1 ratio, the gold coin would be worth three tetradrachms (3.95g x 12 = 47.4/3 = 15.8g). However, as there is only one coin, and small variations in gold weight matter, this must remain tentative.

[81] Sheedy *et al*. 2020: 149-50. Because of the die link, Sheedy suggests that the silver Chian drachms/Aeginetan tetrobols might be just light weight Attic drachms. However, when one looks at Siphnos in context with Melos and Naxos, it becomes clear that that is not the case and also what the appropriate historical context must be. See now Kagan 2022.

[82] Kinns 1989: 184-5.

[83] (5.7 x 12) / 17.2 = 3.97 Attic tetradrachms. Explaining Klazomenai's choice here of the Attic instead of the Chian weight standard lies beyond the scope of this paper. However, the best discussion so far remains Kinns 1989: 184-6.

[84] Callataÿ 2018. De Callataÿ fleshes out the argument in further detail in his contribution to this volume (above, Chapter 3)

[85] (8.35 x 12) / 11.2 = 8.94 double sigloi. This of course recalls the pricing structure we have already seen with the Attic weight standard (1 daric = 27 Attic drachms in the 5th century) and subsequently with the Chian standard (1 daric = 9 Chian tridrachms [i.e. the ΣΥΝ coinage] or 27 Chian drachms). In this case, troops could be paid either a double siglos every three days or a tetrobol a day. The 27 may just be coincidence and driven by seeking divisibility by 3. But there seems to be a general desire to have a coin that would allow the paying on a daily basis (albeit there were 29 or 30 days in a month) of approximately the silver equivalent of a Daric a month.

satrapal authorities. These changes designed to accommodate the 12:1 ratio can therefore be tied directly to the Persian authorities.

Pisa, Olympia (365-362) – In the years when the Arcadians occupied the sanctuary and made use of its treasuries, two denominations of gold coins were issued: trihemiobols (1.54g) and obols (1.04g) on the Aeginetan standard. As Seltman noted, at the 12:1 exchange rate 1 gold trihemiobol = 1.5 Aeginetan silver staters (12.3g) and 1 gold obol = 1 stater.[86]

The Troad (*ca.* 360-355) – We have two mints in the Troad which produced Chian weight silver coinage in the early 350s. Abydos on the Hellespont minted tetradrachms, drachms, and hemidrachms, while Tenedos off the western coast of the Troad produced tetradrachms, didrachms, drachms, hemidrachms, and obols. The drachms of these coinages (the best attested denomination in both cases) appear from their weights to have been minted to a theoretical weight of 3.5g rather than the 3.8g to which Chian weight drachms had originally been minted.[87] This gradual reduction in the weight of Chian weight drachms is seen at many mints in western Asia Minor over the course of the first half of the 4th century. The 1 daric = 27 Chian drachms equivalency can be maintained with drachms of 3.5g if we assume a silver/gold exchange rate of 11.33:1.[88] This suggests that the relative scarcity of silver which had brought the rate down from 12.50:1 (the ΣΥΝ coinage) to 12:1 (Teos, Klazomenai) in the early 4th century had continued to exercise downward pressure on the rate over the next two decades to bring it to 11.33:1 by *ca.* 360-355 (Abydos and Tenedos).

Salamis, Cyprus (411-331) – There was parallel striking of gold and silver coinage under Evagoras I (411-374), Nikokles (374-361), Evagoras II (361-351), and Pnytagoras (351-331).[89] The trajectory of the state exchange rate at Salamis is the same as that which we have seen in the coinages of mainland Asia Minor: 13.33:1 under Evagoras I, 12:1 under Nikokles and Evagoras II, and 10:1 under Pnytagoras. As will be discussed below (Sections 4.2-4.4), there is reason to believe that the relative distance of Cyprus from the Aegean delayed the impact of these ratio changes. Thus, we suspect that the 13.33:1 ratio, which in the Aegean ceased to be viable in the course of the Ionian War, was able to continue for some time after this on Cyprus. Likewise, we suspect that the shift to the 10:1 ratio precipitated by the opening of the Krenides mines *ca.* 356 did not reach Cyprus until fifteen years later in 341/0 or shortly after. However, in the absence of a complete study of the silver coinage to match Markou's rigorous study of the gold coinage these conclusions must remain speculative.

Table 3. Summary of the evidence for change in the silver/gold exchange rate between the end of the Peloponnesian War (405/4) and the mid-4th century.

Time and Place	**Silver/Gold Ratio**	**Evidence**	**Ratio of Gold to Silver Coins** (1 daric unless specified = *n* silver coins unless specified)
411-374 (Evagoras I)	13.33:1	Inferred from coins (Markou 2011:113-18)	1 AV 1/10th stater (0.84g) = 1 AR siglos (11.2g)
405/4 (W. Anatolia)	12.50:1	ΣΥΝ coinage (Meadows 2011)	1:27 Chian drachms (3.8g) 1:9 Chian tridrachms (11.4g)
404-390/385	12:1	Inferred from coins	1 AV Chian drachm (3.95g) =

[86] (1.04 x 12) / 12.3 = 1.01 Aeginetan staters. Seltman 1921: 56-8, Melville-Jones 1999: 267.

[87] See the weight tables in Ellis-Evans 2018: 43 (Abydos) and 45-6 (Tenedos).

[88] (8.35 x 11.33) / 3.5 = 27.03 Chian drachms.

[89] See Markou 2011: 113-28 for a catalogue of the gold coinage. The silver coinage can be conveniently accessed through http://kyprioscharacter.eie.gr/en/.

(Thasos)		(Le Rider 1967:187-8)	3 AR Chian tetradrachms (15.3g)
401 (Babylonia)	12:1	Xen. *Anab.* 1.7.18	300:1 Babylonian talent (30,060g)
***ca.* 405-387** (Teos)	12:1	Inferred from coins (Kinns 1989:187)	1 AV Chian hemidrachm = 6 AR Chian drachms (3.8g)
***ca.* 400-390** (Maroneia)	12:1	Inferred from coins (Psoma *et al.* 2008:175)	1 AV 3.22g = 3 AR 12.9g staters
***ca.* 394** **(Siphnos)**	12:1	Inferred from coins (Sheedy 2020: 149-50)	1 AV 4.29g = 12 Attic drachms (4.33g)
***ca.* 380** (Klazomenai)	12:1	Inferred from coins (Kinns 1989:184-6)	1 AV Attic octobol (5.7g) = 4 AR Attic tetradrachms (17.2g)
380s-360s (S. Anatolia)	12:1	Inferred from coins (Callataÿ this volume)	1:27 tetrobols / 1/3rd staters 1:9 double sigloi (11.1g)
374-361 (Nikokles)	12:1	Inferred from coins (Markou 2011:119-22)	1 AV 1/3rd stater (2.8g) = 3 AR sigloi (11.2g)
365-362 (Pisa)	12:1	Inferred from coins (Seltman 1921:56-8)	1 AV Aeginetan obol = 1 AR Aeginetan stater
361-351 (Evagoras II)	12:1	Inferred from coins (Markou 2011:123-6)	1:27 Chian drachms (3.7g) (i.e. 13 didrachms + 2 hemidrachms)

4.2 The Persic Standard (*ca.* 350-330)

In contrast to the incremental changes to the silver/gold exchange rate which we see *ca.* 400-360, in the period *ca.* 350-340 there is a rapid and widespread change in weight standards and denominations across Persian-controlled Asia Minor to accommodate a 10:1 silver/gold exchange rate, which recalls the equally dramatic shift to the Chian standard after 405. This phenomenon was first identified in the context of north-west Asia Minor by Georges Le Rider as a switch to the Persic standard and a preference for hemidrachms minted to a theoretical standard of 2.78g.[90] With the evidence available to him, Le Rider was unable to date this switch any more precisely than to the 350s-330s. However, thanks to a recently published hoard group from the Troad it is now possible to date this shift, at least in this particular region, to *ca.* 350 or soon after.

In the mid-350s, seven mints from the Troad, and possibly also Kyzikos in neighbouring Mysia, produced drachms which, to judge from their weights, were minted to a theoretical standard of 3.1g. This would imply a quite dramatic drop in the exchange rate from 11.33:1 just a few years earlier *ca.* 360-355 to 10:1 by *ca.* 355-350.[91] In the case of two of these mints, Abydos and Assos, the transition from minting Chian drachms to Persic hemidrachms happens mid-series with the types staying the same and only the weight standard and denomination changing. The impression which the numismatic evidence gives is that the price of silver suddenly increased in the mid-350s: it would seem that these mints initially tried to accommodate this shift by significantly lowering the weight of the drachms, but soon decided instead to change the weight standard and denominations of the coins altogether. The advantage of switching to the Persic standard was that, on a 10:1 silver/gold exchange rate, 1 daric = 30 Persic hemidrachms.[92] This was only a light adjustment to the 'drachm a day' pricing structure which had been prevalent in Asia Minor since the 5th century.

[90] Le Rider 1963, Le Rider 1971: 144-51.

[91] See the weight tables in Ellis-Evans 2018: 42-9.

[92] (8.35g x 10) / 2.78g = 30 Persic hemidrachms. Once more we see the introduction of a coin that allows for an easy silver equivalency to a pay structure of a Daric a month.

The local conditions of the Troad at this moment in time may have also contributed to the rapidity of these changes. During the period *ca.* 356-354, Artabazos, the satrap of Hellespontine Phrygia, was in revolt from Artaxerxes III and spending heavily on hiring Greek mercenary forces.[93] It is strongly suspected on the basis of both literary and numismatic evidence that his deputy in charge of the Troad, Memnon of Rhodes, was responsible for co-ordinating the unusually high volumes of silver production which we see at Troad mints in the 350s.[94] Several anecdotes in Book 2 of Pseudo-Aristotle's *Oeconomica* likewise portray Memnon as squeezing the cities of the Troad for funds and coming up with various schemes for making his stretched silver supplies go further.[95] It therefore seems likely that the coincidence of Artabazos' revolt starting at precisely the moment when the Krenides mines were opened greatly exacerbated the impact of the latter event on the silver supply of the Troad. Silver was going to disappear from circulation anyway as it suddenly appreciated in value post-Krenides, but this process would have been greatly hastened in the Troad by wartime conditions in which the state was trying to exact as much silver as possible to fund the fighting while the region's inhabitants were doing what they could to hide their wealth.

This sudden shift in the weight standard and denominations of silver coins in north-west Asia Minor appears to be coincident with the start of Philip II's coinage in the late 350s. This coinage consisted of gold staters on the Attic standard (8.6g) and silver staters (14.3g) and 1/5th staters (2.88g) on the so-called Milesian standard which had been prevalent in the nearby Chalkidike for the last century. Inscribed accounts from Delphi attest a 10:1 silver/gold exchange rate being used for Philip II's coinage in 335.[96] If we assume that this was the rate which the Macedonian kingdom had been using when it first started issuing Philip's coinage, then 1 gold stater = 6 staters or 30 of the 1/5th staters.[97] This 1 gold coin = 30 silver coins pricing structure is, of course, precisely what we see mints in north-west Asia Minor switch to at exactly the same time. It is worth noting that the 1/5th stater denomination had not previously existed in the Chalkidian system: its creation is therefore best explained by the need to make these neat coin equivalencies work. On the currently available evidence, it is unclear whether Philip's coinage in Macedonia or the switch to the Persic standard in north-west Asia Minor came first. In any case, it is more important to emphasize that *both* coinages were most likely responding

[93] Ellis-Evans 2018: 37-42.

[94] Ellis-Evans 2018: 58-9.

[95] Ps-Arist. *Oec*. 2.2.29 = 1351b1-19.

[96] *CID* 2.76, Col. II.9-12: [*ν* τοῖς] ναοπ[οι]οῖς εἰς κυπάρ[ισ]σον φιλιππείους |*ν* χρυσοῦ[ς] ἑ[κατὸν πε]ντήκον[τα], ἕκαστον ἐν ἑπτὰ |*ν* στατῆρ[σιν. *ν*] τούτου ἐγένετο εἰς ἀργυρίου παλαιοῦ |[*ν* λ]όγον μναῖ τριάκοντα ('To the temple builders for cypress wood, 150 gold Philippeioi, each reckoned at 7 staters, making in old silver coinage 30 minas').

[97] (8.6g x 10) / 2.88g = 30 Milesian 1/5th staters. In his important monograph on Philip II's coinage, Le Rider 1977: 359-60, 439-41 made a valiant if convoluted effort to show that Philip struck on 12:1 rather than 10:1. In his defence, Le Rider was well aware that it was a practical impossibility for Philip to be issuing at 10:1 when neighbouring regions were at 13.33:1 which he assumed remained in existence in Anatolia. By contrast, numismatists of an earlier generation such as Barclay Head (*HN*^{2} [1911]: 222) had had no reservation in interpreting Philip's denominational structure as indicating a 10:1 ratio. In addition to Philip, there are Attic weight gold issues of Amphipolis, Philippi, and the Chalkidian League. Psoma 2001: 179-87 accepts that at least the late Chalkidian issues are at 10:1, thus creating a *terminus ante quem* of 348. We suspect the choice of the Attic standard for all these gold issues was driven by its easy exchangeability with Chalkidian weight silver at 10:1. However, there are a number of difficult chronological questions here which go beyond the scope of this paper (e.g. did Amphipolis strike its gold before or after it fell under Philip's control), and so we cannot discount the possibility, if some of the issues are indeed early, that the choice of Attic standard for the gold coins might have been driven by a need to interact with Attic weight silver at 12:1.

to the opening of the Krenides mines *ca.* 356 which flooded the market with gold.[98] The result of this exogenous shock to the market will have been to reduce the price of gold, increase the price of silver, and induce private individuals to take silver out of circulation to arbitrage the resulting price difference. The sudden drop in the state exchange rate which we see in the Troad from 11.33:1 to 10:1 in the mid- to late 350s is consistent with this scenario.

When Alexander the Great began to mint coinage in his own name in 333, the one major change he made to his father's coinage was to move the silver coinage from the Milesian standard to the Attic standard.[99] At the 10:1 exchange rate, 1 gold Attic stater = 20 silver Attic drachms.[100] Despite the tremendous size of Alexander's lifetime coinage, the 10:1 exchange rate remained stable. Opportunities for arbitrage did not arise because sufficiently large quantities of both gold and silver were appearing on the market simultaneously. By contrast, with the discovery of the 'third contact' at Laurion in the 510s/500s and the opening of the Krenides mines *ca.* 356, only one of the two metals (silver and gold respectively) was becoming super-abundant. As price data from Babylon appears to suggest, the main economic impact of Alexander massively increasing the money supply in this way was instead price inflation.[101]

4.3 Ionia and Caria: The Pixodaros Hoard

As we have seen in the previous section, the impact of the opening of the Krenides mines on the silver/gold ratio was felt almost immediately in neighbouring regions such as Macedonia and north-west Asia Minor. However, modern parallels would lead us to expect that the impact on regions further afield would be delayed as a result of distance and the peculiarities of individual regions. For example, in the mid-19th century France operated a bimetallic currency system which made the country vulnerable to bimetallic arbitrage should a significant new supply of precious metals come onto the market. This is precisely what happened with the California Gold Rush of 1848. As Angela Redish has shown, bimetallic arbitrage in the form of silver exports for gold only became profitable in France from 1851, and as a result it was not until the mid-1850s that French cities began to run out of silver coinage. However, once Gresham's Law had begun to take effect, it did so with a vengeance: by the end of the 1850s, silver made up only 2-3% of circulating coinage.[102] As this example illustrates, even in the globalized economy of the mid-19th century it could take time for a new supply of precious metals to affect global markets. Consequently, we should expect the impact of the opening of the Krenides mines to be staggered according to distance, but the consequences for the silver/gold ratio to be no less swift once they hit.

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[98] Diod. 16.8.6-7. Ancient gold discoveries do not provide the same stories of people giving up everything and moving to the place of discovery as was true in the 19th century and continues to this day in the Amazon. There are probably a number of explanations for this relating to mobility, the local power in control, and the use of slave labour. But that does not mean such discoveries were any less newsworthy. The best classical evidence for the enthusiasm a discovery could produce can be found in Herodotus' first-hand account of his visit to Thasos (6.47). In viewing the gold mines, the most marvellous (θωμασιώτατα) of which were founded by the Phoenecians, he sees, "a whole mountain ... turned upside down in the search for gold" (trans. De Sélincourt).

[99] For the dating see Le Rider 2007: 8-18.

[100] (8.6g x 10) / 4.3g = 20 Attic drachms. We here see a return to the 20:1 relationship that had existed in the 5th century between the siglos and daric, although whether this was being consciously evoked or was simply a matter of convenience is hard to say.

[101] Pirngruber 2017: 107-22.

[102] Redish 2000: 181-5.

For Ionia and Caria, the Pixodaros Hoard (*CH* 9.421) may provide evidence for precisely this dynamic. The hoard, reportedly consisting of *ca.* 2,600 silver coins of which 1,504 were subsequently recorded, was found near the ancient theatre of Halikarnassos in September 1978 and dispersed in trade the following year.[103] Based on the coins of Pixodaros included in the hoard we know that it closed in 341/0.[104] As the authors of the original hoard publication note, the character of the Pixodaros Hoard is difficult to pin down. The appearance of much earlier coinages (e.g. some of the Thasian issues, the Kolophon coin) in a similarly fresh condition to coinages which were produced immediately before the hoard closed (e.g. the Pixodaros coins) and the inclusion of series from regions far removed from Caria which one would expect to take some time to circulate this far south (e.g. Thasos and Kyzikos) suggest that this is a savings hoard built up over a long period of time. Nevertheless, study of the individual coinages led the authors to conclude that all the coinages had been taken out of circulation at the same time and thus that their production could in most cases be dated to shortly before 341/0.[105] However, in arriving at this conclusion, the authors were of course not in a position to appreciate that, as we have argued above, the particular silver/gold ratio reflected in the weights and denominations of the coins may itself be a chronological indicator. When this is taken into account, a rather different reconstruction of the hoard presents itself. As we shall argue below, the Pixodaros hoard is best understood as a 'hybrid': whereas the Ionian and Carian elements primarily reflect what was in circulation locally at the time the hoard closed in 341/0, the rest of the material represents a savings hoard consisting of a number of different packets which we therefore cannot assume all closed at the same time.

The hoard coins can be split into two groups: **1)** tetradrachms (1,256 = 83.5%) and didrachms (7 = 0.5%) on the normal Chian standard reflecting a 12:1 ratio with the daric; **2)** didrachms (241 = 16%) on a reduced version of the Chian standard reflecting a 10:1 ratio with the daric. The reduced-weight didrachms were minted by Pixodaros (182), Kos (48), and Rhodes (11), and thus by three of the four mints represented in the hoard which were most closely located to its find spot at Halikarnassos (the fourth mint is Knidos, represented by just two Chian weight didrachms in the hoard).[106] The coins of Pixodaros make it clear that the switch to the 10:1 ratio had happened at the very beginning of his reign in 341/0 immediately before the hoard was buried. Pixodaros is represented in the hoard by 14 Chian weight tetradrachms (13 of which use obverse dies originally cut for his predecessor Idrieus) and 182 mint-condition

[103] Ashton *et al.* 2002b: 159.

[104] Konuk in Ashton *et al.* 2002b: 229.

[105] Ashton *et al.* 2002b: 159-60: "The Hecatomnus hoard [*CH* 9.387] seems to be a straightforward 'circulation' hoard in which the older coins tend to be more worn than the recent, whereas the Pixodarus hoard exhibits a different pattern. Although at first sight the appearance of much earlier coins in similarly fresh condition to later coins seems to suggest that Pixodarus may have been a savings hoard, built up over a long period of time, detailed examination of the contents yields a more complex pattern. As will be seen in the studies that follow, the pattern of issues of the mints of Cyzicus, Cos and Samos included in the hoard strongly suggests removal from circulation at one time. The absence of earlier issues of all three mints, particularly the massive issue of Hegesianax at Samos, makes it highly unlikely that this is a straightforward savings hoard. Moreover, the pattern of wear on Ephesian issues seems to support the interpretation that most of the coins in the hoard were taken out of circulation at one time. Thus, while there clearly are certain individual coins which seem to exhibit less wear than we might expect (such as early issues of Thasos and the coin of Colophon), this must be explained in terms of the treatment of these coins prior to deposition in this hoard. It may also be that some selection on the part of the depositor lies behind such odd cases".

[106] Knidos: Ashton in Ashton *et al.* 2002b: 220-1 who concludes at p. 221 that these coins date to the late 350s: 'Both Cnidian didrachms in the Pixodaros hoard are in fresh condition, suggesting that they had been removed from circulation some years before concealment of the hoard in the late 340s'.

didrachms which weigh just 7g rather than the *ca.* 7.5g we would expect for a Chian weight didrachm.[107] Pixodaros minted these 7g didrachms in parallel with gold half darics (4.2g) and fractions thereof, producing an equivalency whereby 6 didrachms = 1 half daric at the 10:1 ratio.[108] We may here compare the 7g didrachms which Pnytagoras minted in parallel with 1/12th darics (0.7g – a fractional denomination Pixodaros likewise produced).[109]

The coins of Kos and Rhodes in the hoard likewise bridge this shift from the 12:1 ratio to the 10:1 ratio and are therefore consistent with the conclusion that this switch in the silver/gold ratio only occurred in Caria at the very end of the 340s, a full decade after it had happened in Macedonia and north-west Asia Minor. Kos is represented in the hoard by 74 tetradrachms on the normal Chian standard and 48 didrachms minted to *ca.* 7g which therefore fit the 6 didrachms = 1 half daric equivalency we have seen both Pixodaros and Pnytagoras adopting.[110] The tetradrachms in the hoard consist of one Phase 2 example (*ca.* 350), 38 Phase 3 examples (*ca.* 350-345), and 37 Phase 4 examples (*ca.* 345-340), suggesting that the Koan portion of the hoard represents what was in circulation at the time the hoard closed.[111] As Meadows' study shows, the didrachms at *ca.* 7g belong exclusively to Phase 4 (*ca.* 345-340), thus making them contemporary with Pixodaros' didrachms from 341/0.

Rhodes is represented in the hoard by 12 didrachms, of which 11 are just below 7g whereas one with a club + Φ weighs 7.42g. As Ashton notes, the weights of the other 8 club + Φ didrachms known to him show that they were on the full Chian standard, whereas all the subsequent didrachms were minted to the *ca.* 7g standard we have seen Pixodaros, Pnytagoras, and Kos using.[112] Ashton also notes that only the first quarter or first third of the obverse dies Rhodes used to mint these *ca.* 7g didrachms are represented in the Pixodaros hoard.[113] This suggests that the series may have begun only shortly before 341/0, and thus that the switch from 12:1 to 10:1 within this series (indicated by the switch from full-weight to reduced didrachms) had likewise only just occurred.

As has been noted above, the authors of the Pixodaros hoard publication argue that the rest of the coins in the hoard were removed from circulation at one time in the 340s. However, in the case of Thasos this leads to the rather unlikely conclusion that a mint in the immediate vicinity of the Krenides mines was continuing to mint Chian weight coinage on a 12:1 ratio at a time when Carian and Cypriot mints were instead switching to a reduced Chian standard in order to accommodate a 10:1 ratio. Moreover, in the cases of Ephesos and Thasos we know that coinage reflecting the new 10:1 ratio was minted soon after the latest part of the series represented in the Pixodaros hoard.

The latest Thasian coins represented in the hoard are Chian weight tetradrachms belonging to the issue West 39. Almost immediately after this (West 41-47) Thasos introduced *ca.* 14g

[107] Konuk in Ashton *et al.* 2002b: 223-9.

[108] (4.2 x 10) / 7 = 6 Chian didrachms (reduced weight). Pixodaros half darics: HNO Caria nos. 53, 54, 1710 (temporary numbers).

[109] Pnytagoras: see Section 4.1 under 'Salamis, Cyprus (411-331)'. Pixodaros 1/12th darics: HNO Caria nos. 239, 2057 (temporary numbers).

[110] Meadows in Ashton *et al.* 2002b: 230-3 (tetradrachms), 233-6 (didrachms).

[111] Meadows in Ashton *et al.* 2002b: 236-8.

[112] Ashton in Ashton *et al.* 2002b: 241-2.

[113] Ashton in Ashton *et al.* 2002b: 242.

tetradrachms and *ca.* 7g didrachms.[114] These appear to have been minted in parallel with gold drachms weighing *ca.* 3.5g and which on a 10:1 ratio would therefore be worth 5 didrachms.[115] As Meadows has noted, the end of the series post-Pixodaros is well-represented in the Robinson hoard (*IGCH* 716, *ca.* 360-330?) and the Le Rider hoard (*IGCH* 723, *ca.* 345).[116] On the assumption that the Thasos coins in the Pixodaros hoard were minted soon before it closed in 341/0, Meadows wanted to bring these two hoards down to *ca.* 335 and 330 respectively.[117] However, this may be unnecessary. It would work well for the series to have ended by *ca.* 350-345 (the *terminus ante quem* provided by the Le Rider hoard), the didrachms at the end of the series (represented in the Robinson hoard) to have been minted a few years earlier than this (*ca.* 355-350?), and, given the proximity of Thasos to the Krenides mines, the switch to the 10:1 ratio to have been almost immediate in *ca.* 355. The Chian weight tetradrachms in the Pixodaros hoard would thus represent a packet which had closed before *ca.* 355 and been kept as savings in the meantime. Meadows notes that the coins look to have been taken out of circulation in one group and that even the earliest Thasian issues in the hoard are fresh.[118]

Ephesos provides an interesting complication to our overall model. The Ephesian portion of the Pixodaros hoard consisted only of Chian-weight tetradrachms. Kinns has divided the Chian weight coinage of Ephesos into ten classes labelled A-J. Of these, all but H, I, and J are represented in the hoard, with classes F (*ca.* 360-350) and G (*ca.* 350-340) best represented, and many of the examples of class G appearing in uncirculated condition.[119] Evidently, the Chian tetradrachm survived the change to the 10:1 ratio at Ephesos. Indeed, Pixodaros' successor Rhoontopates resumed the issue of Chian tetradrachms, and there are other Chian-weight issues from Rhodes (down to *ca*. 315), Erythrae *ca*. 325-315, Miletus (*ca*. 330 or later?), and Kos (early 3rd century).[120] Thus, within the broader picture of most mints altering the weight standards and denominations of their silver coinage so as to accommodate the new 10:1 ratio, a minority of mints were evidently able to find ways to make the Chian standard continue to work. The rule of thumb should therefore be that a change in the weight standard of a coinage should make us suspicious that something may be happening to the silver/gold exchange rate, but the absence of such a change is not evidence in and of itself that the ratio is not changing, the coinage of Athens being a case in point.

4.4 The Periphery: The Black Sea, Sicily, and Sogdiana

[114] West 1929: 44-5. The tetradrachm is BNF Fonds Général 2030 (13.91g).

[115] (3.5 x 10) / 7 = 5 Chian didrachms (reduced weight). Le Rider 1967: 188 with Planche II, no. 32 (this coin: BM 1958,0304.15 – 3.43g, bunch of grapes countermark).

[116] Robinson 1934, Le Rider 1956.

[117] Meadows in Ashton *et al.* 2002b: 164-5.

[118] Meadows in Ashton *et al.* 2002b: 164.

[119] Kinns in Ashton *et al.* 2002b: 191.

[120] Rhoontopates: Konuk 1998: 340-1; Erythrae: Kinns 1980 1: 47-9 and 2: 431-2, nos. 69-74; Miletos: Meadows in Ashton *et al.* 2002: 206-9; Kos: Requier 1996; Rhodes: Ashton 2001: 82-5, 102-3 and nos. 81-108 (cf. also the postscript at p. 112 on *CH* 9.463). We are grateful to Philip Kinns and Richard Ashton for drawing this evidence to our attention and discussing its implications with us. Following Kinns' Class J Chian weight tetradrachms, there is a short-lived series of cross-band tetradrachms on a lower 12.4g standard with 3.1g drachms. Kinns (in Ashton *et al.* 2002b 200) dates these in the 320s and suggests internal stasis brought on by Alexander for the drop in standard. Interestingly, at a 10:1 gold/silver ratio the familiar 27 drachms to the daric equivalency would arise once more. This is tentative evidence for the survival in Ionia for a number of years after Alexander's arrival of accounting in and/or circulation of darics. Not surprisingly, the cross-band coins were replaced by Attic-weight octobols.

We can complete this picture of how the impact of Krenides on the silver/gold ratio expanded out from Thrace over time by looking to three case studies from the peripheries of the Greek world – Olbia on the northern shore of the Black Sea, Syracuse in Sicily, and the Rock of Ariamazes in Sogdiana.

From Olbia we have the famous monetary decree which values a Kyzikene electrum stater at 8.5 Olbian silver staters.[121] The most recent work on the composition of Kyzikene electrum suggests that these were consistently minted with 60% gold.[122] If, therefore, we can identify the silver staters referred to in the inscription (which were presumably being minted at around the same time the decree was passed) and date the decree itself, then it should be possibly to identify the silver/gold ratio in use at Olbia at this time. However, the dating of both the coins and the decree is somewhat controversial.

At the 13.33:1 ratio these Olbian silver staters would need to weigh 15.9g, at 12:1 they would need to be 14.4g, and at 10:1 they would have to be 12.1g.[123] In the 5th century Olbia minted a series of silver coins bearing the name Eminakos on a light version of the Aeginetan standard.[124] Olbia did not then mint silver coinage again until the mid-4th century when it produced silver staters with a head of Demeter as the obverse type and a dolphin with an eagle on its back as the reverse type.[125] While Karyshovski reports one example weighing as much as 12.8g, the majority instead weigh around 12.1g.[126] It is therefore clear that the eagle-on-dolphin coins are the ones referred to in the inscription and that they represent a 10:1 silver/gold ratio. Vladimir Stolba has recently established that these coins most likely date *ca.* 340-335 and for a variety of reasons cannot date before *ca.* 350.[127] However, in his edition of the inscription, Laurent Dubois, although likewise identifying the eagle-on-dolphin staters as the coins referenced in the decree, has instead preferred to date the decree (and thus the coins) to *ca.* 360 based on his view that the spelling of secondary diphthongs by single vowels disappears at Olbia after 350.[128] Dubois' linguistic argument has been doubted on its own terms, and from a numismatic perspective a *ca.* 360 date is doubly impossible: the coins cannot date this early, as Stolba has argued, and nor can the 10:1 ratio, as we have shown above. We would therefore argue that the inscription needs to be brought down to *ca.* 340 and that it was around this time that the shift to the 10:1 ratio occurred at Olbia.

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[121] *IGDOlbia* 14.23-6: τὸ δὲ χρυσίον πωλεῖν καὶ ὠνεῖσθ[αι τὸ]|ν μὲν στατῆρα τὸν Κυζικηνὸν ε[ἰνά]|το ἡμιστατήρῳ καὶ μήτε ἀξιώτερο[μ μή]|τε τιμώτερον ('Buy and sell gold coinage at the rate of one Kyzikene stater to 8.5 staters [i.e. of Olbian silver] and let it be neither cheaper nor more expensive').

[122] Gitler *et al.* 2020.

[123] These calculations assume a Kyzikene electrum stater of 60% gold and 40% silver. Composition analysis shows that the silver could be replaced with up to 5% copper: Gitler 2020. We assume that this represented a premium for the mint and was treated as silver. At the 13.33:1 ratio the calculation is as follows. Gold: 60% of 16.1g = 9.66 x 13.33 = 128.8. Silver: 40% of 16.1g = 6.44. Combined: 128.8 + 6.44 = 135.24 / 8.5 = 15.9g.

[124] *SNG* The British Museum: The Black Sea 358. See Karyshkovski 1988 139, Table 7 for a weight table.

[125] *SNG* The British Museum: The Black Sea 434, 436.

[126] Karyshovski 1988 139, Table 7 (cf. 148-9, Table 12) gives the following figures (n = 38): 12.80-12.66 – 1; 12.65-12.51 – 3; 12.35-12.21 – 5; 12.20-12.06 – 4; 12.05-11.91 – 7; 11.90-11.76 – 5; 11.75-11.61 – 3; 11.60-11.46 – 3; X<11.45 – 7.

[127] Stolba 2015: 51. We are grateful to Vladimir Stolba for helpful discussion on this point over email.

[128] Dubois 1996: 32 (dating), 36-7 (coins). For doubts regarding this dating principle see already the review of Johnston 1998.

As we discussed above (Section 2.2), silver production at Syracuse came largely to a halt by *ca.* 390 due to Dionysios I's use of a 15:1 ratio. However, after Timoleon captured the city in 343, he introduced gold 10 litra coins (2.15g) and Corinthian-style silver staters with Pegasi types (8.6g). These denominations reflect a 12:1 ratio whereby 1 gold coin = 3 silver coins, and indeed this ratio is perhaps indicated on the gold coins by the three dots below the forelegs of Pegasus.[129] The 12:1 ratio was maintained at least down to the early part of the reign of Agathokles, who *ca.* 317-310 minted gold drachms on the Attic standard (4.3g) in combination with silver Pegasi (8.6g) producing an equivalency of 1 gold coin = 6 silver coins.[130]

Finally, at the opposite end of the emergent Hellenistic world in deepest Sogdiana, the Alexander historians Arrian and Curtius relate an interesting story about Alexander offering prizes to the first men to scale the Rock of Ariamazes. In Arrian's version, prizes are offered from 12 talents to the man who summits first to 300 darics for the man who comes last.[131] Curtius' version instead gives the top prize as 10 talents, but adds the details that the prizes will decrease in one talent increments and that there will be ten prizes.[132] While the two versions are not perfectly congruent, the basic logic of what Alexander did is clear. The number of talents given as the top prize is also the number of available prizes (whether 12 or 10), the prizes go down in one talent increments, and so when Arrian says that the last prize is 300 darics this means that one talent is equal to 300 darics.[133] This is the same 12:1 ratio which Xenophon documented in Babylonia in 401 (Section 4.1 above). It would therefore seem that, when Alexander reached Samarkand in early spring 327 almost thirty years after Philip had opened the Krenides mines in 356, the impact of this new supply of gold had still not been felt in this distant periphery of the Persian Empire. One also wonders at this date how the looting of the royal Persian treasuries were perceived in terms of relative supply of gold and silver.

Table 4. Summary of the evidence for change in the silver/gold exchange rate between the 350s and 300s.

Time and Place	**Silver/Gold Ratio**	**Evidence**	**Ratio of Gold to Silver Coins** (1 daric unless specified = *n* silver coins unless specified)
***ca.* 360-355** (Troad)	11.33:1	Inferred from coins (Ellis-Evans 2018)	1:27 Chian drachms (3.5g)
***ca.* 355-350** (Thasos)	10:1	Inferred from coins	1 AV drachm (*ca.* 3.5g) = 5 'Reduced' Chian didrachms (7g)
***ca.* 350** (Troad)	10:1	Inferred from coins (Ellis-Evans 2018)	1:30 Persic hemidrachms (2.78g)
Pre-348 (Chalkidian League, Philip II)	10:1	Inferred from coins	1 AV stater (8.6g) = 6 AR Milesian staters (14.3g) 30 AR 1/5th staters (2.88g) [Philip only]

[129] (2.15g x 12) / 8.6g = 3 Pegasi. AV 10 litra: *SNG* ANS 492-493 (no. 493 has the three dots below the forelegs). AR Pegasi: *SNG* ANS 494-510 with Calciati 1990 2: 607-10.

[130] (4.3g x 12) / 8.6g = 6 Pegasi. AV decadrachm: *SNG* ANS 549-553. AR Pegasi: *SNG* ANS 554-560 with Calciati 1990 2: 610-14. On the coinage of Agathokles see most recently Lisle 2017.

[131] Arr. 4.18.7: ἔνθα δὴ ἐκήρυξεν Ἀλέξανδρος τῷ μὲν πρώτῳ ἀναβάντι δώδεκα τάλαντα εἶναι τὸ γέρας, δευτέρῳ δὲ ἐπὶ τούτῳ τὰ δεύτερα καὶ τρίτῳ τὰ ἐφεξῆς, ὡς τελευταῖον εἶναι τῷ τελευταίῳ ἀνελθόντι τριακοσίους δαρεικοὺς τὸ γέρας ('Then Alexander proclaimed that the first to scale the height should have a prize of 12 talents, the second a second prize, the third another prize and so on, the last to reach the top to have 300 darics').

[132] Curt. 7.11.12 (Alexander speaking): '*Praemium erit ei, qui primus occupaverit verticem, talenta X, uno minus accipiet, qui proximus ei venerit, eademque ad decem homines servabitur portio*' ('The reward for him who first reaches the top will be 10 talents; he who comes next will receive one less, and the same proportion will be maintained up to the number of ten men').

[133] Le Rider 2007: 243-4.

***ca.* 350-311** (Abdera)	10:1	Inferred from coins[134]	1 AV stater (8.6g) (issued as ¾ and ¼ stater denominations) = 8 AR tetradrachms (10.75g)
343 (Syracuse)	12:1	Inferred from coins	1 AV 10 litra (2.15g) = 3 AR staters (8.6g)
***ca.* 341/0** (Kos, Rhodes, Pixodaros)	10:1	Inferred from coins	1:6 'Reduced' Chian didrachms (7g)
***ca.* 341/0 (?)** (Pnytagoras)	10:1	Inferred from coins (Markou 2011)	1 AV 1/12th daric (0.7g) = 1 AR 'Reduced' Chian didrachm (7g)
***ca.* 340** (Olbia)	10:1	*IGDOlbia* 14.23-6	1 EL stater (16.1g) = 8.5 AR staters (*ca.* 12.1g)
335 (Delphi)	10:1	Inscribed accounts (*CID* 2.76, Col. II.9-12)	1 AV stater (8.6g) = 6 AR Milesian staters (14.3g) 30 AR 1/5th staters (2.88g)
333 (Alexander III)	10:1	Inferred from coins	1 AV stater (8.6g) = 5 AR Attic tetradrachms (17.2g) 20 AR drachms (4.3g)
***ca.* 320's** (Ephesos)	10:1	Inferred from coins	1:27 'Cross-band' drachms (3.1g)
327 (Sogdiana)	12:1	Arr. 4.18.7, Curt. 7.11.12 (Le Rider 2007: 243-4)	300 darics = 1 AR Babylonian talent
317 (Syracuse)	12:1	Inferred from coins	1 AV decadrachm (4.3g) = 6 AR Pegasi (8.6g)

5. The Fourth Century: The Literary Evidence

Now that, based on the numismatic evidence, we have a clear sense of where, when, and how the silver/gold ratio dropped from 13.33:1 to 10:1 over the course of the 5th and 4th centuries, we can make better sense of two important passages from the literary sources which have often been misinterpreted.

5.1 Xenophon, *Poroi* 4.10-11

Xenophon devoted chapter 4 of his *Poroi* to advocating for the rejuvenation of the silver mines at Laurion. At paragraphs 10-11 he makes the following observations about the relative values of gold and silver:

> **(§10)** εἰ δέ τις φήσειε καὶ χρυσίον μηδὲν ἧττον χρήσιμον εἶναι ἢ ἀργύριον, τούτῳ μὲν οὐκ ἀντιλέγω, ἐκεῖνο μέντοι οἶδα, ὅτι καὶ χρυσίον ὅταν πολὺ παραφανῇ, αὐτὸ μὲν ἀτιμότερον γίγνεται, τὸ δὲ ἀργύριον τιμιώτερον ποιεῖ. **(§11)** ταῦτα μὲν οὖν ἐδήλωσα τούτου ἕνεκα, ὅπως θαρροῦντες μὲν ὅτι πλείστους ἀνθρώπους ἐπὶ τὰ ἀργύρεια ἄγωμεν,

[134] Abdera has two issues of gold coins, one in Period VIII and one in Period IX. The choice of the Attic standard and the similarity of the profile head of Apollo to the staters of Philip makes it highly likely that they were issued on the same gold/silver ratio. The choice of denominations (¾ and ¼ stater) necessitates that the ratio to the corresponding silver is divisible by four. At 10:1, the ¾ stater would be worth six tetradrachms on the reduced silver standard introduced at this time ((8.6g x 10) / 8 = 10.75g) and the ¼ stater, two tetradrachms. The reduced-weight Abdera silver coins of Period IX should be defined, even if sometimes underweight, as equal to ¾ of the 14.3 g stater of Philip of Macedon and not defined as either Chian or Persic. The signer of the first issue of gold coins, Hikesios, has surviving one silver tetradrachm of 11.40g and one drachm of 2.6g (2.6 x 4 = 10.4g). May placed this issue at the start of his Period VIII. However, the rarity of Hikesios' silver issues and the gold issue probably makes it more likely that his coins started after the massive issues of Pausanias It is the issue of gold that probably introduced the standard change. See the valuable discussion in Chryssanthaki-Nagle 2007: 152-60 despite her starting point of 12:1 under Philip. The relationship between the coinage of Abdera and Philip needs to be taken into account in defining the relationship between the city and the kingdom in the second half of the 4th century.

> θαρροῦντες δὲ κατασκευαζώμεθα ἐν αὐτοῖς, ὡς οὔτε ἐπιλειψούσης ποτὲ ἀργυρίτιδος οὔτε τοῦ ἀργυρίου ἀτίμου ποτὲ ἐσομένου.
>
> **(§10)** Someone might claim that gold is no less useful than silver. This I do not contradict. However, one thing I know is that when plenty of gold is being found, its value falls, but that of silver rises. **(§11)** So: the reason I explained these matters was in order that we should have the confidence to bring as many people as possible into the silver mines, and have the confidence also to make arrangements in them – on the basis that silver-bearing ore will never run out and that silver itself will never lose its value (trans. Whitehead).

The passage appears to contain a serious contradiction. Xenophon seems to be saying that an abundance of gold can result in the appreciation of silver relative to gold, but that rejuvenating the Laurion mines and thus introducing a new supply of silver to the market will not likewise result in the depreciation of silver relative to gold.[135] While Xenophon's assertion may seem non-sensical in the abstract, it makes rather better sense when placed in the context of the opening of the Krenides mines. As someone with a significant interest in both foreign affairs and in the mining of precious metals, we can reasonably expect that, by the time he was composing the *Poroi ca.* 355, Xenophon would have heard about Philip's re-opening of the Krenides mines in 356 and would have grasped what its consequences would be for the silver/gold ratio.[136] Throughout the *Poroi*, Xenophon's aim is not to formulate general axioms on civic finances, but rather to provide actionable advice on financial matters to the Athenians in the specific circumstances of *ca.* 355.[137] Viewed from this perspective, his statement is valid and indeed perceptive.

Firstly, he foresees that the effect of this major new supply of gold coming onto the market will be to make silver appreciate relative to gold and thus to make the silver/gold ratio decrease. As we have seen, this is exactly what happened in the years which followed when the ratio dropped from 12:1 to 10:1. Secondly, he sees that, *in this specific context*, rejuvenating the Laurion mines and thus introducing a new silver supply to the market will not result in silver depreciating. Xenophon's point is that, with a new and voluminous supply of gold on the market, no amount of silver that Laurion can produce will cancel out the impact of the Krenides mines opening. Consequently, the Athenians can work the Laurion mines as hard as they like without having to worry that the introduction of this enlarged supply of silver to the market will precipitate its depreciation and thus become a counter-productive economic strategy. His advice to the Athenians is therefore extremely sensible: the price of silver is about to go up because of Krenides, so get as much silver out of Laurion as you can while the price is favourable and you are insulated from the possibility of silver depreciation. Interpreted in this way, the passage is a valuable insight into how a financially literate Greek such as Xenophon understood the market in precious metals and its relationship to state finances.

5.2 Pseudo-Aristotle, *Oeconomica* 2.1.2-3 = 1345b20-24

[135] See Gauthier 1976: 132-3 and most recently Whitehead 2019: 182-3 for discussion of the scholarship on this point.

[136] See Whitehead 2019: 7-15 on the date of composition and whether Xenophon was in Athens at the time.

[137] See Gauthier 1984 for an overview of the debate on Xenophon's aims in the *Poroi*. Figueira 2012 offers a similar defence of Xenophon's "appreciation of the operation of economic factors". He informs us by email that he is wary of attributing a knowledge of Krenides to Xenophon. For a more theoretical economic defence of Xenophon see Lianos 2014.

The three treatises gathered under the title *Oeconomica* in the Aristotelian corpus appear to have been written by three different authors, quite possibly at different times, and cover three very different aspects of this capacious category in Greek thought. Whereas 'Books' 1 and 3 discuss household management and marriage, Book 2 examines income and expenditure and is thus a work on economics in our sense of the term.[138] The particular significance of Book 2 for our argument is that in the theoretical introduction to the work (2.1.1-8) the author makes the following statement on the subject of coinage:

> πρῶτον μὲν τοίνυν τὴν βασιλικὴν ἴδωμεν. ἔστι δὲ αὕτη δυναμένη μὲν τὸ καθόλου, εἴδη δὲ ἔχουσα τέσσαρα, περὶ <τὸ> νόμισμα, περὶ τὰ ἐξαγώγιμα, περὶ τὰ εἰσαγώγιμα, περὶ τὰ ἀναλώματα. τούτων δὲ ἕκαστον. περὶ <μὲν> τὸ νόμισμα λέγω ποίον καὶ πότε[139] τίμιον ἢ εὔωνον ποιητέον …

We would translate this passage as follows:

> Let us therefore examine the royal economy first. This exercises power over the whole and has four aspects – coinage, exports, imports, expenditure. To take each of these separately: in regard to the coinage, I mean the question as to what coin should be struck and when it should be of a high or a low value …

Traditionally, Pseudo-Aristotle has been understood as here saying that the right to mint coinage was the exclusive prerogative of the king. However, as has often been noted, this is a *prima facie* unlikely statement about non-royal coinage in the Persian Empire.[140] There were of course coinages which, with good reason, we think of as being backed by the Persian authorities or minted at their behest. However, it is another thing altogether to claim that the Persians attempted to control *all* coinage production within their territory and thus to turn the right to coin into an imperially dispensed privilege. This is certainly what Rome later did in the Imperial period, but the Roman authorities were also substantially more willing to intervene in local affairs than the Persians, who took a minimalist approach to imperial administration.[141] The various interpretations of the phrase τίμιον ἢ εὔωνον ('of a high or a low value') which understand this in reference to coin denominations run into the same objection: given that even the Romans did not micromanage coin production to this level, it is *a fortiori* unlikely that the Persians would have done so.[142]

We are therefore left with three alternatives. One possibility is to accept the traditional interpretation, but to argue that the theoretical first part of the work which contains this passage was written later under the Seleukids when it would be more accurate.[143] As we shall see below, this approach meets with insuperable difficulties. A second possibility is to conclude that Pseudo-Aristotle did indeed have the Persian Empire in mind but simply did not understand it. Such a fundamental misunderstanding would bring the value of the work as a whole into doubt

[138] On all three treatises see the comprehensive treatment of Zoepffel 2006.

[139] John Ma has suggested to us the gentle emendation of πότε<ρον> for πότε here.

[140] See e.g. Aperghis 2004: 131.

[141] For the emergent trend in the late Hellenistic period of treating the right to mint as an imperially dispensed privilege see Meadows 2001, esp. p. 62. For the Persian Empire's attitude to coinage see most recently Ellis-Evans 2018: 33-5.

[142] See e.g. Aperghis 2004: 119 for an attempt to interpret the phrase in this way.

[143] Most recently Aperghis 2004: 129-35.

and should thus be considered an explanation of last resort.[144] Finally, the third possibility is that the traditional interpretation itself is at fault. It is this third possibility which we would like to explore.

In speaking of coinage as one of the four aspects of the royal economy, the author is not excluding the possibility of there being coinage unrelated to the royal economy, just as he is not excluding the possibility of there being exports, imports, and expenditure unrelated to the royal economy. Rather, as the clarifying statements for these other three aspects of the royal economy make clear, he is talking about each topic specifically as it relates to the revenues and expenditure of the royal economy.[145] Thus, the clarifying statement on coinage needs to be read not as talking about coinage in general but specifically about royal coinage. Read in this way, the author is not making an improbable statement about the Great King determining what kinds of coin every city within his territory is minting, but rather what kind of coin *he* is minting. The full significance of this becomes apparent once we clear up the interpretation of the phrase τίμιον ἢ εὔωνον.[146]

As discussed, most translations understand this phrase to be referring to whether the coins were of large or small denominations.[147] As a result, van Groningen went so far as to delete it on the grounds that it was simply a later gloss on ποίον which had crept into the text.[148] However, this overlooks the possibility that τίμιον ἢ εὔωνον instead refers to the *value* of royal coinage *relative* to specie in other metals, and thus that what Pseudo-Aristotle is in fact talking about here is the king's ability to set the exchange rate between his gold coinage and local silver coinages.[149] The term τίμιος is often used to refer to the relative values of coins or monetizable commodities. For example, in the passage of *Poroi* discussed in Section 5.1 we saw Xenophon using the term precisely in the context of comparing the relative values of gold and silver. In addition to a passage of Herodotus which uses it to contrast the value of gold and bronze, there are two further texts from the third quarter of the 4th century which use τίμιος in this way.[150] On our view of the date of Book 2 of the *Oeconomica* (see below), these texts would be directly contemporary with the period when the theoretical introduction was composed. Firstly, in the

[144] For just such a judgement of the work's value see most stridently Finley 1970b (esp. 317: "that circle too [i.e. the Peripatetics] had its idiots"), Finley 1970a: 15 n. 51 ("excruciating banality"), Finley 1973: 20 ("crashing banality"): 122 ("painfully naïve").

[145] Ps-Arist. *Oec.* 2.1.3 = 1345b23-28: περὶ δὲ τὰ ἐξαγώγιμα καὶ εἰσαγώγιμα πότε καὶ τίνα παρὰ τῶν σατραπῶν ἐν τῇι ταγῆι ἐκλαβόντι αὐτῶι λυσιτελήσει διατίθεσθαι· περὶ δὲ τὰ ἀναλώματα τίνα περιαιρετέον καὶ πότε, καὶ πότερον δοτέον νόμισμα εἰς τὰς δαπάνας ἢ ἀντὶ νομίσματος ὤνια ('In the matter of exports and imports, what commodities it will be advantageous to receive from the satraps under the royal rule and dispose of and when; in regard to expenditure, what expenses ought to be curtailed and when, and whether one should pay what is expended in coin or in commodities which have an equivalent value', trans. Forster).

[146] For further discussion of this passage see Meadows (above, pp. 000-000).

[147] The Loeb uniquely (and improbably) understood it to be a reference to the king setting prices ('the seasonable regulation of prices'). Rostovtzeff 1941 1: p. 442 instead wondered, on analogy with Ptolemaic practice, whether it referred to variations in weight standard.

[148] Van Groningen 1933: 31-2 and van Groningen, Wartelle 1968: 53 n. 4, most recently followed by Aperghis 2004: 119.

[149] In his review of van Groningen's Budé, P. Thillet, *REG* 1969: 578 criticized this emendation and already arrived at an interpretation very similar to our own: "l'athétèse τίμιον καὶ [*sic*] εὔωνον mutile le texte: les variations du pouvoir d'achat des monnaies, de leur parité, ainsi que les dévaluations sont à la discrétion du souverain; dans le monde hellénistique, de tels phénomènes furent fréquents".

[150] Hdt. 3.23.4: ἔστι δὲ ἐν τούτοισι τοῖσι Αἰθίοψι πάντων ὁ χαλκὸς σπανιώτατον καὶ τιμιώτατον ('Among these Ethiopians there is nothing so scarce and so precious as bronze').

Olbian monetary decree (*ca.* 340: see Section 4.4), right after the exchange value is established between the Olbian silver staters and the Kyzikene electrum staters, this ratio is qualified by the expression μήτε ἀξιώτερο[μ μή]|τε τιμιώτερον ('neither cheaper nor more expensive').[151] Secondly, Aeschines in his speech *Against Ctesiphon* (delivered in 330) uses τίμιος to refer metaphorically to how an olive crown used to be 'valued' more than a gold crown.[152]

Thus, the significance of the king deciding what kind of coin to strike is that the value of other coinages within the kingdom would be determined relative to this. The king would want to be able to set the exchange rate between his royal gold coinage and the various local coinages of his kingdom because this affected the value of the taxes he collected and the price which he paid for services (above all in the form of military expenditure).[153] Thus, when talking about the role of coinage in the royal economy, Pseudo-Aristotle focuses on the exchange rate issue because this is the aspect of royal coinage which most directly relates to the question of revenue and expenditure, the two topics which he likewise highlights when discussing the other three aspects of the royal economy. In sum, if we read the passage in this way then what Pseudo-Aristotle is saying requires no improbable hypotheses about the Persian Empire's attitude to coinage, describes a reality which we have amply documented in the numismatic evidence, and fits the context of both the immediate passage and the broader concerns of the treatise.

This interpretation of Pseudo-Aristotle's remark on coinage also bears on the question of how to date Book 2 of the *Oeconomica*. The scholarship is divided into two camps on this question.[154] The first camp notes that, since the latest dateable anecdotes in the second part of the work belong *ca.* 325-323, the work as a whole must have been composed in the last quarter of the 4th century.[155] The second camp instead argues that the theoretical first part of the work (2.1.1-8) was written by a separate and later author to the individual who compiled the stratagems found in the second part of the work (2.2.1-41). One of the stronger arguments which can be made in favour of this is that, on the traditional interpretation of what Pseudo-Aristotle is saying about coinage, it better describes the situation under the Seleukids than

[151] *IGDOlbia* 14.25-6. Dubois 1996: 38-9 notes that ἄξιος is here being used in the sense 'good value for money', i.e. cheap (LSJ s.v. A.I.3.b).

[152] Aes. 3.187: ἔγραψε ... στεφανῶσαι φαλλοῦ στεφάνῳ αὐτῶν ἕκαστον, ἀλλ᾽ οὐ χρυσῷ· τότε μὲν γὰρ ἦν ὁ τοῦ θαλλοῦ στέφανος τίμιος, νυνὶ δὲ καὶ ὁ χρυσοῦς καταπεφρόνηται ('He moved … that each of them be crowned with a crown of olive, not of gold; for at that time the crown of olive was prized, but today even a crown of gold is held in disdain').

[153] Although sigloi are often considered a Persian royal coinage because of their archer types, it is clear they did not have the same status as darics, and so we assume that for Pseudo-Aristotle royal coinage meant darics alone. Based on a review of the literary evidence, Tuplin 2014 133 neatly articulates the distinction: "Persian silver, even if coined, is just silver, but Persian gold is naturally (if not always) seen in terms of a specific coined form". As Konuk 2012: 52 notes, whereas darics circulated throughout the empire, sigloi were only ever produced in Asia Minor and only ever circulated there. Thus, despite their archer types, the sigloi are better understood as a regional or satrapal coinage. Finally, it should be recalled that sigloi production had largely ceased by the end of the 5th century and that the sigloi still in circulation in the 4th century were heavily countermarked (see Section 3.3 above). Thus, when a 4th century Greek thought about the royal coinage of the Persian Empire, it was the daric, and the daric alone, which would have come to mind.

[154] For a full discussion of this question settling on a date a decade either side of *c.* 300 see Meadows (above, pp. 000-000).

[155] Van Groningen 1933: 37-48. This position has most recently been defended against the arguments of Aperghis (see next footnote) in Brodersen 2008 and Brodersen 2017.

under the Achaemenids.[156] However, if the passage is instead interpreted as we would prefer then the argument is reversed: the author's statement makes very good sense in a Persian context but very poor sense in a Seleukid context. More fundamentally, the underlying assumption here that the theoretical and anecdotal sections cannot belong to the same treatise gives insufficient weight to the fact that this is the expected structure of the esoteric writings of the Peripatetics.[157]

Further to this, we may also want to question the traditional dating of the work to the last quarter of the 4th century. As mentioned, this is based on the principle that the latest dateable anecdote in the work provides a *terminus post quem* for its composition. While there are many works for which this would be a safe inference (e.g. Xenophon's *Poroi*), it is not a valid dating principle when applied to the esoteric works of Aristotle's school. As a result of originating in a teaching context, these texts continued to evolve long after the initial moment of composition.[158] A well-understood example which illustrates the problem is Theophrastos' *Historia Plantarum*. The core of this work is research which Theophrastos conducted on Lesbos and in the Troad in the 340s and in Macedonia in the 330s. References throughout the text make it clear that he continued to gather information through informants and students in the 320s-300s. He probably began to teach this material as a course at Athens in 314/13, and as he did so he continued to add material (a process revealed to us by the glancing references in the work to Alexander's early successors).[159] Thus, although the text 'closed' in the late 300s, the period of composition was really the 310s, and the period when the core research was done and the theoretical reflections which informed this were first articulated was the 340s/330s.

Something similar appears to be the case with Book 2 of the *Oeconomica*. The second part of the work discusses the stratagems of forty-one individuals or groups.[160] The first thirty date from the 7th century to the mid-4th century, with the overwhelming majority (between twenty and twenty-five) dating to the first half of the 4th century and the latest being a reference to Mentor of Rhodes in 342/1 (no. 28).[161] There then follow six individuals active in the reign of Alexander (nos. 31-36), followed by an 'appendix' which includes a Persian satrap active in Mysia in the early 4th century (Itabelis: no. 40) and four individuals who had been mentioned earlier (Chabrias, Antimenes, Kleomenes, Dionysius I: nos. 37-39, 41).[162] We would thus suggest that nos. 1-30 represent the core examples which the author initially provided in support of the theoretical first part of the work and which he advertised at the end of that

[156] See most recently Aperghis 2004 129-35, with discussion of the coinage passage at p. 131. This builds on the suggestion of Rostovtzeff 1941 1: 74-5, 440-6 that the author had the kingdom of Antigonos Monophthalmos in mind and that Ps-Aristotle's analysis could therefore be used to characterize the Seleukid royal economy.

[157] Van Groningen, Wartelle 1968: xii.

[158] Amigues 1988: xviii-xxxvi, esp. xix: "Comme les autres productions ésotériques du Lycée, le traité de Théophraste était à l'origine un cours, qui a pris sa forme actuelle au terme de remaniements successifs. Par consequent, il doit être rapport non à une année précise, comme un ouvrage publié, mais à la période durant laquelle son contenu fut enseigné et maintes fois modifié par le scolarque du Lycée".

[159] Amigues 1988: xix, discussing the references to Ophellas, Demetrius Poliorcetes, and Antigonus Monophthalmos.

[160] Whitehead 2019: 290-7 provides a convenient summary which identifies and dates all the examples.

[161] The evidence for this episode is discussed in Ellis-Evans 2018: 37-42.

[162] For the correction of the transmitted name Stabelios to Itabelis see Sekunda 1989: 95-8.

section.[163] The examples from the reign of Alexander (nos. 31-36) and the 'appendix' of additional examples (nos. 37-41) were then added in the 330s and 320s while the work was being delivered as lectures, with the text finally 'closing' soon after 323. On this interpretation, the Mentor of Rhodes story dating to 342/1 represents the real *terminus post quem* for the work's initial formulation, thus suggesting that the theoretical first part of the work reflects the realities of the very last years of the Persian Empire before Alexander's conquest.

6. Conclusions

In the course of this paper we have attempted to establish the following points. Firstly, the silver/gold exchange rate in Asia Minor did not remain fixed at 13.33:1 from the 540s down to the conquests of Alexander in 334/3: it decreased to 12.50:1 *ca.* 413-411, to 12:1 by *ca.* 400, to 11.33:1 by *ca.* 360, and to 10:1 by *ca.* 355 where it then remained. Secondly, these changes happened in response to changes in the silver/gold exchange rate in neighbouring regions of the Greek world, in particular silver scarcity towards the end of the Peloponnesian War and the abundance of gold after the opening of the Krenides mines. Thirdly, the effect of sudden contractions in the silver supply or the introduction of a new source of gold to the market was not immediately felt everywhere, but instead could be delayed by a combination of distance and local circumstances. Finally, whereas longer term trends (e.g. the continuing relative scarcity of silver in the first half of the 4th century) were accommodated by incrementally lowering the weights of silver coins, exogenous shocks (e.g. silver scarcity at the end of the Peloponnesian War, the opening of the Krenides mines) precipitated the adoption of new weight standards, new denominations, and significantly different ratios of gold to silver coins. If these claims are accepted, then they are of significance for a number of broader questions.

Firstly, numismatics. It has been known for some time that there was a major shift in weight standards and coin denominations in western Asia Minor *ca.* 405 (the switch to the Chian standard) and another in north-west Asia Minor after *ca.* 350 (the switch to the Persic standard). However, we are now in a position not just to observe that these changes happened, but to explain what prompted these changes to occur, understand why they caught on so quickly, and see how apparently unrelated changes in weight standards and denominations elsewhere in Asia Minor were in fact responses to the same underlying market conditions. In turn, this potentially provides a new numismatic criterion by which to fix the chronologies of coinages produced *ca.* 405-340. However, much detailed work on individual series will need to be done to substantiate and, just as importantly, complicate this assertion.

Secondly, the inter-penetrability of economies along the Greco-Persian frontier. The basic premise of our argument is that significant changes in the value of gold and silver in the economy of the Greek mainland impacted the value of these metals in Persian-controlled Asia Minor, and that, by the standards of the ancient world, these changes were felt relatively rapidly. As the Krenides case study demonstrates, distance from a new source of precious metals and the state's desire to maintain a favourable silver/gold exchange rate could delay the impact for a while but not indefinitely. If we accept this premise, then it suggests a significant degree of integration between economies either side of the frontier between the Greek and Persian spheres of influence. Indeed, the idea that Persian-controlled Asia Minor could have

[163] Ps-Arist. *Oec.* 2.1.8 = 1346a26-28: ὅσα δὲ τινες τῶν πρότερον πεπράγασιν εἰς πόρον χρημάτων, εἴ<τε> τεχνικῶς τι διώκησαν, ἃ ὑπερλαμβάνομεν ἀξιόλογα αὐτῶν εἶναι, συναγηόχαμεν ('We have further made a collection of all the methods that we conceived to be worth mentioning, which men of former days have employed or cunningly devised in order to provide themselves with money', trans. Forster).

been immune to economic events in neighbouring regions, that the Persian state was able to impose the use of the 13.33:1 silver/gold exchange rate in the teeth of market forces, and that it could achieve this through the thesaurization of vast quantities of gold and silver all play into the familiar old stereotype of the 'immobile Orient' – the idea that 'Oriental' economies are backward, inefficient, and overly reliant on absolute power to achieve their aims.[164] Such a characterization is clearly quite wrong in this case, where we have instead argued that the Persian state was responsive and flexible in its handling of a bimetallic currency system.

Thirdly, the economic health of Asia Minor in the 4th century. An old and now discredited narrative had it that the Persian Empire's relationship to the economy of its subject peoples was essentially parasitic: the empire hoovered up wealth through tribute collection which then lay immobilized in Persian treasuries, leaving its subject peoples impoverished and thus eager for Alexander's liberation when it came.[165] If Persian-controlled Asia Minor had been operating a monometallic currency system, then the steady reduction in the weights of local silver coinages *ca.* 405-350 could have been interpreted as evidence for this economic crisis, since when we observe this in a monometallic system it is reasonable to assume that the issuing authority is financially strapped and that economic activity is declining. However, in a bimetallic system one cannot automatically make this assumption, especially when it can be shown that the changes are being driven by new sources of gold, as we think is the case after the opening of the Krenides mines *ca.* 356. In light of our reconstruction of how the Persians operated the bimetallic system in Asia Minor, the numismatic evidence does not confirm the narrative of economic decline and impoverishment at the hands of the empire, but rather illustrates the flexibility of the Persian system which could be responsive to significant changes in the market rate and which permitted individual mints to take the action which was needed to accommodate fluctuations in commodity prices within a bimetallic system. To be clear, however, responding to market rates is not evidence that Persian policies in regard to tribute and state expenditures did not exacerbate the constraints on silver supply and impact the economic health of non-monetized parts of the empire reliant on silver bullion like Mesopotamia.[166]

Finally, the character of Persian imperialism. An empire's attitude to coinage will always be revealing regarding the kind of state it is and wants to be because, by its nature, coinage is inextricably intertwined with issues of revenue, expenditure, sovereignty, and self-representation at both the civic and imperial level. Viewed from this perspective, the Persian Empire's approach to running a bimetallic currency system is more broadly indicative of its approach to being an imperial state. Whereas in the Imperial period the Roman state carefully managed all aspects of the bimetallic currency system from the centre, the Persian model was instead (on our interpretation of the Pseudo-Aristotle passage) to set the silver/gold ratio relative to the daric and then leave it to localities to produce compatible silver coinage however

[164] For the origins of this interpretation in 18th and 19th century historiography see Briant 2009 and Briant 2017: 334-9. For reflections on how to move past this paradigm without downplaying the very real violence and oppression of the Persian Empire see Ma 2021, esp. 191-3.

[165] Droysen 1833 [1925]: 438 provides a particularly lurid statement of the argument: "When the new royal power which reigned in Asia now gave flight to these hidden riches, when it let them overflow from its breast, like the heart pumps out blood, it is easy to understand that work and commerce began to spread them, by an ever-increasing speed of circulation, through the long-tired limbs of the empire. One can see how, by these means, the economic life of peoples, which the Persian domination had sucked the strength out of like a vampire, renewed and prospered ...". On this passage see Briant 2017: 338-9.

[166] See Bresson 2020b.

they saw fit.[167] As a result, we encounter a remarkable variety of solutions involving alterations to weight standard and denominations which were clearly taken at the civic or satrapal level rather than at the imperial centre. It is also significant that, as discussed above, the Persian authorities were able to run a relatively flexible bimetallic currency system without any major crises for two centuries. Since decisions about the state exchange rate were ultimately taken at the centre, this success rather suggests that there were open and effective lines of communication between subject communities, satraps, and the imperial centre through which information about market conditions on the far western border of the empire could be fed back to the Great King and decisions taken accordingly.

[167] For the Roman case see Butcher, Ponting 2014.

Bibliography

Alram, M. 2011. 'Daric' *Encyclopaedia Iranica*, VII/1: 36-40.

_____. 2012 'The coinage of the Persian Empire' in W. E. Metcalf (ed.), *The Oxford Handbook of Greek and Roman Coinage*. Oxford: 61-87.

Amigues, S. 1998. *Théophraste. Recherches sur les plantes, Tome 1: Livres I-II.* Paris.

Aperghis, G.G. 2004. *The Seleukid Royal Economy: The Finances and Financial Administration of the Seleukid Empire*. Cambridge 2004.

Asheri, D., A.B. Lloyd, A. Corcella, O. Murray, A. Moreno and B. Graziosi. 2007. *A Commentary on Herodotus Books I-IV*. Oxford.

Ashton, R.H.J. 2001. 'The coinage of Rhodes 408 – *c.* 190 BC' in A. Meadows and K. Shipton (eds.), *Money and its Uses in the Ancient Greek World.* Oxford: 79-115.

Ashton, R.H.J., P. Kinns, K. Konuk and A.R. Meadows. 2002a 'The Hecatomnus Hoard (*CH* 5. 17, 8. 96, 9. 387)' in A. R. Meadows and U. Wartenberg (eds.), *Coin Hoards Volume IX: Greek Coins.* London: 95-158.

Ashton, R.H.J., N. Hardwick, P. Kinns, K. Konuk and A.R. Meadows. 2002b. 'The Pixodarus Hoard (*CH* 9.421)' in A. R. Meadows and U. Wartenberg (eds.), *Coin Hoards Volume IX: Greek Coins.* London: 159-243.

Boehringer, C. 1979. 'Zu Finanzpolitik und Münzprägung de Dionysios von Syrakus' in Mørkholm, O. and N. M. Waggoner (eds.), *Greek Numismatics and Archaeology: Essays in Honor of Margaret Thompson*. Wetteren: 9-32.

_____. 2006. 'Zwei Fragen zur syrakusanischen Numismatik', *RN*[6] 162: 25-35.

Boyer-Xambeu, M.-T., G. Deleplace, L. Gillard. 1994. 'Régimes monétaires, points d'or et "serpent bimétallique" de 1770 à 1870', *Revue économique* 45: 1139-74.

Bresson, A. 2020a. 'The choice of electrum monometallism: when and why' in van Alfen, P. and U. Wartenberg (eds.), *White Gold: Studies in Early Electrum Coinage*. New York: 477-496.

_____. 2020b. 'Silverization, prices and tribute in the Achaemenid Empire' in Tuplin, C. J. and J. Ma (eds.), *Aršāma and his World: The Bodleian Letters in Context*. *Vol. 3: Aršāma's World* (Oxford): 209-248.

Briant, P. 2009. 'Alexander and the Persian Empire, between "decline" and "renovation"' in Heckel, W. and L. A. Tritle, *Alexander the Great: A New History*. Malden, MA: 171-188.

_____. 2017. *The First European: A History of Alexander in the Age of Empire*. Cambridge, MA.

Brodersen, K. 2008. 'Nützliche Forschung: Ps.-Aristoteles' *Oikonomika* II und die Haushalte griechischer Poleis' Burrer, F. and H. Müller (eds.), *Kriegskosten und Kriegsfinanzierung in der Antike*. Darmstadt: 106-127.

_____. 2017. 'Poleis on the brink: violence and Greek public finances in Ps.-Aristotle's *Oikonomika* II' in Champion, M.and L. O'Sullivan (eds.), *Cultural Perceptions of Violence in the Hellenistic World*. London: 58-77.

Butcher, K. and M. Ponting. 2014 *The Metallurgy of Roman Silver Coinage: From the Reform of Nero to the Reform of Trajan*. Cambridge.

Cahill, N. and J.H. Kroll. 2005. 'New archaic coin finds at Sardis', *AJA* 109: 589-617.

Calciati, R. 1990. *Pegasi*, 2 vols. Mortara.

de Callataÿ, F. 2008. 'La monnaie de compte à l'époque hellénistique: le nécessaire réexamen des textes (en particulier du sens du terme argurion) à la lumière de la documentation numismatique', *AIIN* 54: 19-34.

_____. 2018. ‘Overstrikes on Pamphylian and Cilician silver sigloi (5th-4th c. BC)’ in Tekin O. (ed.), *Second International Congress on the History of Money and Numismatics in the Mediterranean World*. Antalya: 131-150.

Carradice, I. A. 1987. ‘The ‘regal’ coinage of the Persian Empire’ in Carradice I. A. (ed.), *Coinage and Administration in the Athenian and Persian Empires*. Oxford: 73-108.

Chryssanthaki-Nagle, K. 2007. *L’histoire monetaire d’Abdere en Thrace*. Athens.

Davies, J. K. 2007. ‘The Phokian hierosylia at Delphi: quantities and consequences’ in Sekunda, N. (ed.), *Corolla Cosmo Rodewald*. Gdansk: 75-96.

Develin, R. 1990. ‘Numerical corruption in Greek historical texts’, *Phoenix* 44.1: 31-45.

Droysen, J. G. 1925. *Geschichte des Alexanders Großen*, 6th ed. Gotha.

Dubois, L. 1996. *Inscriptions grecques dialectales d’Olbia du Pont*. Geneva.

Ellis-Evans, A. 2016. ‘Mytilene, Lampsakos, Chios and the financing of the Spartan fleet (406-406)’, *NC* 176: 1-19.

_____. 2018. ‘Memnon and Mentor of Rhodes in the Troad’, *NC* 178: 33-69.

Esty, W.W. 2011. ‘The geometric model for estimating the number of dies’ in F. de Callataÿ (ed.), *Quantifying Monetary Supplies in Greco-Roman Times*. Bari: 43-58.

Figueira, T. 1998. *The Power of Money: Coinage and Politics in the Athenian Empire*. Philadelphia.

_____. 2012. ‘Economic Thought and Fact in the Works of Xonophon’ in Hobden F. and C. Tuplin (eds.) *Xenophon: Ethical Principles and Historical Enquiry*. Leiden: 665-688.

Finley, M. I. 1970a. ‘Aristotle and economic analysis’, *Past & Present* 47.1: 3-25.

_____. 1970b. Review of van Groningen, Wartelle 1968, *CR* 20. 3: 315–319

_____. 1973. *The Ancient Economy*. London.

Fischer-Bossert, W. 2012. ‘The coinage of Sicily’ in W. E. Metcalf (ed.), *The Oxford Handbook of Greek and Roman Coinage*. Oxford: 142-156.

_____. 2017. *Coins, Artists, and Tyrants: Syracuse in the Time of the Peloponnesian War* (New York 2017).

Flandreau, M. 2004. *The Glitter of Gold: France, Bimetallism and the Emergence of the International Gold Standard 1848–1873*. Oxford.

Gartland, S. D. 2013. ‘The electrum coinage of Thebes’, *NC* 173: 23-32.

Gauthier, P. 1976. *Un commentaire historique des Poroi de Xénophon*. Geneva.

_____. 1984. ‘Le programme de Xénophon dans les *Poroi*’, *RPh* 58: 181-99.

Gitler, H., Y. Goren, K. Konuk, O. Tal, P. Van Alfen and D. Weisburd. 2020. ‘XRF analysis of several groups of electrum coins’ in van, Alfen P. and U. Wartenberg (eds.), *White Gold: Studies in Early Electrum Coinage*. New York: 370-422.

Guépin, J. P. 1962. ‘Greek coinage and Persian bimetallism’, *Jaarboek voor Munt- en Pennigkunde* 49: 1-19.

Hardwick, N. 1996. ‘The solution to Thucydides 8.101.1: the «Chian fortieths»’, *NAC* 25: 56-69.

_____. 2010. ‘The coinage of Chios 600-300 BC: new research developments 1991-2008’ in Tselekas, P. (ed.), *Coins in the Aegean Islands*, Obolos 9, 2 vols. Athens: 217-245.

_____. 2013. ‘The coinage of Chios 600-300 BC: new research developments 1991-2008: correction’, *Journal of the Oriental Society of Australia* 45: 116-17.

Hemmerdinger, B. 1988. ‘Notes hérodotéennes’, *BollClass* 9: 51-56.

Hornblower, S. 1991-2008. *A Commentary on Thucydides*, 3 vols. Oxford.

How W.W. and J. Wells. 1912. *A Commentary on Herodotus, with Introduction and Appendixes*, 2 vols. Oxford.

Johnston, A. 1998. Review of Dubois 1996, *JHS* 118: 251-252

Johnston, J. 1932. ‘An international managed currency in the fifth century’, *Hermathena* 47: 137-157.

Johnston, R.H.W. 2003. *Century of Endeavour: A Biographical and Autobiographical View of the 20th Century in Ireland*. Bethesda, MD.

Jursa, M. 2010. *Aspects of the Economic History of Babylonia in the First Millennium BC*. Münster.

Kagan, J.H. 2014. ‘Notes on the coinage of Mende’, *AJN* 26: 1-32.

_____. 2022. ‘Stopping and starting coinage: case studies in the Cyclades and the Chalkidike during the Athenian Empire and its immediate aftermath’, *RBN* 168: 1-14.

Kallet, L. 2001. *Money and the Corrosion of Power in Thucydides: The Sicilian Expedition and its Aftermath*. Berkeley.

Karyshkovski, P.O. 1988. *Monety Ol’vii*. Kiev.

Karwiese, S. 1980. ‘Lysander as Herakliskos Drakonopnigon (‘Heracles the snakestrangler’)’, *NC* 140: 1-27.

_____. 1993. ‘Zur Metrologie der persischen Sigloi’, *Res Orientales* 5: 46-49.

Kinns, P. 1980. *Studies in the Coinage of Ionia, Erythrae, Teos, Lebedus, Colophon, c. 400-30 BC*, 3 vols. Unpublished PhD Thesis. Cambridge.

_____. 1989. ‘Ionia: the pattern of coinage during the last century of the Persian Empire’, *REA* 91: 183-193.

Konuk, K. 1996. *The Coinage of the Hekatomnids of Caria*. Unpublished PhD Thesis. Oxford.

_____. 2012. ‘Asia Minor to the Ionian Revolt’ in Metcalf, W. E. (ed.), *The Oxford Handbook of Greek and Roman Coinage*. Oxford 2012: 43-60.

Kroll, J.H. 1976. ‘Aristophanes’ πονηρὰ χαλκία. A reply’, *GRBS* 17: 329-341.

_____. 1993. *The Greek Coins*, Athenian Agora 26. Princeton.

_____. 1996. ‘The Piraeus 1902 Hoard of Plated Drachms and Tetradrachms (*IGCH* 46)’ in *Χαρακτήρ. Αφιέρωμα στην Μαντώ Οικονομίδου*. Athens: 139-146.

_____. 2008. ‘The monetary use of weighed bullion in Archaic Greece’ in Harris, W. V. (ed.), *The Monetary Systems of the Greeks and Romans*. Oxford: 2-37.

_____. 2009. ‘What about coinage?’ in Ma, J., N. Papazarkadas, and R. Parker (eds.), *Interpreting the Athenian Empire*. London: 195-209.

_____. 2020. ‘The inscribed account on lead from the Ephesian Artemision’ in van Alfen, P. and U. Wartenberg (eds.), *White Gold: Studies in Early Electrum Coinage*. New York: 49-64.

Le Rider, G. 1956. 'Trésor de monnaies trouvé à Thasos', *BCH* 80: 1-19.

_____. 1963. *Deux trésors de monnaies grecques de la Propontide (IV^e siècle avant J.-C.)*. Paris.

_____. 1967. 'Les monnaies thasiennes' in *Guide de Thasos*. Athens: 185-191.

_____. 1971. 'Sur le monnayage de Byzance au IV^e siècle', *RN* 13^6: 143-153.

_____. 1977. *Le Monnayage d'argent et d'or de Philippe II frappé en Macédoine de 359 à 294*. Paris.

_____. 2001. *La naissance de la monnaie: pratiques monétaires de l'Orient ancien*. Paris.

_____. 2007. *Alexander the Great: Coinage, Finances, and Policy*. Philadelphia, PA.

Lewis, D.M. 1968. 'New evidence for the gold-silver ratio' in Kraay, C. M. and G. K. Jenkins (eds.), *Essays in Greek Coinage Presented to Stanley Robinson*. Oxford:105-110.

Lianos, T. 2014. 'Xenophon's theory of money', *History of Economic Ideas* 22(2): 41-53.

de Lisle, C. 2017. 'The coinage of Agathokles of Syracuse: Sicilian and Hellenistic influences', *NC* 177: 9-28.

Ma, J. 2020. 'Aršāma the vampire', in Tuplin, C. J. and J. Ma (eds.), *Aršāma and his World: The Bodleian Letters in Context. Vol. 3: Aršāma's World* (Oxford): 189-208.

Markou, E. 2011. *L'or des rois de Chypre: numisamtique et histoire à l'époque classique*. Athens.

Meadows, A.R. 2001. 'Money, freedom, and empire in the Hellenistic world' in Meadows, A. R. and K. Shipton (eds.), *Money and its Uses in the Ancient Greek World*. Oxford: 53-63.

_____. 2011. 'The Chian revolution: changing patterns of hoarding in 4th century BC western Asia Minor' in Faucher, T., M.-C. Marcellesi, and O. Picard (eds.), *Nomisma. La circulation monétaire dans le monde grec antique*. Athens: 273-295.

Melville-Jones, J.R. 1993-2007. *Testimonia Numaria: Greek and Latin Texts Concerning Ancient Greek Coinage*, 2 vols. London.

_____. 1999. 'Ancient Greek gold coinage up to the time of Philip of Macedon' in Amandry M. and S. Hurter (eds.), *Travaux de numismatique grecque offerts à Georges Le Rider*. London: 257-275.

Nicolet-Pierre, H. 1996. 'Or perse en Grèce: deux trésors de dariques conserves à Athènes' in *Χαρακτήρ. Αφιέρωμα στην Μαντώ Οικονομίδου*. Athens: 200-207.

Nicolet-Pierre, H. and S. Gjongecaj. 1995. 'Le monnayage d'argent d'Égine et le trésor de Hollm (Albanie) 1991', *BCH* 119.1: 283-338.

Picard, O. 2000. 'Le monnayage de Thasos aux époques grecque et romaine' in Y. Grandjean and F. Salviat, *Guide de Thasos*, 2nd ed. Athens: 303-314.

Pirngruber, R. 2017. *The Economy of Late Achaemenid and Seleucid Babylonia*. Cambridge.

Psoma, S. 2001. *Olynthe et les Chalcidiens de Thrace: études de numismatique et d'histoire*. Stuttgart.

Psoma, S., C. Karadima and D. Terzopoulou. 2008. *The Coins from Maroneia and the Classical City at Molyvoti*. Athens.

Redish, A. 2000. *Bimetallism: An Economic and Historical Analysis*. Cambridge.

Requier, P. 1996. 'Les premiers tétradrachmes hellénistiques de Cos', *SNR* 95: 53-75.

Robinson, E.S.G. 1934. ‘A find of coins of Thasos’ *NC*[5] 14: 244-254.

Rood, T. 2010. ‘Xenophon’s parasangs’, *JHS* 130: 51-66.

Rostovtzeff, M. 1941. *The Social and Economic History of the Hellenistic World*, 3 vols. Oxford.

Samons, L. J. 2000. *Empire of the Owl: Athenian Imperial Finance*. Stuttgart.

Sekunda, N.V. 1989 [1998]. ‘Itabelis and the satrapy of Mysia’, *AJAH* 14.1: 73-102.

Seltman, C.T. 1921. *The Temple Coins of Olympia*. Cambridge.

Sheedy, K.A., D.B. Gore, M. Blet-Lemarquand and G. Davis. 2020. ‘Elemental composition of gold and silver coins of Siphnos’ in Sheedy K. and G. Davis (eds.), *Metallurgy in Numismatics 6*. London: 149-164.

Sosin, J.D. 2001. ‘Accounting and endowments’ *Tyche* 16: 161-175.

Solba, V.F. 2015. ‘“Archers” of the blessed city: city’s deliverance in the coinage of early Hellenistic Olbia’, *Notae Numismaticae* 10: 43-58.

Tekin, O. 2000. ‘“Aspendian wrestlers”: an iconographic approach’ in Casabonne, O. (ed.), *Mechanismes et Innovations Monetaires dans L'Anatolie Achemenide*. Paris 2000: 159-169.

Thompson, W.E. 1964. ‘Gold and silver ratios at Athens during the fifth century’, *NC*[7] 4: 104-23.

Thompson, W.E. 1966. ‘The functions of the emergency coinages of the Peloponnesian War’, *Mnemosyne* 19: 337-343.

_____. 1970. ‘The golden Nikai and the coinage of Athens’, *NC*[7] 10: 1-6.

Thuillier, G. 1962. ‘Pour une histoire monétaire en France: spéculations sur l’or et l’argent en 1857’, *Annales ESC* 17: 722-731.

_____. 1983. *La monnaie en France au début du XIX*[e] *siècle*. Paris.

Tuplin, C.J. 2014. ‘The changing pattern of Achaemenid imperial coinage’ in P. Bernholz and R. Vaubel (eds.), *Explaining Monetary and Financial Innovation: A Historical Analysis*: 127-168.

Van Alfen, P. 2012. ‘Coinage of Athens, sixth to first century BC’ in Metcalf, W. E. (ed.), *The Oxford Handbook of Greek and Roman Coinage*. Oxford: 88-104.

Van Groningen, B. A. 1933. *Aristote. Le second livre de l’Économique*. Leiden.

Van Groningen B. A. and A. Wartelle. 1968. *Aristote. Économique*. Paris.

Vickers, M. 1990. ‘Golden Greece: relative values, minae and temple inventories’ *AJA* 94.4: 613-625.

West, A.B. 1929. *Fifth and Fourth Century Gold Coins from the Thracian Coast*. New York.

Whitehead, D. 2019. *Xenophon: Poroi (Revenue-Sources)*. Oxford.

Wilson, N.G. 2015. *Herodotea: Studies on the Text of Herodotus*. Oxford.

Zoepffel, R. 2006. *Oikonomika: Schriften zu Hauswirtschaft und Finanzwesen*. Berlin.