Assessing the Interaction Between the Yield Curve and the Business Cycle in Britain, 1800 - 1913

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Short Abstract

Much attention has been paid to the tendency, identified by a number of prior studies, for an inversion of the yield curve to have reliably preceded recessions in the United States since the mid-twentieth century. This thesis focusses on the comparatively under-explored question of whether a predictive relationship between the yield curve and economic growth also existed in Britain between the years of 1800 and 1913. First, a contextualising historical overview is provided of the relevant developments in British financial institutions. This overview aims to identify which interest rates could be taken as representative of the yield curve in that period, how best to divide the timeframe into sub-periods between which results can be compared, and whether any institutional developments are likely to have affected the expected relationship. Evidence is then presented which suggests that the yield curve was not as consistent in its tendency to invert only prior to recessions in nineteenth century Britain as it was in the late twentieth century United States. However, there does seem to have been a positive association between the slope of the yield curve and future economic growth, and a tendency for the yield curve to have been flatter or more inverted prior to recessions than at other times. Investigation into the causes of this predictive relationship finds limited empirical support for the view that the expectations hypothesis of the term structure accounts for the course of long-term interest rates in nineteenth century Britain. Instead, a historical and theoretical case is made that efforts by the Bank of England to raise short-term interest rates in response to the inflation and outflows of reserves which tended to accompany the peak of the business cycle represent a neglected cause of the predictive relationship between the yield curve and economic growth in nineteenth century Britain.

Long Abstract

Since the late 1980s there has been an upsurge of scholarly interest in the relationship between the term structure of interest rates — often referred to by the name of its graphical representation, the yield curve, which charts the yields of bonds of equivalent quality but different terms to maturity — and the business cycle. While the focusses, approaches, and conclusions of the various studies of this topic have naturally differed, the academic consensus which emerged suggested that, in the United States since the mid-twentieth century, there has been a positive association between the slope of the yield curve (i.e. the level of of long-term relative to short-term interest rates) and future economic growth, and furthermore yield curve inversions (i.e. situations in which short-term interest rates are higher than long-term interest rates) have tended to occur prior to recessions and not at other times. This finding has generated considerable interest in the predictive qualities of the yield curve, and of yield curve inversions as signals of oncoming recessions, amongst not only academic economists and economic historians but also financial professionals and journalists.

However, much of the prior literature on this subject has so far confined itself to investigating the predictive qualities of the yield curve in the United States since the mid-twentieth century, with relatively fewer studies having focussed on other countries, and far fewer having focussed on time periods before 1945. The central aim of this thesis is to contribute to the expansion of this literature by investigating the extent to which a similar predictive relationship existed between the term structure of interest rates and future economic growth in a time and place which has so far been almost completely neglected with regard to this topic: Great Britain between the years of 1800 and 1913. The significance of this time and place stems not only from the ongoing Industrial Revolution, but also from parallel developments in the structure of the British banking system, from the increasing adoption by the Bank of England of tools and goals characteristic of a

modern central bank, from the emergence of the business cycle as a widely recognised and scrutinised phenomenon, and from the significance of London as the preeminent international financial centre during the unprecedented globalisation of the decades before the First World War.

Following an introductory chapter, Chapter 2 of this thesis begins with a review of the prior literature on the predictive qualities of the yield curve, with particular attention to the methods and conclusions of studies which have focussed on times and places other than the United States since the mid-twentieth century. A description is then given of the structure of the financial system in Britain at the outset of the nineteenth century, and of the key prior developments which had contributed to the development of those institutional arrangements. The national debt, its constituent components, and the nature of and participants in the markets in which it was traded at the time are also reviewed, with the goal of identifying which interest rates could best be taken as representative of short-term and long-term interest rates from which a monthly yield curve data series could be constructed. An overview is then provided of the key developments which occurred between 1800 and 1913 in the British economy, financial system, and in the powers and goals of the Bank of England, with a view to dividing that long timeframe into meaningfully distinct sub-periods between which the results of later chapters can be compared.

Chapter 3 addresses the central question of the extent to which a predictive relationship existed between the slope of the yield curve and future economic growth in Britain between the years of 1800 and 1913. The case is made for taking the yield on consols, the perpetual annuities which were the most widely traded form of British government debt between 1800 and 1913, as representative of long-term interest rates, with the discount rate on three-month prime or first class commercial bills being taken as representative of short-term interest rates, for the purpose of constructing a monthly series of yield curve data. This yield curve data is compared with a monthly chronology of business cycle peak and trough dates, arrived at by considering a noteworthy recent annual business cycle chronology in combination with the insights of a range of other contemporary and recent accounts. Comparing these reveals that yield curve inversions, as discrete events, were not reliable signals of oncoming recessions in Britain between the years of 1800 and 1913, or in any of the sub-periods of that timeframe, as they seem to have been in the late twentieth century United States. Of the 60 yield curve inversions which took place during the full 1800 to 1913 timeframe, two thirds were 'false positives' which were not followed by a recession within 18 months, and around half of the 23 recessions which occurred were not preceded by the start of a yield curve inversion within the preceding 18 months. However, there does seem to have been a positive association between the slope of the yield curve and a range of other macroeconomic variables. Regression analysis indicates that increases in the slope of the yield curve (i.e. increases in long-term relative to short-term interest rates) were associated to a statistically significant extent with subsequent increases in real GDP, share prices, and wholesale/producers prices between 0 and 18 months hence. This positive association appears to have been particularly strong in the 1800 to 1821 sub-period, when the convertibility of the currency into specie was suspended, which tends to support the conclusions of prior studies which have found that the predictive qualities of the term structure of interest rates were greatest during periods of higher inflation expectations. Furthermore, the slope of the yield curve is found to have been significantly lower on average in the 18 months prior to recessions than at other times. In other words, although yield curve inversions did not reliably occur only prior to recessions in Britain between the years of 1800 and 1913, the yield curve did tend to become significantly flatter or more inverted prior to recessions, and a positive relationship does seem to have existed between the slope of the yield curve and future economic growth, with this finding generally reflecting the results of prior studies.

Chapter 4 then turns to the question of the causes of this predictive relationship between the term structure of interest rates and the business cycle in Britain between the years of 1800 and 1913.

Two contrasting views are assessed, preceded by a review of the competing interest theories in which they are based. The first of these two possible explanations, which has been called the policy anticipations hypothesis, argues that the yield curve tends to flatten or invert prior to recessions because market participants foresee an oncoming recession and therefore anticipate countercyclical monetary policy to be pursued during the recession, with this leading them to expect that short-term interest rates during the anticipated recession will be lower than their present pre-recession levels. This expectation of a future decline in short-term interest rates causes long-term interest rates to decline relative to short-term interest rates in the present, according to the expectations hypothesis of the term structure of interest rates, which stipulates that the yield of a long-term bond is the average of the expected yields of a series of short-term bonds which cumulatively amount to the same duration to maturity as the long-term bond. In order to assess the plausibility of the policy anticipations hypothesis as an explanation of the predictive qualities of the yield curve in nineteenth century Britain, a method is adapted which had been developed in the prior literature for determining the level of long-term interest rates which the expectations hypothesis suggests should have prevailed based on the future course of short-term interest rates, in situations when those long-term interest rates are represented by the yields of perpetual annuities such as consols. The ex post rational series of long-term interest rates arrived at by this method is compared with the actual course of consol yields, with this producing results which do not conclusively support the idea that the expectations hypothesis can account for the course of long-term interest rates in nineteenth century Britain. While actual consol yields do appear to have aligned with the ex post rational rates suggested by the expectations hypothesis on average to some extent during the overall 1800 to 1913 timeframe, and to a lesser extent during the 1800 to 1821 sub-period, the relationship between consol yields and the future course of short-term interest rates was precisely the opposite of that suggested by the expectations hypothesis between 1821 and 1870, and no significant relationship is evident in the 1870 to 1913 sub-period. The nineteenth century British data also violate certain implications of traditional expectations models, including that long-term interest rates ought to rise on average when they are high relative to short-term interest rates and fall on average when they are relatively low, and that the variance of actual long-term interest rates must not be greater than the variance of the ex post rational long-term interest rates derived from the average of future short-term interest rates. This lack of conclusive evidence for the view that the expectations hypothesis accounts for the level of consol yields in Britain between the years of 1800 and 1913 tends to undermine the persuasiveness of the idea that the policy anticipations hypothesis explains the predictive relationship between the yield curve and the business cycle in that period, with this result reflecting the limited empirical support for the expectations hypothesis in the prior literature.

Having considered the policy anticipations hypothesis which characterises pre-recession yield curve inversions as declines in long-term relative to short-term interest rates, a contrasting explanation of the predictive qualities of the yield curve is investigated which highlights the role of the banking system, and particularly the central bank, in influencing short-term interest rates upwards relative to long-term interest rates prior to recessions. A theoretical outline is provided concerning why a central bank could be expected to aim to contract the supply of credit in order to limit the inflation and outflows of reserves which tend to accompany the peak of a business cycle. This could be seen as explaining the pre-recession tendency of short-term interest rates to rise relative to long-term interest rates when combined with the insight that short-term interest rates tend to be influenced by changes in central bank policy rates more immediately than the less responsive long-term interest rates, as detailed in most interpretations of the transmission mechanism of monetary policy. However, this view of the source of the predictive qualities of the yield curve could equally be seen as an implication of a number of notable business cycle theories, which argue that unsustainable credit expansion by the banking system initiates the expansionary phase of the business cycle, before the threat of inflation and outflows of reserves forces a credit contraction which depresses economic activity. To investigate the extent to which this view offers a plausible explanation of the predictive relationship between the yield curve and the business cycle in Britain between 1800 and 1913, a historical overview is undertaken of the development of the goals and policy tools of the Bank of England during that period. The case is made that the prevention of outflows of the country's gold reserves was amongst the primary objectives of the Bank throughout the period, and that making the Bank rate effective as a tool for contracting credit was a perennial concern of the Bank. Furthermore, other goals the Bank was gradually adopting over the course of the nineteenth century, such as acting of lender of last resort or adhering to the 'rules of the game' of the international classical gold standard, are argued to have been unlikely to have impacted its goal of influencing interest rates upwards in response to the inflation and outflows of reserves which tend to accompany the peak of the business cycle. Having established that the Bank of England can be regarded as having aimed to raise interest rates at the peak of the business cycle, a descriptive statistics approach is taken to illustrate the extent to which such efforts appear to have been successful. Short-term interest rates are seen to have risen by 0.5 per cent in the 8 quarters prior to the average recession during the full 1800 to 1913 timeframe, both overall and relative to long-term interest rates, or closer to 1.5 per cent on average after 1844, with most of this rise tending to occur between six and 12 months prior to recessions. The greater variance of short-term than long-term interest rates is illustrated, as is the seemingly greater influence of the Bank rate on short-term than long-term interest rates in each sub-period after 1821. A significant negative association can also be seen between the ratio of the Bank of England's specie reserves to notes in circulation and the level of short-term interest rates, further suggesting that outflows of reserves tended to be met with efforts to contract the supply of credit. While a more comprehensive exploration of this subject would be necessary to conclusively prove the extent of the influence of changes in monetary policy on short-term and long-term interest rates in Britain between 1800 and 1913, these results tend to support the view that the predictive relationship between the term structure of interest rates and the business cycle in that period in part reflects the tendency for short-term interest rates to be raised relative to long-term interest rates to counteract the inflation and outflows of reserves which tend to accompany the peak of the business cycle.

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Chapter One: Introduction

Given that uncertainty about the future and the need to allocate and use scarce resources have always been characteristic features of human existence, attempts at economic forecasting, of one kind or another, can well be assumed to have been a preoccupation of humankind from time immemorial. The ‘Nilometers’ of Ancient Egypt, which were used to record and predict the water level of the Nile, offer an early example of a protoscientific attempt to forecast a variable of clear economic significance (Chaney 2013; Osama et al. 2016). However, prior to the modern era, attempts to foresee the future were often more closely related to the much-studied role of magic in pre-modern thought (see Machielsen and Pfeffer 2023) than to the methods of the contemporary economic forecaster. The subject of forecasting and the different methods by which it might be pursued had been explored at least as early as 44 BC by Cicero, who distinguished between ‘natural’ and ‘artificial’ divination, a distinction arguably dating further back to Plato (Hahmann 2024). Natural divination sought to foresee the future by means of dreams, divine visions, and other supernatural revelations which might present themselves to those “under the influence of mental excitement” (Cicero 1964, 263). In contrast, artificial divination could be employed by any trained and sober-minded person to predict the future based on observable aspects of the world around them, such the behaviour of birds, weather anomalies, astrology, and other omens. However, the doubtful efficacy of such methods at predicting future events, economic or otherwise, may partly account for the expulsion of diviners, astrologers, “sorcerers”, and other soothsayers from Italy on nine occasions between 139BC and 93AD (McCloskey 1992, 27).

It wasn't until the late nineteenth and early twentieth centuries that the discipline of economic forecasting began to develop into a more recognisably modern form, reflecting a desire to harness the rapid scientific advances of that era, including developments in economic theory and statistics, to better foresee and understand the increasing complexities of the industrial economy (Friedman 2014, ix-xi). It could be argued that the first business cycle theories constituted an early attempt to use economic theory to predict future events. While earlier economists had sought to describe and explain individual economic crises, and some had even suggested a periodic cycle of rising and falling prosperity,[1] it wasn't until 1862 that the first true business cycle theory was developed by Clément Juglar, who proposed a six to ten year cycle divided into different phases of boom, slump, and recovery (Dal-Pont and Hagemann 2007; Dimsdale and Thomas 2019, 13). Juglar's theory was followed by a number of other business cycle theories in the succeeding decades, during the same period that economic forecasting was developing as a discipline. Amongst these early theories, those which highlighted the influence of various cyclically fluctuating factors as drivers of the business cycle included William Stanley Jevons's view that variation in solar activity influenced agricultural productivity and thereby commercial "moods" (Peart 1991), Joseph Kitchin's inventory cycle theory based on the idea that the impact of changes in demand on prices will be offset or exacerbated by businesses' changing desire to build up or sell off inventories at different points in the cycle, and Simon Kuznets's theory of a long 15-25 year cycle based on fluctuations in immigration and swings in building and infrastructure investment (Dimsdale and Thomas 2019, 12-13; Islatince 2023). To the extent that these theories found the source of business fluctuations in factors which could be expected to cyclically rise and fall continuously into the future, they implicitly offered the tantalising possibility of predicting future business conditions based on careful observation of the relevant underlying factors.

[1] The seventeenth century English economist Sir William Petty had suggested a cycle with a typical length of seven years, "within which Dearths and Plenties make their revolution" (Petty 1662, 24-25).

This desire to extrapolate the business cycle into the future inspired the efforts of some of the early economic forecasters of this era. In 1875, Ohioan farmer Samuel Benner used data from 1780 to 1872 to predict future fluctuations in the production of pig iron, hogs, corn and other goods, and to predict the dates of future panics and periods of prosperity up until 2059 (Benner 1876). Benner's work inspired the influential early forecaster Roger Babson, whose weekly newsletter became one of the first periodicals to regularly publish macroeconomic data series, beginning shortly after the Panic of 1907, as well as economic predictions based on Babson's questionable application of the Newtonian theory of gravity to the rise and fall of the business cycle (Friedman 2014, 7). At around the same time, *Wall Street Journal* editor William Peter Hamilton was developing the Dow Theory, named after his predecessor in that role Charles Henry Dow, which he used to offer forecasts over the course of a series of editorials and books, based on extrapolating industrial and transportation indices (Brown et al. 1998). Interest in forecasting was also growing amongst academic economists of the time, notably including the eminent neoclassical economist Irving Fisher. Although the most well remembered of Fisher's economic forecasts is likely his infamous October 1929 proclamation that the stock market was undervalued, prior to that he had built a reputation as an influential forecaster as a result of a series of forecasts made in academic journals and newspapers since 1911, based on theoretical insights concerning the impact of changes in price levels on real and nominal interest rates (Friedman 2014, 51-85; McGrattan and Prescott 2004). While the Great Depression disrupted public faith in economic forecasting, after 1945 the discipline increasingly shifted away from the newsletters and columns of individual entrepreneurial forecasters and into the domain of government departments; official macroeconomic forecasts, sometimes in the form of targets, were produced by the governments of the Netherlands and the Scandinavian countries from the late 1940s onwards, by the United Kingdom from the early 1950s, and by the governments of most other developed economies from the 1960s (Hawkins 2005). As a result of these and subsequent developments, as well as the obvious incentive of entrepreneurs to investigate potential methods for gaining insight into future business conditions, the field of economic forecasting has continued to be pursued vigorously since its emergence in its modern form in the late nineteenth and early twentieth centuries, with a search for new indicators and relevant variables naturally constituting one of the key concerns of the field.

A significant development in this search occurred in the late 1980s and early 1990s, when economic forecasters increasingly began to turn their attention to the term structure of interest rates. The relationship between the business cycle and the term structure of interest rates — often referred to by the name of its graphical representation, the yield curve, which charts the yields of bonds of equivalent quality but different terms to maturity — had been assessed in the academic literature at least as early as the mid-1960s. Kessel (1965) had examined U.S. interest rates dating back to 1865, and found that short-term interest rates had tended to reach their highest level relative to long-term interest rates at around the peak of a given business cycle, falling to their lowest point relative to long-term interest rates at around the trough of the cycle. A broadly similar pattern was observed by Cagan (1966), who studied U.S. data since 1878.[2] Both of these studies were primarily concerned with describing and explaining this pattern in terms of economic theory, rather than focussing on investigating the potential of the yield curve as a forecasting tool. However, the economic instability of the 1970s and early 1980s, and the concomitant decline of confidence in the post-War Keynesian consensus and its use of forecasts based on monetary aggregates and theoretical tools such as the Phillips curve, helped to spark a renewed search for alternative forecasting indicators (Stock and Watson 2003, 788). In this context, a flurry of studies emerged on the predictive qualities of the yield curve, beginning in the late 1980s (see for example Harvey 1986, 1988, 1989, 1991; Laurent 1988, 1989; Keen 1989; Fama 1990; Stock and Watson 1989; Estrella and Hardouvellis 1991; Brown and Goodman 1991; Friedman and Kuttner 1993). While the specific

[2] A more detailed discussion of these studies, and of the broader literature relevant to the topics of this thesis, can be found in the next chapter.

focusses, methods, and conclusions of these various studies differed, the consensus which seemed to emerge amongst them suggested that yield curve inversions had reliably tended to precede the onset of recessions in the United States since at least the mid-twentieth century (Bordo and Haubrich 2004, 3). A yield curve inversion can be defined as a situation in which short-term interest rates are higher than long-term interest rates.[3] This contrasts with the expectation that long-term interest rates will typically be higher than short-term interest rates, as lenders can be expected to demand a higher rate to incentivise them to part with their funds for a longer period of time, other things being equal, due to various factors including the greater risk of default or inflation over the term of a longer loan (Bondarenko 2014). The consistency with which yield curve inversions were found to have preceded recessions in the late twentieth century United States was such that even one of the few studies which argued against their reliability as a forecasting tool could point to only two yield curve inversions between the years of 1956 and 1997 which were not followed by a recession within a year, of a total of eighteen yield curve inversions in that timeframe (Dotsey 1998, 37). This discovery of a seemingly reliable harbinger of oncoming recessions naturally generated widespread interest, not only amongst academic economists and economic historians, but also amongst financial professionals and journalists (see for example Pasha 2005; Rennison 2019; Hughes 2024).

Following the establishment of this academic consensus that yield curve inversions had reliably tended to precede recessions in the United States in the latter half of the twentieth century, subsequent studies gradually began to expand the purview of this research area to assess the extent to which the same relationship had held in other countries, and during other timeframes. Hu (1993), Davis and Henry (1994), Plosser and Rouwenhorst (1994), Estrella and Mishkin (1997), Bonser-Neal and Morley (1997), and Stock and Watson (2003) all assessed the relationship between the

[3] Whether yield curve inversions ought to be thought of as constituting a rise in short-term above long-term interest rates, or a decline in long-term below short-term interest rates, is a focus of the fourth chapter of this thesis.

term structure of interest rates and other macroeconomic variables, including real output growth and inflation, across a number of the G7 developed economies in the second half of the twentieth century.[4] Again, the methods of these studies and the details of their findings differed, but their conclusions all tended to confirm that the term spread of interest rates (i.e. the slope of the yield curve) offered significant predictive insight into future real economic output.

While only a relatively small subset of the scholarly literature on the predictive qualities of the yield curve focusses on countries other than the United States, even fewer studies have sought to assess whether those predictive qualities existed in time periods prior to 1945. As mentioned above, Kessel (1965) and Cagan (1966) had incorporated late nineteenth century U.S. interest rate data into their respective works. American interest rate data from 1862 onwards had also been examined by Wood (1983), although his study was primarily concerned with explaining the role of expectations in causing fluctuations in the yield curve, rather than testing its predictive qualities. More recently, Bordo and Haubrich (2004; 2008a; 2008b; 2020) produced a series of studies incorporating late nineteenth century U.S. data, which found that the expected predictive relationship between the term structure of interest rates and the business cycle seemed to have existed in the United States throughout the whole period from 1875 to 1997, although it presented more strongly at some times than others. Baltzer and Kling (2007) assessed German yield curve data from 1870 to 2003, and found that the predictive qualities of the yield curve were strongest during periods of higher inflation, including the inter-war hyper-inflationary periods and to a lesser extent under the Bretton Woods international monetary system. More recently, Capie, Goodhart, and Mills (2019, 11) examined British data from 1822 to 2016, and found "reasonably strong support" for the view that yield curve inversions tended to occur up to eighteen months prior to recessions in the United Kingdom during the pre-First World War and post-Second World War periods. All of these studies contributed to a broadening of the focus of this area of research to other countries and time periods.

[4] Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.

However, the United States in the years since 1945 has still received by far the most attention amongst studies of the predictive qualities of the term structure of interest rates

The goal of this thesis is to contribute to the further expansion of this literature, in terms of time period and location, by assessing the extent to which the term structure of interest rates also seems to have offered insight into future economic conditions in a time and place which has so far gone mostly unexplored in this regard, but is otherwise amongst the most discussed in economic history: nineteenth century Britain. Specifically, the central research question of this thesis is whether or not yield curve inversions reliably tended to precede recessions in Britain between the years of 1800 and 1913, as they appear to have done in the United States in the latter half of the twentieth century, and more generally whether a positive association existed between the slope of the yield curve and future economic conditions. Assessing the relationship between the yield curve and the business cycle in this broad new timeframe, and thereby hopefully contributing to the establishment of a foundation from which more specialised and narrowly focussed future studies will be able to further explore the topic, offers the opportunity to gain a more long-term perspective on the varying strength of that relationship across a variety of institutional contexts. In this way, expanding the range of periods and locations in which the predictive content of the term structure of interest rates is investigated offers the opportunity for fresh insights to be gained into the mechanisms underlying this much-discussed forecasting indicator, and the contingent factors which influence its operation.

The decision to focus this study on Britain in the nineteenth century — extended up to 1913 as the last full year before the natural break in economic conditions represented by the First World War — partly reflects the significance of that time and place as a centre of early industrial manufacturing and trade following the onset of the Industrial Revolution, which surely ranks amongst the most scrutinised topics in the field of economic history.[5] The central role of London as the leading global financial centre during that period, and the status of British government debt as a very widely traded and significant asset to the global economy at the time, further justifies the focus on Britain and the yields on British government bonds as worthy of particular consideration in efforts to expand this literature to investigate the relationship between the yield curve and the business cycle in the nineteenth century (Turner 2014, 4; Klovland 1994, 165).[6] Another reason for selecting nineteenth century Britain as a particularly worthwhile time and place in which to investigate the relationship between the yield curve and the business cycle, related to the central place of London in the global economy at the time, concerns the emergence of the business cycle as an increasingly widely understood phenomenon during that period. It is of course true to note that fluctuations in economic activity and agricultural output had occurred throughout history (Broadberry, Campbell, Klein, Overton and van Leeuwen 2022), and occasional speculative bubbles driven in part by monetary factors had arguably occurred since at least the famous early example of the Dutch 'Tulip Mania' of the 1630s (French 2006).[7] However, from at least the time of the severe Panic of 1825 — which has been called the first modern financial crisis due to the key role played

[5] Reviews of various aspects of the extensive literature on the Industrial Revolution in Britain are offered by, amongst others, Kelly et al. (2023, 59-64), Humphries (2013), Crafts (2011), and Temin (1997).

[6] A detailed discussion of which particular interest-bearing securities this thesis will examine as representative of the yield curve for nineteenth century Britain, and why, can be found in the next chapter.

[7] French (2006) argues that an influx of coin and bullion into Holland — due to a range of factors including the stability of the Bank of Amsterdam, a policy of free coinage, and the strength of Dutch trade and commerce in general — partly fuelled the significant rise in Dutch tulip prices in the 1630s. However, it should be noted that the popular understanding in the present day of the Dutch Tulip Mania as the ultimate historical example of an absurd speculative bubble is partly based on contemporary sources which were polemical in nature and likely exaggerated (Quinn and Turner 2020, 13-14). In her extensive study of the subject, Anne Goldgar (2007) argues that the Tulip Mania was both less widespread and less financially catastrophic than has previously been suggested. While prices of as much as 5,000 guilders for a single flower were indeed recorded, Goldgar found evidence of only 37 individuals ever having spent more than 400 guilders on a tulip, and found no clear evidence of even a single bankruptcy attributable to the Tulip Mania. Goldgar also highlights the important role played in the tulip market by art collectors who valued the flowers for aesthetic reasons, which undermines the view that the rise in the prices of tulips was purely a speculative phenomenon. This perspective aligns with that of Garber's (1989) prior research on this subject, which argued that speculation was less a driver of the rise in tulip prices than were fundamental supply and demand factors, stemming in part from the difficulty of reproducing rare bulbs. For these reasons, it is not clear that the Dutch 'Tulip Mania' should be characterised as a straightforward speculative bubble.

by monetary factors and credit expansion in its origins, as opposed to external shocks such as a war, famine, or an influx of specie (Morgan and Narron 2015; Turner 2014, 67-71) — Britain bore witness to a succession of financial crises, including but not limited to the well known Panics of 1847, 1866, and 1890.[8] These and other economic downturns experienced in Britain and elsewhere between the years of 1800 and 1913 contributed to a growing sense of a reoccurring cycle of panics and periods of prosperity, which no doubt spurred the aforementioned emergence of the first business cycle theories in the second half of the nineteenth century. The role of cyclical factors, as opposed to occasional external shocks, in driving rises and declines in economic activity in nineteenth century Britain suggests that the period from 1800 to 1913 is a more fruitful timeframe than prior centuries in which to study the nature and causes of the relationship between the business cycle and the yield curve, and to compare those results to the more recent experience of the much-studied late twentieth century United States. Finally, the development of the goals and tools of the Bank of England throughout the nineteenth century represents a further reason why Britain between the years of 1800 and 1913 represents a particularly interesting and illuminating period in which to assess the relationship between the yield curve and the business cycle. While the Bank of England had existed since 1694, the nineteenth century was a pivotal period in its development into a more recognisably modern central bank. In 1800, the Bank of England was still just one of several institutions tasked with managing the national debt, it was one of hundreds of banks which issued their own bank notes, its bank notes lacked legal tender status, and it had no provincial branches (Roseveare 1991, 59; Pressnell 1956, 11; Moss 1996). By 1913 however, it was less than ten years away from achieving a monopoly on the issue of bank notes in England and Wales, its notes had gained legal tender status, it had begun to conceive of itself as an institution with a public duty to act as lender of last resort, and it had begun to employ recognisably modern tools of central banking

[8] A detailed discussion of the dates of the various business cycle peaks and troughs which occurred in Britain between 1800 and 1913 can be found in Appendix A of this thesis.

such as open market operations (Born 1983, 8; Bignon et al. 2012; Capie et al. 1994, 129). Therefore, examining the changing behaviour of the yield curve and its relationship to the business cycle in nineteenth century Britain offers the opportunity to gain insight into the changing nature and extent of the Bank of England's influence over short-term and long-term interest rates during that important period, and the changing motives and goals in the pursuit of which it exercised that influence. For all of these reasons, nineteenth century Britain stands out as a time and place for which further investigation of the relationship between the term structure of interest rates and the business cycle ought to yield insights which might contribute to a richer understanding of a range of related topics.

Given the level of interest and the large number of studies which have focussed on nineteenth century Britain and the predictive qualities of the term structure of interest rates as separate subjects, it is perhaps surprising how little scholarly attention has so far been paid to uniting these two subject areas in asking the question of whether or not the term structure of interest rates contained predictive information about future economic conditions in nineteenth century Britain. Indeed, the subject appears to have gone largely unexplored until the recent study by Capie, Goodhart, and Mills (2019), who assessed the extent to which yield curve inversions preceded recessions in the United Kingdom between 1822 and 2016, as mentioned above. Aside from the invaluable contribution of opening up this important subject area to scholarly scrutiny for the first time, and of course their aforementioned presentation of evidence suggesting "reasonably strong support" (Capie et al. 2019, 11) for the hypothesis that yield curve inversions predicted recessions up to eighteen months in advance in the United Kingdom between the years of 1822 and 1913, their paper also offered a roadmap for how subsequent studies might approach this topic in the distinctive context of nineteenth century Britain. For example, one major question which studies of this subject must grapple with is which yields on which securities ought to be taken as representative of short-term and long-term interest rates for the purpose of constructing yield curves, a question which is complicated given the much smaller and more idiosyncratic range of government bonds which were commonly traded in nineteenth century Britain, compared to the much-studied late twentieth century United States.[9] Capie, Goodhart, and Mills take the three-month Treasury bill yield as representative of short-term interest rates for the 1822 to 1913 period, and to represent the long-term interest rate in that period they use the yield on consols, the perpetual annuities which were the most widely traded form of long-term British government debt in that period (Capie et al. 2019, 8; Ellison and Scott 2020, 230). Another sense in which their study offers a framework which might be followed by subsequent studies to facilitate comparison of results is in their identification of eighteen months as an appropriate window of time prior to a recession within which a yield curve inversion could be taken as accurately predicting the oncoming recession, a standard which conforms with that suggested in the prior literature (see for example Estrella and Mishkin 1996).

However, despite the merits of their pathbreaking study, there are still many important avenues of investigation into this subject which remain unexplored. In particular, the relatively brief length of their study despite its broad scope, covering the entire period from 1822 to 2016 over the course of 13 pages, leaves much opportunity for a more extensive presentation of contextualising historical details. Such contextualisation could help to clarify the nature of the institutional arrangements of the London money market between the years of 1800 and 1913, which differed from the more familiar late twentieth century U.S. experience in several key respects, including in the structure of the financial system, the goals and powers of the central bank, and the range and nature of the securities which were widely traded at the time. Elucidating this context allows for a more complete and detailed methodological discussion of how best to study of the relationship between the yield curve and the business cycle in nineteenth century Britain, while also helping to clarify the senses in which the results arrived at offer insights into the changing nature of those institutional arrangements over the course of that important century. For example, whether changes

[9] This subject will be explored in detail in the next charter of this thesis.

in the relationship between the yield curve and the business cycle over the course of the period reflect changes in the influence of the Bank of England over interest rates, and the goals it pursued in exercising that influence.

Another way this thesis aims to offer a more detailed analysis than has so far been presented will be in analysing the extent to which the predictive capabilities of the yield curve appear to have varied over the course of the period from 1800 to 1913, by subdividing that long timeframe into a number of sub-periods between which results can be compared. This enables the comparison of these results with the conclusions of prior studies which have assessed the relationship between the yield curve and the business cycle in other time periods which might share certain relevant similarities with one of the sub-periods under consideration here. Division of the 1800 to 1913 timeframe into sub-periods allows an assessment of how the predictive qualities of the term structure of interest rates appear to have varied over the course of the broader timeframe, and whether these changes reflect institutional changes or other relevant factors which differed between sub-periods.

Another straightforward but significant sense in which this thesis aims to contribute to this literature is by assessing the relationship between the yield curve and the business cycle during the period from 1800 to 1821, which fell outside the timeline investigated by Capie et al. (2019). This sub-period differed considerably from the rest of the broader 1800 to 1913 timeframe in that the convertibility of the pound into specie was suspended, with the gold standard only being resumed from 1st May 1821. Assessing the relationship between the yield curve and the business cycle in this sub-period therefore offers the opportunity to compare those results to those presented by the prior literature for other times and places characterised by floating exchange rate systems, such as those adopted by the G7 countries after the end of the Bretton Woods international monetary system. Britain was also involved in the ongoing Napoleonic Wars for much of the period from 1800 to 1815, with the transition back to a peacetime economy continuing at least until the resumption of the convertibility of the currency into specie in 1821, which further distinguishes the 1800 to 1821 sub-period from the rest of the timeframe. To the extent that the economic downturns which occurred during the 1800 to 1821 sub-period were often characterised by war-related external shocks, as opposed to the monetary and financial panics which were associated with many of the economic downturns Britain experienced in the 1821 to 1913 period, additional insight can be gained into the predictive relationship between the yield curve and the business cycle by comparing the strength of that relationship between the 1800 to 1821 sub-period and the rest of the broader timeframe.

For all of these reasons and more it seems clear that, despite the significant contribution of Capie, Goodhart and Mills (2019) in opening this new research area, much scope still remains for fruitful investigation of whether and why the predictive relationship between the yield curve and the business cycle, which seems to have existed in the United States in the latter half of the twentieth century, also existed in Britain between the years of 1800 and 1913. The goal of this thesis is to contribute to the further expansion of this literature by offering a more extensive and detailed assessment of this question than has so far appeared in any prior study, to compare results between sub-periods with a view to illustrating the extent to which the relationship between the yield curve and the business cycle changed over the course of the 1800 to 1913 timeframe, to situate these results within the context of key historical and institutional developments, and to assess whether yield curve inversions in Britain between 1800 and 1913 could best be characterised as reflecting declines in long-term below short-term interest rates, as is suggested by the expectations hypothesis of the term structure of interest rates, or rises in short-term above long-term interest rates.

These points are addressed over the course of a number of chapters, each of which aims to build upon the evidence presented in the last. Following this present introductory chapter, the second chapter of this thesis focusses on providing the context necessary to explain the methods employed by later chapters, and to help interpret their results. The first subsection of the second chapter reviews the prior literature on the predictive qualities of the yield curve, with particular attention to studies which have focussed on times and places other than the much-studied late twentieth century United States. The second subsection of the second chapter reviews the key historical details necessary to contextualise the question of the relationship between the yield curve and the business cycle in nineteenth century Britain, and aims to clarify the relevant institutional arrangements of the time which might be unfamiliar to modern readers. This includes outlining the structure of Britain's financial system in 1800 and the relevant developments prior to that date which culminated in that state of affairs, enumerating the key components of the national debt during the nineteenth century, discussing the operation of the markets in which government bonds and other securities were traded, and by whom they were bought and sold, and reviewing the key developments of the 1800 to 1913 period, with a view to subdividing that timeframe into meaningfully distinct sub-periods between which results can be compared.

The third chapter of this thesis addresses the central question of whether yield curve inversions reliably tended to precede economic recessions in Britain between the years of 1800 and 1913. The chapter opens with a subsection explaining the data and methodology employed, including discussions of which interest rates could best be taken as representative of short-term and long-term interest rates for the purposes of constructing yield curves for Britain between the years of 1800 and 1913, and what method ought to be employed to identify the dates of business cycle turning points during that period, against which the dates of yield curve inversions can be compared. Following that, the second subsection of the third chapter presents and interprets the results of the methods employed, comparing the extent to which the strength of the predictive relationship between the yield curve and the business cycle appears to have varied between the different sub-periods of the broader 1800 to 1913 timeframe. The two appendices at the end of this thesis are both related to this third chapter. Appendix A contains an extensive discussion of how the 'adjusted' monthly business cycle peak and trough date chronology was estimated based on a combination of the insights of both the annual business cycle chronology presented by Broadberry, Chadha, Lennard, and Thomas (2022) and a wide range of contemporary and recent sources. Appendix B presents the complete results of the T-Tests summarised in Chapter Three, comparing the average level of the yield curve prior to recessions and at other times, which were too extensive and cumbersome to present in full within the body of the chapter.

The fourth chapter of this thesis turns to the question of which factors seem to have driven fluctuations in the yield curve in Britain between the years of 1800 and 1913, and whether inversions of the yield curve during that period ought to be thought of as reflecting declines in long-term below short-term interest rates, or rises in short-term above long-term interest rates. The first subsection of the fourth chapter reviews the literature relevant to this question, beginning with an overview of various competing theories of interest and the senses in which they undergird different theories concerning the nature and causes of fluctuations in the yield curve. This leads into a discussion of the expectations hypothesis of the term structure of interest rates, and how it informs a closely related idea concerning the causes of the seemingly predictive qualities of the yield curve, which has been called the policy anticipations hypothesis (Haubrich and Dombrosky 1996). The policy anticipations hypothesis suggests that the tendency for yield curve inversions to occur prior to recessions reflects the fact that investors foresee the oncoming recession and expect short-term interest rates during the recession to be lower than their current pre-recession levels, with this downward revision of their expectations of future short-term interest rates causing long-term interest rates to decline relative to short-term interest rates in the present, according to the process outlined by the expectations hypothesis. This view is contrasted with the perspective that pre-recession yield curve inversions could better be thought of as reflecting a rise in short-term above long-term interest rates, reflecting the tendency of central banks and other financial institutions to raise short-term interest rates in order to counteract the inflation and outflows of reserves which often occur at around the peak of a business cycle. This view has been argued to account for the seemingly predictive quality of yield curve inversions in that such pre-recession credit contraction has the potential to both cause short-term interest rates to rise above long-term interest rates and also to cause a decline in borrowing, investment and spending, contributing to the onset of a recession. This latter view of the source of the seemingly predictive quality of yield curve inversions could be seen as an implication of a number of noteworthy business cycle theories, which will also be discussed in the literature review section of Chapter Four. The second subsection of the fourth chapter investigates whether the expectations hypothesis of the term structure of interest rates is able to account for the movement of long-term interest rates in Britain between the years of 1800 and 1913, and by extension whether the policy anticipations hypothesis appears to explain the predictive qualities of the yield curve in that period. This section discusses and employs methods established in the prior literature for testing how far the expectations hypothesis is able to account for the yields of perpetuities, such as the consols of nineteenth century Britain. The third subsection of Chapter Four investigates the extent to which, contrary to the implications of the policy anticipations hypothesis, the flattening or inversion of the yield curve prior to recessions in nineteenth century Britain could be seen as reflecting a rise in short-term above long-term interest rates. This subsection begins with an overview of the historical development of the Bank of England's goals and policy tools, which makes the case that the prevention of gold outflows from the Bank was one of the primary goals of Bank of England policymakers throughout the 1800 to 1913 period, and that those policymakers appear to have had a robust understanding of the utility of contracting credit and raising short-term interest rates as a means to that end. Following this, a descriptive statistics approach is taken to illustrating the extent to which the Bank of England aimed to influence interest rates upwards in response to the outflows of specie reserves which tended to occur at around the peak of the business cycles between the years of 1800 and 1913, with these results also being compared between the various sub-periods of that broader timeframe. The seemingly greater influence of the Bank of England's policy rate on short-term than long-term interest rates in the broader economy is also illustrated. The results presented tend to suggest that a rise in short-term relative to long-term interest rates, driven in part by Bank of England efforts to limit the inflation and outflows of reserves which tended to accompany the peaks of business cycles, appear to have been a noteworthy source of the seemingly predictive relationship between the yield curve and the business cycle in Britain between the years of 1800 and 1913, alongside the much more often discussed decline in long-term relative to short-term interest rates suggested by the expectations hypothesis.

Finally, Chapter Five summarises the findings of the previous chapters, reflects on the strengths and limitations of the methods used and the implications of the results achieved, compares and contrasts the results with those of prior studies, and also discusses potential avenues for future research in this subject area.

Before concluding this introductory chapter it should be noted that, due to the broad scope of the prior literature on the term structure of interest rates, there are certain aspects of the predictive qualities of the yield curve which have been the focus of some prior studies but which will not be central concerns of this thesis. The ability of yield curve fluctuations to predict future industrial production (Brown and Goodman 1991), consumption (Harvey 1988), and inflation (Mishkin 1990; Kozicki 1997) have all been assessed in the prior literature. Investigating the relationships between the yield curve and all of these variables in nineteenth century Britain would no doubt contribute to a more complete understanding of that significant period in economic history, and these factors therefore represent potentially fruitful directions for future research. However, given the almost total lack of prior studies assessing the predictive qualities of the yield curve in Britain between the years of 1800 and 1913, and given the breadth of that timeframe, to attempt to thoroughly investigate all of those factors would be beyond the scope of what this thesis could expect to satisfactorily accomplish to an appropriate degree of depth. Instead, a more focussed and detailed investigation is pursued of the central research question of whether or not a flattening or inversion of the yield curve tended to precede recessions in nineteenth century Britain, with the choice of this focus reflecting the particular interest in this aspect of the predictive qualities of the yield curve amongst not only academic economists and economic historians but also financial professionals, journalists and others, as discussed above.

Another approach which might be pursued by future studies of this subject but which proved not to be appropriate in this case concerns the data used. A considerable amount of the research undertaken during the early stages of this project involved constructing a new dataset of weekly stock prices collected from primary sources, particularly newspaper archives. This data could have been used to calculate the yields of key bonds for the construction of a weekly yield curve data series, while the influence of fluctuations in the yield curve on the prices of other securities, collected in this way could have been observed. While the endeavour to construct such a dataset might have constituted a contribution to knowledge in its own right to some degree, this approach was ultimately abandoned for a number of reasons. One drawback of this approach was that it was not clear whether a consistent price data series for a wide range of securities for the entire 1800 to 1913 period could realistically have been arrived at by this method, or whether the novelty of such a data series would have justified the labour-intensive methods involved in its construction. Furthermore, using a bespoke dataset would have reduced the potential for ongoing research and comparison of results that could otherwise have been facilitated if data were instead sourced from a well known and widely used dataset. For this reason, much of the data employed in the later chapters of this thesis, including the interest rate series used to construct yield curve data, is sourced from the Bank of England's extensive and freely available 'A millennium of macroeconomic data' dataset (Thomas and Dimsdale 2017). This not only offered the opportunity to incorporate a wider range of data than could realistically have been collected from primary sources by a single person during the course of the research for this thesis, but also allowed for the use of data series which spanned the full 1800 to 1913 timeframe.[10] Of course the data drawn from this source is not entirely without limitations of its own, which are discussed in the Data and Methodology section of Chapter 3. However, the prominence of this dataset and its wide use in studies of British economic history suggests that its use may render the results presented in this thesis more transparent and conducive to comparisons with the findings of future studies on this topic or existing studies on related topics.

Finally, a brief note on some shorthand phrases used throughout this thesis. Due to the technical nature of the subject matter under discussion, the use of long sentences and frequent repetition of certain lengthy but important phrases (for example 'the relationship between the yield curve and the business cycle in Britain between the years of 1800 and 1913') has often proved difficult to avoid. For the sake of readability, some near-synonymous words and phrases are used interchangeably throughout the course of this thesis, such as 'the yield curve' being used interchangeably with 'the term structure of interest rates', as is standard throughout much of the prior literature. 'The nineteenth century' is also often used to refer to the 1800 to 1913 timeframe, when it is clear from the context that the full period under investigation is being discussed. 'Britain' is also typically used as shorthand for the United Kingdom, when discussing the country in which the relationship between the yield curve and the business cycle is being investigated. Of course Britain and the United Kingdom were meaningfully different entities in the nineteenth century, as they are today, and it might be objected that this conflation obscures relevant differences between the various parts of the United Kingdom, such as the structural differences between the English and Scottish banking systems in the early nineteenth century, which have often been highlighted by prior studies (White 1984; Turner 2014, 8). These factors are touched upon by the overview of relevant historical context appearing in the second chapter of this thesis, and future studies might further enhance our understanding of the relationship between the yield curve and the business

[10] Details of the specific data drawn from this and other sources, and the methods by which that data was employed, can be found in the later chapters of this thesis, particularly Chapter Three.

cycle in the nineteenth century by distinguishing between how this relationship manifested in the different parts of the United Kingdom, and in other British territories at the time. Given the exceptional importance of London as a global financial centre and as the centre of the British banking system during the 1800 to 1913 period, the interest rate data and other securities prices used are generally the London prices, although citations detail the specific sources of the data presented. The business cycle turning point dates used in this thesis are derived from the annual series of business cycle peak and trough dates estimated by Broadberry, Chadha, Lennard, and Thomas (2022), whose study focusses on Great Britain for the 1800 to 1870 period and then the United Kingdom thereafter, as noted above. Therefore, the use of 'Britain' as a shorthand in this thesis could strictly speaking be taken to mean that the subject of investigation is the relationship between the London yield curve and the business cycle in Great Britain prior to 1870, and in the United Kingdom thereafter.

Chapter Two: Literature Review and Historical Context

The following chapter is comprised of two main sections, the first of which aims to provide an overview of the pre-existing literature relevant to the question of whether or not a flattening or inversion of the yield curve tended to precede economic downturns in Britain between the years of 1800 and 1913, which is the primary research question of Chapter 3 of this thesis. Numerous prior studies have assessed the relationships between the yield curve and other key macroeconomic variables in the United States in the years after 1945, but this chapter's literature review pays particular attention to those studies in the pre-existing literature which, like this thesis, have aimed to investigate the extent to which such relationships have existed at other times and in other countries.

Following the literature review, the second and final main section of this chapter aims to provide an overview of the historical context relevant to the subjects explored later in this thesis. Given the relative unfamiliarity of the institutional arrangements of the British economy and financial system between the years of 1800 to 1913, from a modern perspective, providing this context may offer a broad but valuable picture of the period under consideration, and may also help to illuminate the reasoning behind the methodological approaches taken in later chapters. This second section is divided into three subsections, the first of which aims to illustrate the structure and functions of the British financial system between the years of 1800 to 1913, and the prior developments which resulted in the existence of those institutional arrangements by start of the nineteenth century. The second of these subsections aims to provide a similar overview of the institutional arrangements and historical context surrounding Britain's national debt, its constituent components, the markets in which it was traded, and reviews some of the key developments which had shaped that system prior to the year 1800. Finally, the third subsection provides an overview of the major developments and changes in Britain's financial system between the years of 1800 and 1913, with a view to dividing that long timeframe into a number of shorter sub-periods, between which the results of later chapters can be compared in order to gain insight into the changing relationship between the yield curve and the business cycle in Britain between 1800 and 1913. Specifically, it will be argued that four meaningfully distinct periods suggest themselves for comparison: the period from 1800 to 1821, which was characterised by the conclusion of the Napoleonic Wars, a relatively high government debt to GDP ratio, and the suspension of the pound's convertibility into gold; the period from 1821 to 1844, following the resumption of specie payments; the period from 1844 to 1870, following the significant Bank Charter Act of 1844; and finally the period from 1870 to 1913, which was characterised by fewer banking crises and significant institutional changes, a push toward amalgamation in the banking sector, and secular declines in price levels.

I - Literature Review

The period from the late 1980s up until the present day has seen an increasing interest, both amongst academic economists and financial journalists, in the predictive relationship between the term structure of interest rates and other economic variables, and particularly in the extent to which yield curve inversions act as reliable signals of oncoming downturns in the business cycle. The relationship between the term structure of interest rates — commonly referred to by the name of its graphical representation, the yield curve — and the business cycle had been explored at least as early as the mid-1960s by Kessel (1965) and Cagan (1966). However, the economic instability of the 1970s and early 1980s contributed to a decline of confidence in the post-War Keynesian consensus and established forecasting methods based on monetary aggregates and theoretical tools such as the Phillips curve (Stock and Watson 2003, 788).[11] In this context, there was a surge of scholarly interest in the predictive qualities of the yield curve in the late 1980s and early 1990s, initiated in no small part by the pathbreaking doctoral dissertation and subsequent studies of Campbell R. Harvey (see for example Harvey 1986, 1988, 1989, 1991; Laurent 1988, 1989; Keen 1989; Fama 1990; Stock and Watson 1989; Estrella and Hardouvellis 1991; Brown and Goodman 1991; Friedman and Kuttner 1993).

The various studies which comprised this growing literature addressed a range of questions, including the potential of yield curve fluctuations to offer predictive insights into the future movement of industrial production (Brown and Goodman 1991), consumption (Harvey 1988), overall economic growth, and inflation (Mishkin 1990; Kozicki 1997), and exhibited a range of differences in their methodologies and the specific details of their conclusions. However, the academic consensus which emerged from this literature was that there had been a positive

[11] Lucas and Sargent's influential argument against the Phillips curve questioned both its theoretical basis and practical usefulness for policymakers in light of its "spectacular recent failures" amidst the stagflation of the 1970s (Lucas and Sargent 1978, 69).

association between the slope of the yield curve (i.e. the level of long-term relative to short-term interest rates) and future economic growth in the United States since at least the mid-twentieth century, and yield curve inversions (i.e. situations in which short-term interest rates were higher than long-term interest rates) had reliably tended to precede the onset of recessions in that timeframe (Stock and Watson 1989, 383; Furlong 1989, 1; Stojanovic and Vaughan 1997; Bauer and Mertens 2018a, 1; Burgess 2019, 1). Indeed, so strongly did this conclusion seem to present itself that even one of the few studies which sought to argue against the reliability of yield curve inversions as predictors of oncoming economic recessions nevertheless noted that, in the United States, the yield curve inverted "18 times over the sample period [1956-1997], and on only two occasions [did] it erroneously signal a recession" (Dotsey 1998, 37).[12] The general consensus reached by this literature was concisely encapsulated by Bordo and Haubrich (2004, 3) as the insight that yield curve "inversions (short rates higher than long rates) predict recessions … and more generally, a steep yield curve predicts fast growth and a flat curve [predicts] slow growth".

With this consensus having been arrived at amidst the sudden growth of scholarly interest in this subject in the late 1980s and early 1990s, a number of studies then moved toward assessing whether a predictive relationship between the term structure of interest rates and future economic conditions also existed in times and places other than the United States since the mid-twentieth century. Hu (1993) found evidence that the slope of the yield curve had been positively related to

[12] The two yield curve inversions which Dotsey suggests did not accurately signal an oncoming recession were the inversions occurring in the fourth quarter of 1966 and the first quarter of 1979. The 1966 yield curve inversion is indeed generally regarded as the most prominent example in the late twentieth century U.S. experience of a 'false positive' yield curve inversion not followed by a recession, although it was followed by a slowdown in growth (Haubrich 2021, 342). However, it is not clear that the 1979 yield curve inversion should also be counted as a false positive. Dotsey marks the 1979 yield curve inversion as a false signal "only because it occurred five quarters prior to the onset of a recession" (Dotsey 1998, 37). This is a relatively strict standard, with other studies having regarded yield curve inversions as having successfully predicted oncoming recessions if the recession occurs anywhere up to six or eight quarters after the inversion (Estrella and Mishkin 1996, 1; Goodhart et al. 2019, 11; Aramonte and Xia 2019). Furthermore, it is not clear that it is correct to characterise the 1979 yield curve inversion as having taken place more than a year before the subsequent recession, as the inversion took place in March of 1979 (Allan 1979) and the subsequent recession has been dated as having begun in January of 1980 (National Bureau of Economic Research 2023).

expected real output growth in the G7 developed economies[13] during the period 1958-1992, and furthermore that the forecasting power of the yield spread had been greater than that of changes in stock prices. Davis and Henry (1994) likewise found evidence that fluctuations in the yield curve offered more information than other macroeconomic variables about future changes in output and inflation in both the United Kingdom between the years of 1968 and 1991, and in Germany between the years of 1971 and 1992. In the same year, Plosser and Rouwenhorst found that “the term structure [had] significant predictive power for long-term real economic growth” in the United States and Germany between the years of 1973 and 1988, although the evidence for the United Kingdom during the same period was less conclusive, a fact which they attribute to the high and variable inflation in the latter country during the period (Plosser and Rouwenhorst 1994, 154). They further argued that the information about future economic growth contained in the term structure of interest rates was not entirely accounted for by the current and expected future course of monetary policy (Ibid. 149/50). This tends to detract from the view of the source of the predictive qualities of the term structure which has been called the policy anticipations hypothesis, which holds that pre-recession inversions of the yield curve reflect investor expectations that accommodative monetary policy during the oncoming recession will cause short-term interest rates to be lowered in the future, with this in turn causing long-term interest rates to decline relative to short-term interest rates in the present (Haubrich and Dombrosky 1996).[14] Estrella and Mishkin (1997) likewise found that fluctuations in the yield curve were influenced significantly but not exclusively by monetary policy, and that yield curve fluctuations offered significant insight into the future course of real economic activity in the United States and Germany between the years of 1974 and 1994. Estrella and Mishkin also presented evidence in support of the view that fluctuations in the yield curve offered “very significant” insights into the future course of real output as much as four to eight quarters in

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[13] Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.

[14] The policy anticipations hypothesis is described and analysed in greater detail in the fourth chapter of this thesis.

advance (Estrella and Mishkin 1997, 1385), which reflects a similar time horizon to that employed by numerous other studies of this subject (see for example Stock and Watson 2003; Harvey 1993; Capie et al., 2019). Bonser-Neal and Morley (1997) studied the extent to which the yield spread was able to predict levels of economic activity up to three years in advance, across eleven developed economies,[15] between the years of 1971 and 1996. Their results were broadly consistent with those of prior studies, finding a statistically significant relationship between the yield spread and future real GDP growth in most countries studied (i.e. higher long-term relative to short-term interest rates was associated with greater future economic growth), with this predictive relationship being more reliable than forecasts based on past real GDP growth. Their results indicated that the predictive relationship was strongest in Canada, Germany, and the United States, where variations in the yield spread seemed to account for 30 to 50 per cent of the variation in future real economic activity. The relationship was weakest in Japan and Switzerland, where variations in the yield spread seemed to explain less than 10 per cent of variations in future real economic activity. The United Kingdom fell in the middle of the pack, with variation in the yield spread explaining around 18 per cent of variation in economic activity up to two years ahead (Bonser-Neal and Morley 1997, 43). An expansive study by Stock and Watson (2003) not only provided a detailed review of the literature on the ability of asset prices to predict inflation and output, but also used quarterly data across 43 different asset price variables (including interest rate spreads) to assess their predictive capabilities across the G7 developed economies between the years of 1959 and 1999. Their findings conformed with those of Bonser-Neal and Morley (1997) in finding that the term spread of interest rates proved to be particularly useful as a predictor of output growth in the United States and Germany prior to the mid-1980s. Although their study did not find that any one variable maintained its predictive capabilities consistently throughout the period and across all the countries examined, they

[15] Australia, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom, and the United States.

nevertheless noted that "the term spread perhaps comes closest to achieving this goal" (Stock and Watson 2003, 822).

Just as these studies had expanded the scope of this growing field of research to analyse the predictive qualities of the term structure of interest rates in countries other than the United States, a more limited number of studies likewise sought to investigate the same question in time periods other than the mid- to late twentieth century. Interestingly, while many of the studies of this relationship which emerged during the surge of scholarly interest in this topic from the late 1980s onwards focussed their attention on the evidence from the United States in the second half of the twentieth century, of the smaller number of studies which had addressed this topic prior to the late 1980s, several had incorporated evidence from earlier time periods (Kessel 1965; Cagan 1966; Wood 1983). Kessel's pathbreaking 1965 study looked at U.S. interest rates dating back to 1865, albeit with the goal of describing the cyclical fluctuations of the yield curve and explaining its movement in terms of economic theory, rather than focussing on its usefulness and reliability as a predictive tool. Employing business cycle peak and trough dates from the National Bureau of Economic Research and the yields on a range of U.S. government bonds with maturities ranging from three months to twenty years, Kessel found that movements of long-term and short-term interest rates exhibited a relatively consistent pattern throughout most of the period under his consideration (Kessel 1965, 60). Greater variation was observed in short-term interest rates than in long-term interest rates over the course of a typical business cycle, and short-term interest rates were seen to have generally reached their peak relative to long-term interest rates at the apex of a given business cycle, falling to their lowest points at around its trough (Kessel 1965, 61-74). In other words, Kessel's data indicated a flattening or even inversion of the yield curve shortly before a downturn in the U.S. business cycle throughout most of the period from 1865 to 1961. Although Kessel argued that "the cyclical nature of interest rates before and after Wold War II are similar"

(Ibid. 71), he nevertheless noted that this cyclical pattern of yield curve fluctuations seemed to be particularly strong during the period after 1945, with his data indicating that the fluctuations of interest rates within a given business cycle were on average 50 per cent greater than the secular changes in rates from cycle to cycle during the post-War period (Ibid. 59). The one period during which this pattern did not present itself so strongly in Kessel's data was between 1921 and 1945, during which Kessel argued that the association between fluctuations in the term structure and the business cycle became "tenuous at best" (Ibid. 71). To explain this seeming distortion of the usual cyclical pattern, Kessel pointed to the fact that the coupon payments on key short-term and long-term government bonds was either partially or wholly tax exempt during the 1920s and 1930s. He also noted the infrequent and irregular issuance of short-term bills during the late 1920s and 1930s, and the wartime government support programme which held short-term Treasury bill rates constant for much of the 1938-45 cycle (Ibid. 65-71). It could also be added that the decision to suspend the convertibility of the U.S. dollar into gold between 1933 and 1944 might have limited the extent to which short-term interest rates could be expected to have risen shortly before a downturn in the business cycle in that period. This is because the growth of the supply of money and credit which often accompanies the expansionary phase of the business cycle would no longer have incentivised the redemption of bank notes into specie, diminishing the pressure on the Federal Reserve to sharply raise interest rates in order to stem gold outflows. Despite the obscuring of the typical pattern during the unusual economic circumstances of the 1921-45 period, Kessel's early study nevertheless seemed to indicate that a rise in short-term interest rates compared to long-term interest rates did tend to occur at around the peak of the business cycle in the United States between the years of 1865 and 1921.

Following shortly after Kessel's pathbreaking study, Cagan (1966) likewise sought to illustrate the cyclical fluctuations of different groups of interest rates in the United States between the years of 1878 and 1962. Like Kessel, Cagan's study was not primarily concerned with directly analysing the extent to which yield curve inversions had reliably predicted oncoming recessions. Instead, Cagan aimed to describe and illustrate the movements of the yields of different securities with varying lengths to maturity over the course of several business cycles, and compare the senses in which these intra-cyclical movements had changed in the years from 1878 to 1962. Due to limitations in the available data and changes in the types of financial instruments which were commonly traded, Cagan was unable to employ a single, unchanging set of securities for the entire period under consideration. As representatives of long-term interest rates, Cagan used the yields on high-grade corporate, municipal and railroad bonds, and supplemented these with low-grade corporate bonds for the period after the First World War. These were compared with the short-term interest rates on call money and prime commercial paper for the period before the First World War, supplemented thereafter with Treasury certificates, acceptances, bank loans, and discounts, and finally Treasury Bills were also considered for the period after the Second World War. Business cycle peak and trough dates were sourced from Moore (1961). Cagan found that, throughout the time period under consideration, all interest rates tended to rise gradually during the expansionary phase of business cycles, peak at around the peak of a given cycle, and then decline during recessions, which he suggests conformed with common wisdom at his time of writing (Cagan 1966, 221). However, his data indicated that long-term interest rates had followed these cyclical movements less responsively than short-term interest rates in the years before 1914, with peaks in long-term interest rates lagging several months behind the closely aligned peaks of the business cycle and short-term interest rates. This time lag was less obvious in his data for the period after the First World War. Furthermore, the amplitudes of interest rate fluctuations within a given cycle also increased significantly in the years after 1914, with the increase being particularly pronounced amongst long-term interest rates (Cagan 1966, 220, 244). Cagan suggests that this increase in intra-cyclical fluctuations in interest rates may have been related to the greater fluctuations in the money supply over the course of the business cycle following the foundation of the Federal Reserve in 1913, possibly combined with a change from the pre-1914 to post-1914 period in the demand to hold money over the course of a cycle, although these questions are not the focus of his study (Ibid. 241-244). Nevertheless, Cagan's results illustrate the tendency of short-term interest rates to have peaked at the peak of business cycles in the United States between the years of 1870 and 1914, with long-term interest rates generally not peaking until several months later, suggesting that a flattening or inversion of the yield curve did tend to occur around the time that the cycle turned towards recession, during that period. These results generally conform with the evidence presented by Kessel (1965, 61-74) that short-term interest rates tended to fluctuate more strongly than long-term interest rates over the course of a business cycle, and tended to reach their highest level at the peak of the cycle. It's true to note that Cagan diverges from Kessel in seeming to imply that this relationship was most pronounced between the years of 1870 to 1914, due to the greater time lag between movements in short-term and long-term interest rates in that period; Kessel agrees that the cyclical pattern in the fluctuations of the term structure presents itself strongly in his pre-1914 data, but argues that the relationship between the yield curve and the business cycle was particularly strong in the period after 1945 (Cagan 1966, 244; Kessel 1965, 59). However, their studies both concur that the relationship was at its weakest in the interwar years, with this discrepancy possibly being a result of the different cycle dates and securities from which they draw their data.

Following the studies of Kessel and Cagan, but prior to the growth of scholarly interest in the relationship between the term structure of interest rates and the business cycle in the late 1980s, Wood (1983) aimed to explain the underlying reasons behind fluctuations in the yield curve in terms of expectations theory (see Koppl 2002). Wood presents U.S. data ranging from 1862 to 1982, with yield curves constructed from high-grade corporate bonds for the period after 1900, and from a comparison of the short-term prime commercial paper rate with an index of long-term railroad bond yields for the period before 1900 (Wood 1983, 17-21). Wood argues that the data he presents are most consistent with the view that short-term interest rates are primarily influenced by extrapolative expectations (i.e. if they are currently rising they will be expected to continue to rise, and if they are currently declining they will be expected to continue declining) whereas medium-term and long-term interest rates are influenced to a greater extent by regressive expectations (i.e. if they fluctuate, they will be expected to eventually return to what are generally considered normal levels) (Ibid., 19-20). Wood points to changing monetary standards, and consequently changing inflationary expectations, as the key determinant of what normal level interest rates are expected to return to, with higher inflation expectations typically coinciding with a higher normal rate to which interest rates are expected to return in the long-term. Wood argues that the relatively higher interest rates and more frequent yield curve inversions during the two periods of his study characterised by unconvertible paper currency, 1862 to 1878 and 1971 to 1982, tend to support this conclusion (Ibid., 21-22). Although his study is not primarily concerned with the relationship between the term structure and the business cycle, he nevertheless suggests, in line with the broad conclusions of Kessel (1965) and Cagan (1966), that the yield curve had more often been inverted during periods of his timeframe in which interest rates in general had been high (Wood 1983, 17).

Following the growth in the late 1980s of literature on the predictive relationship between the term structure of interest rates and future economic growth, Bordo and Haubrich produced a series of studies investigating the relationship between the yield curve and future real output growth in the United States between the years of 1875 and 1997. Bordo and Haubrich (2004) highlighted the potential their pre-1945 focus offered for insights to be gained concerning the reliance of the yield curve's predictive ability on the existence of particular institutional arrangements. Most notably, the lack of a central bank in the United States prior to 1913 offered an opportunity to examine the extent to which the yield curve's seemingly predictive qualities stemmed largely from the decisions of monetary policymakers, with the raising of short-term interest rates by the central bank potentially both causing the yield curve to invert and constricting economic activity in such a way as to bring about a recession. However, they noted that the deeper timeframe of their study compared to most of their predecessors also presented certain challenges, particularly regarding the construction of a consistent dataset from which yield curves could be reliably calculated for the entire period. For example, the Treasury Bills which have been widely used in many of the aforementioned studies as a representation of short-term interest rates were not introduced by Congress until 1929, and were not standardised to a three-month maturity until 1938. At the other end of the spectrum, the rates on longer term government debt used in studies with a more recent focus did not always reflect long-term interest rates in the broader market during the earlier period, due to the less regular issuance of such long-term government debt at the time, and its role in backing national bank notes (Bordo and Haubrich 2004, 4). Bordo and Haubrich sought to overcome these issues by constructing their yield curves from the difference between the yield on corporate bonds and the commercial paper rate, with their data being sourced from Balke and Gordon (1986). For their measure of real output they relied on the quarterly real GNP series from the same source, a decision made to overcome the limited availability of national accounts data prior to the First World War. Adopting a cliometric approach, and using a standard which would regard a yield curve flattening or inversion as having correctly predicted a downturn if the latter occurred within four quarters of the former, Bordo and Haubrich found that the predictive relationship between the term structure and the business cycle seemed to exist throughout the entire period, although it presented more strongly at some times than others. Specifically, their data seemed to suggest that the predictive utility of the yield curve was at its strongest during the two periods with the most strikingly contrasting monetary regimes: namely, the pre-Federal Reserve, pre-Gold-exchange standard years of 1875-1913, and the post-Bretton Woods floating exchange rates years, especially between 1971 and 1984 (Bordo and Haubrich 2004, 13). This finding of a strong cyclical relationship between the yield curve and the business cycle between the years of 1875 and 1913, with a rise in short-term interest rates interest relative to long-term interest rates tending to cause a flattening or inversion of the yield curve at around the peak of a given cycle, conforms with the conclusions of Kessel (1965, 71) and Cagan (1965, 220-224), while also suggesting that the predictive qualities of the yield curve are not entirely dependent on the existence of a specific, narrow range of monetary and institutional arrangements. Interestingly, although Bordo and Haubrich did find a significant flattening of the yield curve at most of the business cycle peaks throughout their period, their results did not support the view that inversions of the yield curve reliably occurred prior to each economic downturn and not at other times. They observed inversions of the yield curve at only three of the seven business cycle peaks between the years of 1951 and 1997. The results were stronger during the pre-Federal Reserve years of 1875 to 1913, with yield curve inversions being seen at eight of the nine business cycle peaks in that period. Like Kessel, they found that the cyclical pattern of the term structure was at its weakest during the interwar years: their GNP data suggested the existence of nine business cycle peaks between the years of 1913 and 1951, with only one of those peaks coinciding with a yield curve inversion (Bordo and Haubrich 2004, 6). Despite this, they considered these results strong enough to conclude that the yield curve's "significant predictive power for future economic growth … [had] prevailed for the past 125 years" (Ibid. 13).

Bordo and Haubrich built on this foundation through the publication of two further articles in 2008. The first of these (Bordo and Haubrich 2008a) came to the same conclusions as their 2004 study after having made some improvements to their dataset, while also demonstrating that the corporate-commercial paper spread they used closely followed the spread between ten-year Treasury bonds and three-month Treasury bills, which is the measure of the yield curve more commonly used in studies of the post-1945 U.S. experience. The second (Bordo and Haubrich

2008b) incorporated the more recent work of Wright (2006) and others to find that the accuracy of real growth forecasts is significantly improved by incorporating both the slope and level of the yield curve, measured by the term structure and short rate respectively, in the United States between the years of 1875 and 1997. Most recently, Bordo and Haubrich expanded on these conclusions with a new study in 2020, which used U.S. data dating back to 1876, as well as more recent, late twentieth century data for the United Kingdom, Germany and Japan. The goal of this study was to investigate whether the predictive power of the yield curve persisted even during extended periods of relatively low interest rates, such as in the years from 2008 to 2015, and from 1932 to 1951. Their results tended to suggest that, although "the predictive content of the yield curve varies over time, across countries, and even across data sets", its predictive relationship with real output nevertheless seemed to persist, and perhaps even grow stronger, during these extended periods of relatively low interest rates (Bordo and Haubrich 2020, 16). This significant body of work by Bordo and Haubrich was added to by Gerlach and Stuart (2018), who came to similar conclusions while assessing the yield curve's ability to forecast recessions as defined by the National Bureau of Economic Research (NBER), as opposed to the real economic growth measures which Bordo and Haubrich were aiming to forecast. Gerlach and Stuart argue that using the recession dates established by the NBER avoids certain measurement errors associated with the pre-1913 national income estimates used by Bordo and Haubrich, while also having the advantage that the NBER dates are at a monthly rather than quarterly frequency, and date back to 1857 rather than 1875.

Despite this welcome development of the literature toward the question of how well the yield curve was able to forecast oncoming economic downturns in the United States before 1945, the question of whether or not this relationship existed in other countries prior to 1945 has been analysed much less frequently. Baltzer and Kling (2007) used German yield curve data ranging from 1870 to 2003 to assess the credibility of the German monetary regime during that period.

Their work was based on Bordo and Haubrich's (2004) view that, in a credible monetary regime with low or transitory inflation, both inflationary shocks and real economic shocks could be expected to predominantly influence short-term interest rates, whereas in a less credible monetary regime where high inflation is expected to persist, inflationary shocks will tend to influence both short-term and long-term interest rates, whereas real economic shocks will continue to predominantly influence short-term interest rates; therefore, the predictive power of the slope of the yield curve is argued to be greatest during periods where high inflation is expected to persist. Baltzer and Kling use this insight as the basis for a model which aimed to assess the credibility of Germany's historical monetary regimes, which came to the expected conclusion that credibility was at its lowest during the interwar hyper-inflationary period, and to a lesser extent in the post-Bretton Woods floating exchange rates period, and therefore that the predictive reliability of yield curve-based forecasts was at its greatest during those periods (Baltzer and Kling 2007, 402-404). However, Baltzer and Kling's study is focussed on the task of constructing a model to assess the credibility of Germany's historical monetary regimes, rather than directly addressing the question of how reliable the yield curve was as a predictor of oncoming recessions during the period.

A more recent study by Capie, Goodhart and Mills began the process of more directly assessing the reliability of forecasts based on the yield curve before 1945 in countries other than the United States. Capie et al. (2019) investigate the question of whether inverted yield curves have tended to precede recessions in the United Kingdom in the years from 1822 to 2016, by far the longest period covered by any of the previously mentioned studies. They construct their recession indicator from annual real GDP data for the years 1822-1913, monthly real GDP data for the interwar years of 1920-38, and finally using the monthly FRED/OECD peak-to-trough recession indicator from 1946 onwards, and take the long rate from the yield on consols, and the short rate from the yield on three-month Treasury bills. Their results indicated "reasonably strong support"

(Ibid. 11) for the view that inverted yield curves tended to signal U.K. recessions up to 18 months in advance during the pre-World War One and post-World War Two periods, although they judged their evidence to have been less conclusive for the inter-war years. This largely conforms with the pattern observed in the American data by Kessel (1965, 71) and Bordo and Haubrich (2004, 13), but contrasts with the seemingly strong predictive power of the yield curve in Germany in the inter-war years, suggested by Baltzer and Kling (2007, 402-404).

Despite the valuable contributions made by Capie et al. (2019) in establishing nineteenth century Britain as a new timeframe in which to investigate the predictive relationship between the term structure of interest rates and the business cycle, and in presenting results which provide a preliminary picture of the nature and extent of that relationship, there are nevertheless a number of senses in which further research still has the potential to enhance our understanding of this topic. The most straightforward sense in which Capie et al. leave avenues open for future research stems from the short length of their study relative to the broadness of its scope: it analyses the extent to which yield curve inversions reliably predicted recessions throughout the entire 1822 to 2016 timeframe over the course of a 13 page working paper. As a result, decisions necessarily had to be made concerning which aspects of the subject could be accommodated within the confines of a study of that length, and which could not. Capie et al. made the decision to devote their paper primarily to an explanation of the methods used to define recessions and assess the extent to which yield curve inversions had predicted these, and to a presentation of the results achieved. While these were no doubt the most essential and appropriate two elements to include in a study of that length, there are many other aspects of and approaches to this topic which a more extensive investigation might explore more thoroughly, and which could contribute to a fuller and more detailed understanding of the historical relationship between the term structure of interest rates and the business cycle in Britain. In particular, a discussion of the historical and institutional context of

British financial arrangements in the period under investigation might allow for a more illuminating analysis of the implications of the results achieved, and the extent to which they suggest that the predictive relationship observed between the term structure of interest rates and the business cycle at that time might have stemmed from certain relevant contingent factors, such as the monetary policy pursued at the time. For this reason, incorporation of such historical context into the analysis of this thesis is amongst the main goals of this chapter, and also of Chapter 4.

Another sense in which a more extensive incorporation of relevant historical context might enable further insights to be gained into this topic would be that such context might inform a division of the time period under consideration into an even greater number of sub-periods, distinguished by relevant institutional differences, between which results might be compared to offer a more detailed picture of any variation which the relationship between the yield curve and the business cycle might have exhibited over the course of the timeframe. Some degree of comparison of results between different time periods is already offered by the study of Capie et al. (2019), which divides the 1822 to 2016 timeframe into three parts: pre-First World War, interwar, and post-Second World War. However, considering the years between 1822 and 1913 as a single, undifferentiated era obscures potentially relevant legislative and institutional changes within that period, such as the passage of the Bank Charter Act of 1844 and the increasing adoption of lender of last resort functions by the Bank of England by the later nineteenth century. By dividing the years before the First World War into a greater number of sub-periods, based on the historical context outlined in the next section of this chapter, this thesis aims to offer a more detailed illustration of the extent to which the predictive relationship between the term structure of interest rates and the business cycle varied over the course of that important century, while also analysing the extent to which relevant historical and institutional changes might have influenced such variation.

One of the key institutional changes of potential relevance to the predictive qualities of the yield curve in nineteenth century Britain is entirely excluded from the analysis of Capie et al. (2019) as a result of the 1822 start date of their study: namely, the resumption of the gold standard by Britain on 1st of May 1821, after nearly a quarter of a century of unconvertible paper currency. Comparing results between the pre-1821 suspension period and the post-1821 gold standard era offers the potential for insight to be gained into the extent to which the relationship between the yield curve and the business cycle depended on the existence of one or the other monetary regime. Incorporating results from the pre-1821 suspension period would also allow for an assessment of whether the relatively higher inflation of that era resulted in a more pronounced predictive relationship between the yield curve and the business cycle, which would be consistent with the findings of Baltzer and Kling (2007) in their study of the predictive qualities of the yield curve in twentieth century Germany. For these reasons, this thesis will extend the timeframe under consideration back to the start of the nineteenth century, an earlier period than has so far been analysed by any of the above-mentioned studies of the relationship between the term structure of interest rates and the business cycle.

Another way in which a more expansive study might have the potential to offer a fuller picture of the relationship between the yield curve and the business cycle in nineteenth century Britain than has so far been offered by Capie et al. (2019) would be by incorporating a range of different methodological approaches. While it is true to note that Capie et al. employ different methods for arriving at recession indicators in each part of their timeframe — pre-First World War, interwar, and post-Second World War — to account for the varying data availability in those sub-periods, the crux of their analysis involves the use of a single method (namely, a probit model) to assess the extent to which yield curve inversions predicted recessions. While this method no doubt offers one illuminating perspective, the limitations of the available data for the pre-1913 period, and particularly of GDP data,[16] draws into question the idea that any single methodological approach could be expected to offer a definitive and undeniably accurate picture of the predictive relationship between the term structure of interest rates and the business cycle as it actually existed in nineteenth century Britain. For this reason, this thesis will present a range of results achieved using numerous different methodological approaches. While this eclectic approach does not claim to entirely overcome the limitations inherent in the nineteenth century British macroeconomic data, presenting and interpreting such a collage of different results might contribute to the emergence of a more general impression of the relationship between the term structure of interest rates and the business cycle at that time, which might have a better chance of capturing some part of the true nature of that relationship than could have been gained by the use of a single methodological approach. Furthermore, presenting detailed results achieved using a range of different methods might constitute a useful resource which could be drawn upon by future studies of this topic.

Finally, certain ambiguities in the data employed by Capie et al. (2019) tend to further draw into question the idea that their study could be regarded as having already delivered the final word on the relationship between the yield curve and the business cycle in nineteenth century Britain. In particular, they specify that the representative of short-term interest rates employed by their study for the years between 1822 and 1938 is the yield on three-month Treasury Bills (Capie et al. 2019, 8). However, as is detailed later in this chapter, Treasury Bills were not issued prior to 1877, and the data series on Treasury Bills in the source they cite begins in 1923 (Thomas and Dimsdale 2017).[17]

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[16] The relevant data and their limitations are detailed in the next chapter.

[17] Having contacted the authors of the paper in question (Capie et al. 2019), all three suggested that the specification of the yields of three-month Treasury Bills as the representative of short-term interest rates for the periods of their study prior to 1938 was likely a simple mistake, although none were able to recall the details of what data had been used instead. They variously suggested that the actual data used might have been either the "spliced discount rate on prime short-term paper" series from the same source (Thomas and Dimsdale 2017, Sheet M1, Column 1), or data on best bank bills from an unspecified source. Incidentally, the former of these is the same data series as had been chosen to represent short-term interest rates throughout this thesis.

For all of these reasons, there still seems to be considerable scope remaining to enhance and expand our understanding of the predictive relationship between the yield curve and the business cycle in nineteenth century Britain, despite the merits of the prior study of this topic by Capie et al. (2019). By focussing in on the years between 1800 and 1913, and by investigating the aforementioned relationship in that timeframe more extensively, by a wider range of methods, and with a greater incorporation of contextualising historical and institutional details, this thesis aims to not only offer a more detailed picture of that relationship than has so far been offered by any prior study of that period, but also to establish a foundation which might facilitate the further investigation of this topic by still more narrowly-focussed future studies.

The next section of this chapter reviews such historical and institutional details, with particular attention to relevant developments in the London money market, in order to contextualise the assessment in Chapter 3 of the extent to which a flattening or inversion of the yield curve tended to precede economic downturns in Britain between the years of 1800 and 1913.

II - Historical Context

The economic history of nineteenth century Britain has long been considered particularly noteworthy due to the transformative developments which were being brought about amidst the ongoing Industrial Revolution, and this widespread transformation was evident in Britain's monetary and financial institutions, as in the rest of the economy. The relevance of these changes to the topic of this thesis, as well as the relative unfamiliarity of the institutional arrangements of the time from a modern perspective, suggests that an overview of the development of the British monetary and financial systems between the years of 1800 and 1913 may provide valuable historical context to the core questions of this thesis, and illuminate the reasoning behind the methodological approaches taken in later chapters.

The Development of Britain's Financial System before 1800

As transformative as the nineteenth century was for the British financial system, many of its key elements were already in place by the close of the eighteenth century, with certain developments being continuations of trends which had already long been in motion. The Bank of England had, of course, existed since 1694, although at the start of the nineteenth century it still lacked many of the powers and privileges characteristic of a modern central bank. Its Bank notes had not yet become legal tender, and would not gain that status until the passage of the Bank Charter Act of 1833 (3 & 4 Will. 4., c.98) (Orzechowski 2019, 182; Born 1983, 7; Morgan 1943, 96-99). It had not yet committed to consistently acting as lender of last resort, although it was arguably already functioning in that capacity, albeit in a sporadic manner.[18] It did not have a monopoly on the issuance of bank notes, although it was already able to exert significant influence over the supply of money and credit throughout the country due to how widely its notes and government bonds were held as assets by smaller banks (Sayers 1976, 21; Selgin 1992, 179). However, it only gradually developed a “conscious, regular process” for exerting this influence, over the course of the nineteenth century (Pressnell 1956, 76). The Bank was not even the sole legally privileged financial institution responsible for managing the national debt, at the dawn of the nineteenth century (Roseveare 1991, 59; Needham 2020).

Despite these areas in which its powers differed from those associated with a modern central bank, the Bank of England was, in 1800, already in the midst of a series of ongoing changes which would continue to develop and influence its evolution throughout the period from 1800 to 1913. Over the course of the eighteenth century, the Bank had been expanding its role beyond its initial goals of servicing the national debt and offering short-term loans to the government, by increasingly lending money privately by discounting bills of exchange, and even offering short-term overdraft loans to a large clientele of London merchants, manufacturers, and even tradesmen. By the end of the eighteenth century, the private London banks had also begun holding their gold reserves with the Bank of England (Mathias 1983, 154). From the 1760s onwards, the Bank’s discount business grew considerably in both its profitability for the Bank and its importance to the economy as a whole. The Bank discounted bills of exchange, usually of thirty to sixty days duration, as a means of extending short-term credit to private traders and bankers, and offered this service more-or-less freely to any reputable businessperson introduced by a Director of the Bank (Kynaston 2017, 43/4).

[18] It is widely held that the Bank of England’s responsibility to act as lender of last resort had become generally accepted by at least 1873 (Bignon et al. 2012, 582), thanks in part to the influential writings of Walter Bagehot (Bagehot 1873). However, the Bank’s responsibility to function as lender of last resort appears to have been a matter of debate amongst the Bank’s directors at least as early as the 1830s (Collins 1972, 59), and there is some argument that the Bank was already acting as de facto lender of last resort as early as 1763 (Lovell 1957; Mathias 1983, 154). On the gradual adoption of the role of lender of last resort by the Bank of England, see Turner (2014, 144-156).

The key 'Bank rate' at which this discounting service was offered was typically higher than the market rate for prime short-term commercial paper,[19] but the Bank's bill discounting activity nevertheless represented an important lifeline during periods of distress for the individual borrower or the financial system as a whole. The Usury Act of 1714 (13 Ann. c.15) restricted the maximum level of interest rates the Bank was able to charge to 5 per cent,[20] limiting the Bank's ability to contract the amount of credit it was willing to offer to the banking system by simply adjusting its discount rate. In order to overcome this limitation, the Bank varied the quantity and maximum length to maturity of bills it was willing to discount, and occasionally engaged in explicit credit rationing, to achieve the same effect (Fletcher 1976, 8; Crouzet 1982, 318; Kynaston 2017, 120; Bordo and White 1991, 311).

At the beginning of the nineteenth century, Britain was also still in the midst of its transition from a bimetallic monetary system to a gold standard; both gold and silver coins circulated, but the elevation of gold coins to the status of legal tender in 1774 was followed by a gradual decline in the circulation of silver which continued well into the nineteenth century (Born 1983, 3). The Coinage Act of 1816 (56 Geo. 3., c.68) formally established a gold standard in Britain at a relatively early date compared with most other major economies. It defined the pound as a weight of gold (approximately eight grams) and prohibited the use of silver coins for transactions larger than 40 shillings, although a de facto gold standard had arguably been achieved prior to this legislation (Narsey 2016, 22; Redish 1990).

Likewise, the banking system Britain found itself with at the start of the nineteenth century was the product of developments which had been ongoing since the mid-seventeenth century

[19] Thomas and Dimsdale 2017, Sheet M9, Column C and Sheet M1, Column M.

[20] This restriction was effectively ended in 1833 when short-term bills of exchange were exempted (Homer and Sylla 2005, 205-6), and was finally officially lifted by the Usury Laws Repeal Act of 1854 (17 & 18 Vict. c.90).

(Pressnell 1956, 4), at which time goldsmiths and other businesspeople had used their accumulated capital and business networks to begin offering banking services, becoming the first private goldsmith bankers and merchant bankers. The Bank of England Act of 1708 (7 Ann. c.30) attempted to establish a monopoly for the Bank of England as the only joint-stock bank in England and Wales by prohibiting these 'private banks' from issuing notes if they had more than six partners (Pressnell 1956, 6; Crouzet 1982, 317/8). This restriction of the size of English banks limited their capacity to diversify their portfolios and hence withstand unexpected shocks, and the six partner limit was eventually repealed in 1826 after having been judged to have been one of the causes of the Panic of 1825 (Hickson and Turner 2004, 1914; Cramp 1962, 102). Prior to the repeal of this restriction, however, the growth in demand for banking services over the course of the eighteenth century was consequently met by an increasingly large number of small private banks with unlimited liability, whose partners provided banking services and issued notes with their own capital. Around 50 of these private banks existed at the mid-point of the eighteenth century, of which the vast majority were located in London,[21] but by the year 1800 the number of private banks had risen to around 550 throughout England and Wales (Born 1983, 20/1). The 1708 law did not extend to Scotland, which consequently developed a distinctly different banking system, with both credit provision and note issuing privileges being held by a much smaller group of joint-stock financial institutions, notably including the Bank of Scotland, the Royal Bank of Scotland, and the British Linen Company, founded in 1695, 1727, and 1746 respectively (Born 1923, 6, 21; McDiarmid 2024, 23).[22]

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[21] Edmund Burke (1826, 153/4) estimated that, when he arrived in London in 1750, there were fewer than a dozen "bankers' shops" in England, outside of London, whereas by the mid-1790s they were "in almost every market town". Pressnell (1956, 4) argues that there is little reason to doubt the accuracy of this estimate.

[22] The absence of the six partner limit from the Scottish banking system after 1708, along with the generally small number of legal restrictions on Scottish banks and the lack of a Scottish central bank, has led some authors to argue that the Scottish system between the years of 1708 and 1844 was a noteworthy historical example of a 'free banking' system (White 1984, 21-44; White 1992). However, this system was not completely absent of legal restrictions, and the charters of the three major limited liability joint-stock banks in Scotland "controlled the amount of capital they could issue, forbade them from engaging in any other business apart from banking, and appeared to limit the amount of liabilities that could be issued" (Hickson and Turner 2004, 915).

The roles of the smaller English and Welsh private banks were largely determined by their proximity to London, which had become the world's leading financial centre by 1795, following the relocation there of many major French, Dutch, and German bankers displaced by the events of the French Revolution and the War of the First Coalition (Born 1983, 35; Michie 1999, 33). The private 'city banks' located in and around London, of which there were 70 by 1803 (Born 1983, 21) had largely ceased their note issues by 1770 (Mathias 1983, 149) and begun transacting in Bank of England notes, due in part to the legal privileges Bank notes enjoyed (Selgin 1992, 179). These city banks were "mainly family businesses … were often long established, rich, solid and carried considerable prestige" (Crouzet 1982, 319). Several subsets of city banks existed, with slightly different functions (Pressnell 1956, 75). The West End banks generally handled the financial affairs of the nobility, typically offering long-term mortgages on estates. Private banks in the City of London mainly offered short-term financing of business transactions by discounting bills. Other private city banks specialised in financing foreign trade or facilitating overseas investments (Pressnell 1956, 319; Black 1996, 114-115). Despite the small size of these private banks in terms of the number of partners they were legally permitted to have, many of them nevertheless wielded significant influence and fulfilled highly important functions, with the London banking house of Baring Brothers & Co. being the biggest financier of European governments up until 1815, after which it was overtaken in that role by the various branches of the Rothschild banking family; it remained the most important lender to the governments of Britain and the United States until the middle of the century (Austin 2007, 28; Born 1983, 31). Indeed, many of these private city banks devoted considerable resources toward state loans, arguably not because they necessarily expected these loans to be more profitable than commercial loans, but because it offered the opportunity to form relationships with monarchs and statesmen which would advertise the prestige and solidity of the banks, while opening up the potential for future business opportunities and possible rent-seeking (Born 1983, 31). Most city banks were 'correspondents' to numerous country banks, usually several from a particular area of the country, acting as clearing houses between them and the Bank of England and handling their London-based business (Pressnell 1956, 75-77; Born 1983, 21).

Both the services and Bank notes of the Bank of England did not extend far outside of the boundaries of London prior to the early nineteenth century, creating the opportunity for banking services to be provided by an increasingly enormous number of private ‘country banks’, which grew significantly both in number and in their significance to the British economy from around 1750 onwards (Pressnell 1956, 2; Black 1996, 113-114, 119). At their peak in 1809-10, as many as 900 country banks existed throughout England and Wales, most of which had been established no earlier than the last third of the eighteenth century. It was legal for more-or-less anyone to establish themselves as an issuer of bank notes provided they acquired the correct license, which was not expensive, so most of these country banks were very small, with little capital, no branches, and an exclusively local clientele (Crouzet 1982, 318-322; Newton and Cottrell 1998, 115; Black 1996, 114). This led to a situation in which many country bankers were simply local business people who had begun providing banking services in addition to their other ventures, while some who provided these services in rural areas scarcely considered themselves bankers at all, and didn’t advertise themselves as such (Pressnell 1956, 6). Mathias paints a characteristic picture of the country banking system of the early nineteenth century:

> Often it was difficult to tell to what extent a man was a specialised [country] banker (which accounts in part for the uncertain statistics [concerning the number of country banks])[23] — he had added dealing in money and in credit to his other business activities which still continued, often closely associated with

[23] On the limitations of the available data concerning the country banking system, Pressnell notes: “The bulk of country bank records has perished. Devastation by salvage drives or by air-raids, or by sheer wanton destruction, has been the fate of the books and papers of most country banks” (Pressnell 1956, 3).

his new activity. The bank was often just a separate counter in his office (Mathias 1983, 152).

Despite their generally smaller size, the country banks do not seem to have been significantly more prone to failure than their larger London counterparts; during the period of rapid country bank proliferation, from 1750 to 1800, "only eight failures of country bankers were recorded, compared with a larger number of London bankers and a fairly continuous stream of London goldsmiths" (Pressnell 1956, 4). The primary function of the country banks was the provision of means of payment for their local clientele, which consisted of their own private bank notes for small payments, and bankers' drafts and transfers through London banks for larger transactions (Ibid., 136). However, much like the city banks, country banks also provided short-term commercial loans (Born 1983, 20/1), which they mainly did by simply lending issues of their own bank notes backed by a reserve of Bank of England notes.[24] The country banks also provided short-term credit by discounting bills of exchange, as well as providing discounted bills to their customers to be used as a means of payment, which was a widespread practice prior to the 1820s, especially in some of the more industrialised areas of the country (Crouzet 1982, 320; Mathias 1983, 158/9; Scammell 1968, 124).[25]

This network of country bankers was somewhat integrated by the start of the nineteenth century thanks to the fact that most private London banks acted as correspondents to multiple country banks, usually from a particular region. A given London bank would redeem upon

[24] While the country banks' notes could theoretically be redeemed on request into gold, few country banks kept large gold reserves (Pressnell 1956 76; Barclay 1978, 10), instead taking advantage of the legal privilege which allowed Bank of England notes to be held in reserve as if they were gold (Selgin 1992, 179). However, this legal privilege was not widely understood at the time, either by depositors or even by Members of Parliament, which precipitated a series of runs on country banks during the Panic of 1825 (Pickering 2018, 25-40).

[25] Bills of Exchange most commonly had a term to maturity of three months, although this could vary from as much as six months to as little as a few days. They were the most commonly used financial instrument for providing short-term commercial credit, throughout the period from 1800 to 1913 (Accominotti et al. 2021, 895; Black 1996, 118)

presentation the bank notes of the country bankers with which it maintained such a relationship, execute purchases of securities on their behalf, and facilitate clearing transactions between country banks by transferring the balances of its correspondent country banks to the London agents of other country banks (Black 1996, 117; Scammell 1968, 124). However, integration between country banks in different regions remained limited, aside from clearing transactions between correspondent London banks, due in part to the Bank of England’s lack of provincial branches, and the lack of any large clearing bank with an extensive network of provincial branches. This gap in the market was gradually filled by the emergence of a number of bill brokerages, which first appeared in the 1780s and increased in number after the suspension of specie payments by the Bank of England in 1797 (Fletcher 1976, 7). In exchange for a commission, these bill brokerages would arrange for bills of exchange being held by a given country bank to be discounted by other country banks, facilitating the flow of short-term credit throughout the system. This was of particular use to country banks in the capital-hungry, industrialising areas in the midlands and north of England, in the event that they required liquid funds beyond the limit of their available deposits, and beyond the limit of their drawing rights with their correspondent London banks. By providing the framework within which such bank’s bills could be discounted by other country banks in capital-rich areas such as the south and west of England, the bill brokers played a significant role in further integrating the British financial system and facilitating the flow of money and credit between different regions (Pressnell 1956, 1; Fletcher 1976, 6; Black 1996, 117-119). This integration was accomplished not only by the bill brokerages’ provision of the institutional arrangements needed to facilitate such inter-regional lending, but also as a result of the guarantee they placed on the bills they rediscounted, which helped to overcome the information asymmetries which might otherwise have stymied lending between small, distant country banks (Accominotti et al. 2021, 894, 898; Black 1996, 127). The role of these bill brokerages was expanded when, after the Panic of 1825, an increasing number of London banks felt the need to hold more of their assets in easily accessible, liquid forms, which led them to place their money with bill brokers in the form of short-term deposits, or 'call money', enabling the brokers to discount bills at their own risk and for their own account (Scammell 1968, 133; Fletcher 1976, 9-10). Their capabilities in this regard were further bolstered by the Bank of England's 1830 decision to make its rediscount facilities available to certain bill brokers, with this privilege first being extended to Overend, Gurney and Co., already the largest such broker by this point (Fletcher 1976, 10; Accominotti et al. 2021, 901; Black 1996, 119; Sowerbutts et al. 2016, 96).[26]

Upon their shift from merely acting as intermediaries between country banks in different regions to providers of short-term credit in their own right, the bill brokerages came to be known as 'discount houses', and these played an important role in financing domestic trade and providing short-term commercial credit into the second half of the nineteenth century (Anson et al. 2017, 11; Michie 1999, 40; Bank of England 1967, 144). By 1850, four large discount houses predominated in this market, with estimated total combined deposits of £11 million: Overend, Gurney and Co., Alexander and Company, Bruce, Buxton and Company, and Sanderson and Company (Fletcher 1976, 16). However, from the mid-nineteenth century onwards the discount houses increasingly turned their attention towards financing overseas trade and facilitating the international movement of short-term capital. This growing international focus was spurred by a number of factors, including the development of communications technology at the time, and the parallel evolution of another set of institutions closely related to the discount houses, know as 'accepting houses' (Michie 1999, 73-75; Scammell 1968, 167; Fletcher 1976, 17). For a commission, these latter institutions would accept bills of exchange drawn for the finance of foreign trade, putting their

[26] The Bank's decision to make its rediscounting facilities available to the bill brokers stemmed partly from the Bank's recognition of their increasingly active participation in the discount market, which market them as a potential channel through which liquidity could flow from the Bank to the broader financial system during crises, facilitating the Bank's lender of last resort functions (Fletcher 1976, 14). However, following the strain placed on the Bank's rediscounting facilities during the Panic of 1857, the right of bill brokers and discount houses to access these facilities was restricted in 1858 (Ibid., 20-21).

name to them and underwriting their default risk. This reduced the information asymmetries between the lenders on the London discount market and international borrowers in such a way as to reduce the rates borrowers would be required to pay (Accominotti et al. 2021). The accepting houses would then seek reimbursement from the borrowers when presented with the bill on its repayment date (Fletcher 1976, 17; Grady and Weale 1986, 94-97). The growth of this market is illustrated by the increase in the annual turnover in bills drawn on London from £425 million in 1840 to more than £2000 million in 1913, of which two-thirds had been underwritten by accepting houses (Grady and Weale 1986, 95). In addition to its involvement in the finance of trade, the London discount market also increasingly became the centre of international lending from the 1860s onwards, to both governments and private businesses, both within and outside of the British Empire; £3600 million was lent abroad from London between the years of 1870 and 1913, of which 40 per cent had been raised by accepting houses (Grady and Weale 1986, 95-96; Fletcher 1976, 25, Accominotti et al. 2009). As a result of this growing involvement of discount houses and accepting houses in international trade and finance, the bill of exchange drawn on London came to be one of the most important and liquid financial assets in the global economy, with approximately half of global trade being financed through this instrument immediately prior to the First World War (Accominotti et al. 2021, 892-893).

While the discount houses and acceptance houses retained an important place in international lending and trade finance well into the twentieth century, their role in providing short-term credit to domestic borrowers declined significantly from the 1870s onwards (Scammell 1968, 170; Fletcher 1976, 28). This was a result of a range of factors, including the significant impact of the Panic of 1866 on the discount market. The largest of the discount houses, Overend, Gurney and Co., collapsed during the crisis, shaking the confidence of domestic borrowers (Sowerbutts et al. 2016). By 1867, only three discount houses remained in the domestic market, the National Discount

Company Ltd., the United Discount Corporation, and the General Credit and Discount Company of London (Fletcher 1976, 24). The years from 1870 to 1914 also saw the concentration of Britain's financial system into a smaller number of larger, joint-stock banks, with extensive branch networks, and this increasing integration of Britain's banks diminished the domestic demand for the bill brokering functions of the discount houses (Fletcher 1976, 11-12; Grossman 1999, 323-324). The ratio of demand deposits to discounts and advances also rose throughout the banking system during this period, which diminished bank's demand to rediscount bills in exchange for immediate liquidity rather than holding them until maturity. Overdraft lending also became more widespread during this period of amalgamation for the banking system, diminishing the domestic demand for credit to be supplied via bills of exchange (Nishimura 1971, 57-64; Fletcher 1976, 28; Scammell 1968, 170-171). Improvements in transportation and communications technology may also have contributed to the decline in demand for inland bills, reducing the length of time required to move goods from sellers to buyers, and hence diminishing the demand for short-term credit to finance local trade (Nishimura 1971, 79; Fletcher 1976, 26-27). All of these factors contributed to the increasing specialisation of London's discount houses and accepting houses in international lending and the financing of overseas trade (Fletcher 1976, 25-26).

The National Debt: Components and Markets

Britain's national debt, and the markets in which it was traded were likewise in the midst of a series of ongoing developments at the start of the nineteenth century, closely related to the parallel evolution of Britain's financial system and of the Bank of England. The origin of Britain's permanent national debt is usually dated to coincide with the founding of the Bank of England in

1694 (Ellison & Scott 2020, 229), but this is not to say that English monarchs hadn't borrowed money prior to that date. Indeed, ad hoc, short-term borrowing, particularly during wartime, had been an integral feature of medieval public finance, given the slowness and administrative difficulties of collecting taxes at the time (Munro 2003, 514; Roseveare 1991, 8). The primary instrument by which the government's indebtedness was tracked and managed during the early history of English public debt was the tally stick. These sticks had entered use in the early twelfth century, during the reign of Henry I, and subsequently gained prominence in the English economy primarily as an instrument by which loans to the crown were tracked (Lee 1971, 154). Typically around six inches long and made from polished hazel or willow, notches of different widths to represent different amounts were carved into the tally stick before it was split in half lengthways, with one half given to each of the two parties to the transaction. These two halves would then be reunited upon payment of the loan, to prove the amount owed. This system had the advantage of being resistant to forgery and easily comprehensible even if one or more of the parties to a transaction was illiterate. As a result, tally sticks became widely used as debt instruments in medieval England, even circulating as a medium of exchange, and while they were gradually phased out as the primary national debt instrument from the mid-eighteenth century onwards, in favour of paper bonds, they were still widely used in that capacity throughout the first third of the nineteenth century (Apostolou and Crumbley 2008, 61).

Although public borrowing had been commonplace prior to 1694, presentation of a tally stick served only to prove that the lender was owed a given amount by the crown; the question of when or if this debt would be repaid was entirely at the discretion of the government. As a result, tallies generally traded at a significant discount, and the government was often forced to pay very high interest rates in order to entice lenders (Stasavage 2003, 5). The short duration of these early loans to the government further exacerbated the strain they placed on the public purse, threatening to embarrass the crown if they could not be fully repaid promptly (Slater 2018, 32). The confidence of lenders was moderately bolstered by the introduction of Orders of Repayment in 1664, paper debt instruments which, like tally sticks, had no set date of repayment, but which the government promised to pay off in the order in which they had been issued, giving holders some ability to estimate when they might be repaid (Ibid. 30/31). Whatever confidence this might have created proved short-lived, however, when the government of Charles II, prior to the Third Anglo-Dutch War in 1672, made the decision to suspend its debt payments in order to redirect its revenues toward naval preparations. This so-called ‘Stop of the Exchequer’ was widely perceived as a default, severely impacted several major London banking houses, and underscored the increasing difficulty of financing a modernising state via ad hoc, short-term borrowing (Horsefield 1982; Li 2019, 178-181). As a result, between the years of 1692 and 1694 the government began experimenting with a number of new methods for attracting long-term loans, including life annuities, lotteries, and even tontines, a form of group investment in which the periodical payments received by the subscribers increase each time one of the subscribers dies, with the last survivor consequently receiving the most favourable return on investment (McKeever 2010, 494). However, these attempts were only somewhat successful in enticing lenders, despite still requiring the government to pay between 10 per cent and 14 per cent interest per annum (Slater 2018, 33).

With the founding of the Bank of England in 1694, a significant advancement was made in the difficult matter of establishing a reliable and affordable source of long-term credit for the government. Promoted by a group of London merchants, and with the pooled resources of its 1,268 original subscribers, the Bank offered the government a permanent loan of £1.2 million at 8 per cent, in exchange for a Royal Charter granting it joint-stock limited-liability status, an uncommon privilege at the time,[27] which allowed the Bank to grow rapidly in power and influence (Kynaston

[27] Prior to the 1690s there were only around 15 joint-stock companies in operation in Britain, with a combined capital of £0.9 million. Most of these were companies chiefly concerned with overseas trade, such as the East India Company, the Hudson’s Bay Company, and the Royal African Company (Michie 1999, 15).

2017, 1-8).[28] The size of the Bank's capital, the number of its subscribers, and the average size of their individual investments in its stock were all uncommonly large for the period.[29] As a partial result of this fact, the formation of the Bank of England contributed to a general surge of interest in the buying and selling of securities, as evidenced by the emergence of specialised stockbrokers and the significant increase in the number of investors in the 1690s (Michie 1999, 16-18). Notably, the permanence of the Bank of England's new loan to the government was widely understood, in contrast to the earlier tally stick and Order of Repayment loans which had no explicitly specified length to maturity but were generally expected to be repaid promptly. Furthermore, the Bank's charter specified that it would only lend to the government if Parliament authorised such borrowing, and if Parliament allocated sufficient tax revenues to service the debt in full, a move which reassured creditors by decoupling the credibility of the national debt from the perceived creditworthiness of any individual monarch (Roseveare 1991, 32; Slater 2018, 36).

Following the success of the formation of the Bank of England, the government sought to replicate this model with other large companies, securing a £2 million permanent loan on similar terms from the New East India Company in 1698 in exchange for its charter, a further £3.2 million from the United East India Company in 1708, and an enormous £9 million permanent loan from the ill-fated South Sea Company in 1711, and a £600,000 loan at 5 per cent in exchange for the granting of a charter to the Bank of Ireland in 1782 (Bowen 2005, 30; Roseveare 1991, 52; Whitaker 1983, 18; Slater 2018, 35-9). As had been the case with the Bank of England, these loans amounted to the entire paid up capital of the companies in question, which received in return an equivalent nominal

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[28] The bonds which constituted this new permanent national debt, managed by the Bank of England, are sometimes referred to as 'gilts', supposedly due to the gilt-edged paper upon which they were once printed. However, this etymology is likely apocryphal, and the term did not come into use until the late nineteenth century regardless, so I have opted not to use the term in this thesis (Choudhry 2006, 47; Corporate Finance Institute 2020).

[29] At this time, and between the years of 1800 and 1913, the word 'stocks' was commonly used by British investors to refer to interest bearing bonds, including those which comprised the national debt, in contrast with the modern use of this word to describe equity shares (Michie 1999, 45).

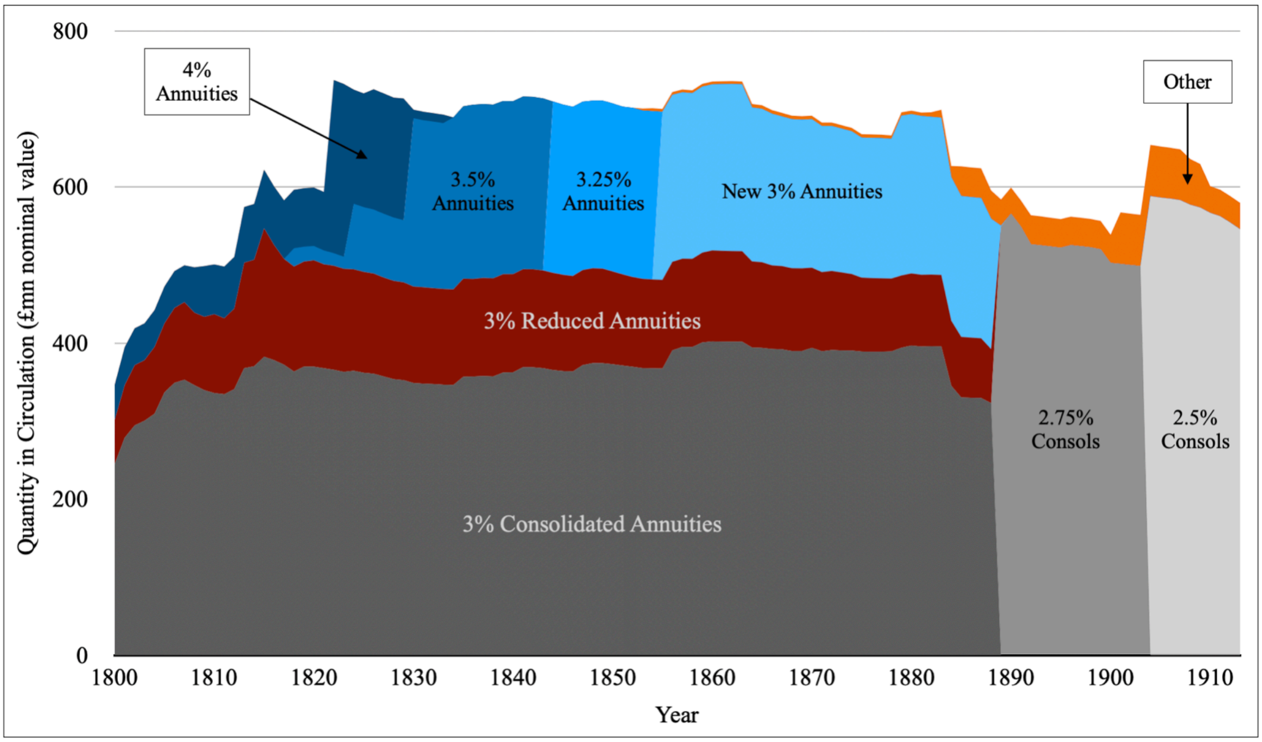
value of largely unmarketable government debt, the interest payments from which would be passed on to the companies' shareholders (Michie 1999, 18). Through these various loans, and with the periodic renewals of the Bank of England's charter, the government was able to convert much of its pre-existing, expensive, short-term debt into the new, cheaper, permanent national debt (Slater 2018, 37; Quinn and Turner 2020, 23-24).

The government also improved upon the earlier Orders of Repayment with the introduction of Exchequer Bills in 1696. Originally issued directly by the Treasury, and then by the Bank of England after 1707, these operated on similar principles to Orders of Repayment, but would be accepted by the government in payment of taxation, and could be cashed at the Bank of England at any time, for a fee, in exchange for gold or Bank notes, if the holder was unwilling to wait for eventual repayment by the government (Graham 2019, 63-66, 78; Dickson 1967, 373). Exchequer Bills were the earliest form of marketable debt to still be in circulation throughout much of the nineteenth century. Having been regulated by the Exchequer Bills and Bond Act of 1866 (29 and 30 Vict. c.25), they gained an explicit length to maturity of five years, with interest paid biannually. They remained a moderately important component of the non-permanent, 'unfunded' national debt until 1897, when the remaining Exchequer Bills in circulation were redeemed and not issued again (Wormell 1999, xxvi; Richards 1936; Sherratt 2021, 9).

Finally, in 1751, the government was able to pass the National Debt Act (25 Geo. 2., c.27), which consolidated all the various annuities across which the national debt was spread into two new redeemable perpetuities managed by the Bank of England, the '3½ per cent Consols' and the '3 per cent Reduced' (Slater 2018, 52; Brown et al. 2004, 5). The 3½ per cent Consols were also reduced to three per cent in 1757, and another issue of three per cent perpetuities, called the 'New Three per cents', was introduced by the government in 1855 (Wormell 2000, 17). Given their functional similarity to one another, these three securities are often collectively referred to as simply 'Three per cent Consols' (Harley 1976, 102), and the word 'consol' came to be used to refer to any marketable British government perpetuity (Nolen 2009). Three per cent consols went on to become by far the most widely traded form of British government debt by the nineteenth century, and as a result they were arguably one of the most significant asset prices in the global economy throughout the period from 1800 to 1913 (Ellison and Scott 2020, 229/30; Klovland 1994, 165; Neal 1990,14). Consols became the investment of choice for the prudent Victorian saver, becoming so popular as to hobble future government attempts to convert the nation's long-term debt from perpetual consols back into finite annuities. One such scheme was initiated by Chancellor of the Exchequer William Gladstone with the introduction of 'terminable annuities' in 1863. These could be purchased in exchange for perpetuities previously issued by the British government, such as consols, or for cash which would then be used by the government to purchase such perpetuities. These would then be cancelled, with the holder of the new terminable annuity receiving both interest payments and the return of their capital after a specified number of years. By the 1890s, however, terminable annuities were mainly held by government departments which had been ordered to take them in exchange for their holdings of consols, and had done little to diminish the private market's overwhelming preference for consols (Wormell 1999, xxviii; Needham 2020; Slater 2018, 102/3, 114). The popularity and liquidity of three per cent consols, combined with the low interest rates they required the government to pay, cemented their position at the centre of British public borrowing throughout the period from 1800 to 1913, as can be seen illustrated in Figure 1.

All of these important developments from the late seventeenth to the mid-eighteenth centuries — particularly the establishment of a permanent national debt for which Parliament, rather than the monarch, was responsible, the establishment of the Bank of England to manage that debt, and the development of the London Stock Exchange upon which the national debt was traded — have been collectively referred to as the British 'Financial Revolution', and facilitated Britain's rise

Figure 1. Composition of the Marketable National Debt of the United Kingdom, 1800-1913



Source: Ellison and Scott (2020).
Note: 'Other' bonds include the 'New 3.5% annuities' in circulation between 1853 and 1893, '2.75% annuities' which entered circulation in 1885, '2.75% War Stock and War Bonds' which were issued in 1900 and redeemed in 1910, the '2.5% Annuities' which entered circulation in 1853 (not to be confused with the more widespread 2.5% consols which came into circulation after 1903), and '2.75% Exchequer Bonds', which were issued by Chancellor of the Exchequer William Gladstone in 1850s (Hawkins 1983). For the sake of simplicity, Irish government bonds and non-marketable national debt held by companies closely associated with the government, such as the Bank of England, the East India Company, and the South Sea Company, are not included.

to the position of the world's leading industrial and imperial power by the early nineteenth century (Sherratt 2021, 1-9; Dickson 1967; Roseveare 1991). In contrast with this flurry of significant innovations in the late seventeenth and eighteenth centuries, the institutional arrangements of Britain's national debt market experienced a period of relative stability and consistency throughout the period from 1800 to 1913.

To the extent that significant changes in the makeup of Britain's national debt did occur during the nineteenth century, these tended to take the form of further pushes toward consolidation into an even smaller number of simpler, cheaper perpetuities. Most notably, the National Debt Conversion Act of 1888 (51 & 52 Vict. c.2) accomplished the impressive feat of converting almost all the three per cent consols down to 2¾ per cent, with a further reduction to 2½ per cent following in 1903 (Harley 1976; Kynaston 2017, 220; Slater 2018, 113). This conversion was accomplished differently for the three different kinds of three per cent perpetuities in circulation. Holders of the 'New Threes' introduced in 1855 were informed that these would be automatically converted into the new 2¾ per cent consols unless they explicitly opted out, which they were only given ten days to do, in which case their bonds would be redeemed at a time of the Treasury's choosing prior to August 1888. Few dissenters chose to opt out of this conversion, and of a total of £166 million of New Threes which were in circulation, only £761,000 were redeemed (Wormell 2000, 17; Miller 1890, 443/4). In contrast, holders of the older three per cent consols and three per cent reduced were induced to opt in to the conversion, with a commission of 1*s*. 6*d*. per £100 being offered to authorised agents in exchange for bonds rendered for conversion, and a further bonus of 0.25 per cent on their principal to be paid in cash to those willing to forgo their usual right to a year's notice before their bonds could be redeemed, in favour of immediate conversion to 2¾ per cent (Goschen 1888, Column 726; Miller 1890, 441; Checkland 1957, 271). In the case of the 1888 conversion, as with many of the other British national debt conversions between the years of 1800 and 1913, the compliance of bondholders was also aided significantly by the high demand for British government debt at the time; the three per cent consols were changing hands on the private market for more than their face value in the years preceding the 1888 conversion (Miller 1890, 439-443; Checkland 1957, 271) As a result, by early November of 1888, only £42 million worth of the three per cent consols and three per cent reduced remained unconverted, of the approximately £427 million which had been in circulation seven months prior. Provisions were made for the redemption of the remaining unconverted three per cent perpetuities by the passage of The National Debt Redemption Act (52 Vict., c.4) on 11th April 1889, which gave holders until October of that year to present their bonds for redemption, or else they would be automatically converted to 2¾ per cent. Ultimately, the Treasury was only required to redeem £19 million of the £593 million worth of three per cent bonds which had been in circulation in March of 1888, with the rest having been successfully converted (Wormell 2000, 17-19; Miller 1890, 444-447).

The latter half of the nineteenth century also saw the addition of two new non-permanent instruments to the national debt. Exchequer Bonds (not to be confused with the aforementioned Exchequer Bills introduced in 1696) had first been issued in 1854 by Chancellor of the Exchequer William Gladstone, and had a term to maturity of 40 years, paying 2¾ per cent for the first ten years, and then 2½ per cent for the next 30, although the Exchequer Bills and Bonds Act of 1866 (29 and 30 Vict. c.25) later reduced the term to maturity of most future Exchequer Bond issues to six years (Wormell 1999, xxvii; Hawkins 1983, 293). Perhaps the most noteworthy issue of Exchequer Bonds between the year of 1800 and 1913 was the £30 million 2¾ per cent National War Loan issued in 1910, which had a term to maturity of ten years (Wormell 1999, xxix; Ellison and Scott 2020, 230). Treasury Bills were then introduced in 1877, which had a maximum term to maturity of twelve months, and these came to eclipse the earlier Exchequer Bills as the government's preferred short-term debt instrument (Wormell 1999, xxvii). One advantage of Exchequer Bonds and Treasury Bills compared to other marketable government debt instruments was that they were bearer instruments, meaning that transfer of ownership simply involved the handing of the piece of paper upon which the bond was printed from seller to buyer. In contrast, the owners of consols were recorded in 'Books' kept at the Banks of England and Ireland prior to 1912, and transfer of ownership generally required the buyer and seller to appear in person at one of the Banks to sign the Books and record the transfer (Wormell 1999, xxxix).[30] By the nineteenth century, however, non-perpetual bonds they were generally only issued by the government in times of crisis, and short-term debt instruments such as Exchequer Bills and Treasury Bills accounted for less than

[30] "Consols could also be held as 'Stock Certificates to bearer'. These differed little from bearer Bonds" (Wormell 1999, xl).

4 per cent of the total national debt, on average, between the years of 1801 and 1914 (Ferguson 2001, 112).

All of these various instruments which comprised Britain's national debt between the years of 1800 and 1913 were grouped into four categories: funded debt, unfunded debt, terminable annuities, and other capital liabilities. The 'funded debt', which made up by far the largest share of the total national debt, consisted of perpetual annuities, including marketable perpetuities such as consols, and the unmarketable debt held by the Bank of England, South Sea Company, and the Bank of Ireland. The 'unfunded debt' consisted of non-perpetual securities, for which the government was liable to pay back the face value at the specified maturity date, in addition to its interest payments. These included the aforementioned Exchequer Bills, Treasury Bills, and Exchequer Bonds. The 'Terminable Annuities', whose introduction in 1863 was previously discussed, were categorised separately from both funded and unfunded debt, and legally required the repayment of their capital on the specified date with no option for the loan to be renewed into a new bond, as was possible with the unfunded debt instruments (Wormell 1999, xxviii; Needham 2020). Finally, 'other capital liabilities' mainly consisted of advances to government departments by the Commissioners for the Reduction of the National Debt,[31] which were typically put toward the construction of public buildings, military facilities, coastguard stations, dockyards, and other government building projects (Wormell 1999, xxix).

Following the various consolidations of Britain's national debt down to a smaller handful of bonds which were managed by the Bank of England and freely traded on the London Stock Exchange (Brown and Easton 1989), the necessity for large companies other than the Bank of England to manage the national debt was diminished. By the latter part of the eighteenth century,

[31] The Commissioners for the Reduction of the National Debt were established by the National Debt Reduction Act of 1786 (26 Geo. 3. c.31), and administered a number of public funds (Wormell 2000, 4). These included the controversial Sinking Fund, which aimed to reduce the national debt by investing tax revenues (Bordo and White 1991, 309-312; Signorino 2016; Wormell 2000, 6-7; Hargreaves 1930, 22-23).

the share of the national debt held by the East India Company was comparatively modest; it had lent £4.2 million in total to the government at three per cent over the course of the previous century, but had also been allowed to re-borrow £2.9 million back from the government at the same three per cent. In 1793, the remainder of the three per cent debt owed to the East India Company was simply "transmuted" into three per cent reduced consols of an equivalent total nominal value, and the company ceased to have any role in the management of the national debt, before it was eventually nationalised following the Indian Rebellion of 1857, and finally dissolved in 1874 (Wright 1997, 659). The South Sea Company retained its role in the management of the national debt for slightly longer, but its practical significance in this regard was significantly reduced by the 1751 consolidation. Following the Seven Years War of 1756-63, the company diverted its attention away from attempting to establish trade with South America and narrowed its focus to simply passing on the interest payments it received from its share of the national debt to its shareholders. These interest payments were set at the same 3 per cent its shareholders would have received if they had simply invested in consols, and in 1853 the South Sea Company was dissolved by the government, and its share of the national debt was consolidated (Needham 2020; Slater 2018, 43-53). As a result, the Bank of England had, by the mid-nineteenth century, gained precedence as by far the most significant institution responsible for managing the national debt.

The simplicity and transparency which characterised this system by the early nineteenth century, particularly in comparison with the financial systems of other major European powers at the time, has often been praised as one of its strengths (Ferguson 2001, 112; Bordo and White 1991, 309-310; Chadha & Newby 2013, 13/14; Slater 2018, 62). The free trading of consols and other British government bonds on the London money market, once they had entered circulation, exemplified the relatively open and democratic quality of the market for Britain's national debt. This trade was centred around the London Stock Exchange, which specialised exclusively in the trading of British public funds prior to 1822 (Michie 1999, 32, 54).[32] The trading of foreign stocks within the Exchange was permitted from 1822 onwards, with trade in joint-stock companies not related to the government following shortly thereafter in 1825, partly as a result of the pressure felt by the Stock Exchange to accommodate the increasing speculation in foreign stocks and the shares of newly-formed joint-stock companies in the mania preceding the Panic of 1825 (Michie 1999, 56; Dawson 1990; Neal 1998, 64; Neal and Davis 2006, 285-9; Quinn and Turner 2020, 39-57). However, even as late as 1840, close to 90 per cent of the securities which changed hands on the London Stock Exchange had been issued by the British government, with much of the remaining trade being in the stock of companies closely tied to the government, such as the Bank of England, the South Sea Company and the East India Company (Sherratt 2021, 3).[33] The direct participants in this market were a community of several hundred individuals and firms (Michie 1999, 50/1, 68) which operated on the Exchange as brokers, bankers, and merchants; the modern distinctions between these various roles had yet to ossify by the beginning of the nineteenth century, and the members of the Exchange consequently tended to function in multiple overlapping capacities (Sherratt 2021, 63). One distinct role which had emerged, however, was the figure of the

[32] The founding of the London Stock Exchange as a formally organised institution is usually dated to coincide with the establishment of its Subscription Room on 3rd March 1801, but the Stock Exchange building had already existed since 12th July 1773 as one of several locations where securities trading took place in the City of London. The earliest emergence of the London Stock Exchange as an informal institution can arguably be dated back to the 1690s, when it began developing as a loose collection of securities traders conducting their business in the alleys and coffee houses adjacent to the Royal Exchange (Michie 1999, 20-35; Smith 1929, 206; Sherratt 2021, 3). The London Stock Exchange had arguably already become the most significant market in London for the trading of the national debt by 1820, and in 1834 the Rotunda of the Bank of England, which had previously been its closest competition as a location for this activity, closed its doors to securities traders (Michie 1999, 44-46).

[33] While trading of consols and other British government bonds constituted a major part of the business at the London Stock Exchange, especially throughout the first half of the nineteenth century, a more diverse selection of private sector bonds, equities, commercial bills, commodities, and so forth were traded at other locations, such as the nearby Royal Exchange, the Dublin Stock Exchange, and the various provincial stock exchanges throughout the country (Michie 1999, 61-3; Ferguson 2001, 112; Killick and Thomas 1970). It should also be noted that the variety of different kinds of stocks on the London Stock Exchange grew over the course of the first half of the nineteenth century, due to a variety of factors including the surge of speculation in the railway industry in the 1840s (Michie 1999, 63; Odlyzko 2010; Quinn and Turner 2020, 58-76). Between the years of 1817 and 1850, the nominal value of the total number of shares quoted on the London Stock Exchange rose by approximately 50 per cent, with the majority of this increase being attributable to shares in foreign and domestic banks, canals, railways, and other utilities (Killick and Thomas 1970, 97). By the middle of the century, the National Debt had shrunk to 70 per cent of the securities quoted on the Exchange (Michie 1999, 64).

stockbroker or 'stock jobber', sufficiently established even by the start of the eighteenth century to already have its own widely-recognised standard rate for commissions (Smith 1929, 207).[34] In the first few years after the establishment of its Subscription Room in 1801, relatively few restrictions were placed on who could become a member of the London Stock Exchange, with the primary requirements being a general reputation for trustworthiness and a willingness to pay the 10 guineas per year subscription fee. As early as 1811, however, membership was being denied to anyone who was not a full-time stockbroker or jobber, with the additional requirement that any partner of a member must also become a member of the Exchange and adhere to its rules, a policy which encouraged further specialisation and helped to spread the regulating influence of the London Stock Exchange throughout the formerly unruly London securities market (Michie 1999, 35-40). Despite the restrictions on its membership, however, more-or-less any private investor was at liberty to invest in the national debt by employing the services of a stockbroker, and to do so in a market which arguably exhibited a degree of efficiency comparable to late twentieth century capital markets (Brown and Easton 1989).[35]

By 1850, the London Stock Exchange had become the largest and most important stock market in the world, and remained so until 1914, despite the growth of the American and German economies by that time. Its position had been bolstered by advancements in communications technology in the late nineteenth century, which helped to integrate national markets and contributed to the growth of an international financial market with London at its centre (Michie 1999, 70-75; Mollan and Michie 2012, 538-540; Roberts 1992, 115-151). Although it did not reach its greatest territorial extent until after the First World War, the power and influence of the British

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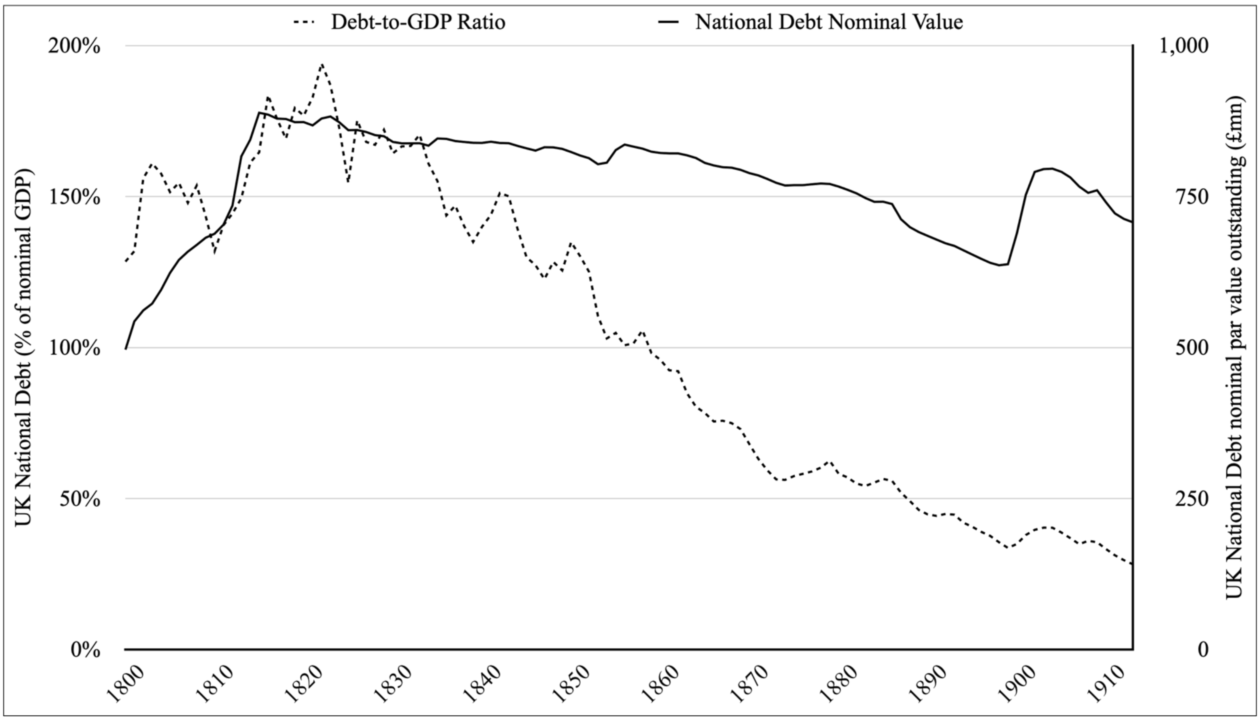
[34] By the early nineteenth century, it was customary for stockbrokers on the London Stock Exchange to charge ⅛ per cent as their rate of commission (Michie 1999, 42).

[35] The study cited here specifically assessed the weak-form efficiency of the market for three per cent consols between the years of 1821 and 1860, and found it to be equivalent to contemporary markets at their time of writing, due in part to the low taxes, low brokerage costs, and six-day trading week which characterised this market (Brown and Easton 1989, 68).

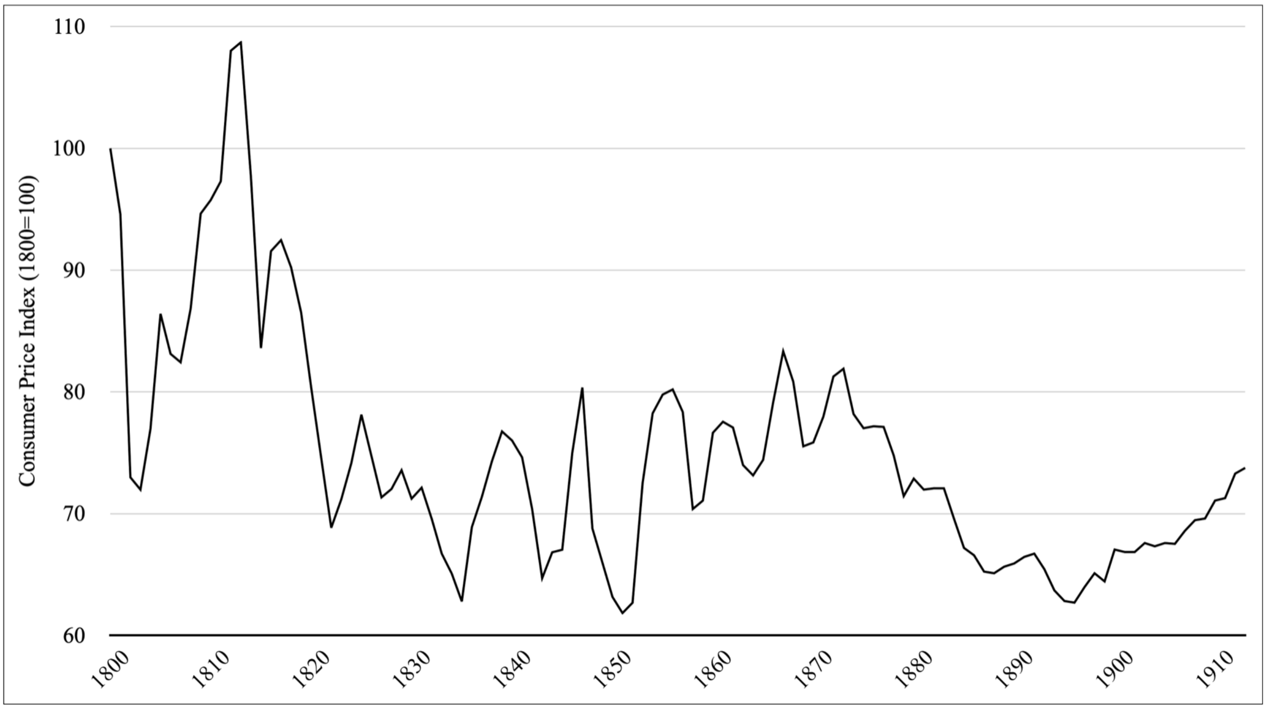
Empire was also arguably at its peak between the years of 1850 to 1913, and the financial influence of London was further reinforced by its central role in providing credit to Britain's many colonies, although different colonies were not able to access this credit on equal terms (Accominotti et al. 2008; Accominotti et al. 2009). For investors at home, these years were characterised by growth in the number and variety of stocks which changed hands on the London Stock Exchange: by 1913, more than 5,000 different securities were quoted on the Exchange, up from fewer than 500 in 1853 (Michie 1999, 95). The number of private investors to be found amongst the British public likewise grew significantly in these years: 0.8 per cent of the population had held securities in 1870, but by 1913 that had risen to 2.2 per cent, and approximately a quarter of the total number of shares in existence worldwide were being held by British investors in 1913, with the average British investor holding between seven and eight different securities in 1910. Not only the number but also the variety of different financial assets available on the London Stock Exchange had grown steadily since the mid-nineteenth century; the share of foreign assets had grown from 8 per cent to 28 per cent between the years of 1850 and 1913, and the trading of shares and debentures belonging to foreign and domestic commercial and industrial companies had also grown significantly (Ibid., 71/2). In particular, foreign and domestic railway stocks, foreign government bonds, and domestic corporate securities all grew in terms of the share of the total trade on the Stock Exchange (Ibid., 90-95). This growth in the variety of different securities sought by investors coincided with a relative decline of the dominance of consols as the central asset of the British financial system. In 1850, the nominal value of the outstanding debt had been equivalent to 21 per cent of the total wealth of the nation, but this had declined to just 4 per cent by 1913, and British government securities went from comprising over 70 per cent of the total nominal value of the securities quoted on the London Stock Exchange in 1853, to less than 11 per cent in 1913 (Ibid., 87-89). Naturally, this was largely a result of the growth of the broader economy during this period, but the total outstanding value of the national debt did also decline, as can be seen illustrated in Figure 2.

Figure 2. UK National Debt Nominal Value and Debt-to-GDP Ratio, 1800-1913



Source: Thomas and Dimsdale (2017, SheetA1, Columns BU and BV)

Figure 3. UK Consumer Price Index, 1800-1913



Source: Thomas and Dimsdale (2017 Sheet A1, Column AO)

Nevertheless, consols retained a significant place as one of the key assets in the British economy throughout the period from 1800 to 1913.

While it was true that British government bonds were freely traded by the members of the London Stock Exchange, after they had first been issued by the Bank of England, the open and democratic qualities for which this system has sometimes been praised (Ferguson 2001, 112; Bordo and White 1991, 309-310; Chadha & Newby 2013, 13/14; Slater 2018, 62) were a relative rather than an absolute virtue of the market for Britain's national debt in the years between 1800 and 1913. It was true in theory that the Bank of England offered newly issued government bonds for sale to the public at large, but in practice the Bank often found it more convenient to sell the bulk of its new issues to 'loan contractors' who acted as middlemen, selling the bonds on to individual investors at a higher price. This arrangement was often very profitable for the loan contractors, and played a significant part in building the fortunes of Barings Bank, N. M. Rothschild & Sons, and the economist David Ricardo, amongst other significant names in nineteenth century British financial history (Neal 1990, 187; Austin 2007, 11; Chapman 1982; Weatherall 2011, 67-72; Wilson 1988, 47/8). Given the extent to which the government came to rely on the loan contractors to quickly purchase large portions of newly issued government bonds, this system gave these loan contractors significant influence over the government and created incentives toward corruption. Sherratt (2021, 54-80) convincingly argues that it was not uncommon for the government and the Bank of England to coordinate with the loan contractors to spread misinformation and manipulate the stock market in such a way as to strengthen the financial position of the loan contractors, and hence benefit the government to whom they lent, at the expense of smaller investors.

The significant rise in government borrowing and expenditure over the course of the eighteenth and early nineteenth centuries did not only serve to benefit the loan contractors, however, and exerted a significant impact on Britain's financial system as a whole. The ever greater numbers of government bonds entering the hands of investors prior to 1815 amplified the significance of the London money market to the economy as a whole. Many investors were able to take advantage of these long-term annuities as short-term investments thanks to the high liquidity of these assets, and the trade on the London Stock Exchange became so brisk that some contemporary observers remarked that the national debt had almost gained the characteristics of a medium of exchange (Michie 1999, 52). Needless to say, the general expansion of the economy during the ongoing Industrial Revolution, and consequent increase in private demand for banking services, amplified this expansion of Britain's financial system. The chief reason for this expansion of government borrowing was the necessity to finance the series of costly wars in which Britain was engaged throughout the eighteenth century and the beginning of the nineteenth century, including the War of Austrian Succession of 1740 to 1749, the Seven Years War of 1756 to 1764, the American Revolutionary War of 1775 to 1786, and Britain's ongoing conflicts with revolutionary and Napoleonic France from 1793 to 1815 (Ellison and Scott 2020, 239). Cumulatively, these conflicts had caused Britain's government debt to balloon to £889 million by the end of 1815 (Thomas and Dimsdale 2017, Sheet A1, Column BU), as much as 250 per cent of GDP by some estimates (Needham 2020). In addition to funding its own military operations, the British government also borrowed considerable amounts each year to subsidise the war efforts of allied countries which were unable to attract lenders as easily (C. P. H. 1931). Due in part to this high level of borrowing, the perceived credibility and creditworthiness of the British government declined significantly in the eyes of lenders over the course of these costly military campaigns. This perception was not helped when excessive printing of bank notes and consequent specie outflows forced the government to allow the Bank of England to suspend the convertibility of its Bank notes into gold on the 27th of February 1797, a suspension which was initially intended to last only three weeks, but ultimately lasted until the 1st of May 1821 (Duryea 2010, 12). As a result of its declining creditworthiness, the British government found itself having to borrow money on terms which were much less favourable to itself, and much more favourable to the growing field of private banks, loan contractors, and ultimately private investors tasked with raising the money. The extent to which this unfavourable development for the British government created profitable opportunities for the participants in Britain's financial system is illustrated by the fact that, between the years of 1793 and 1816, the government had to place loans totalling £911 million in order to raise a mere £590 million for itself, with the remaining £321 million going to private bankers in the form of discounts and commissions (Born 1983, 35). The suspension of gold convertibility between 1797 and 1821 also created the conditions for "an more-or-less continuous credit expansion from 1797 to 1815", which likewise stoked the growth of Britain's financial system by the start of the nineteenth century (Pressnell 1956, 8).

Over the course of the century following the conclusion of the Napoleonic Wars, and Britain's consequent rise to the position of the world's leading military power, the British government was involved with significantly fewer major wars than it had been during the turbulent eighteenth century, and consequently suffered from relatively less pressure to borrow (Wormell 2000, 3). Circumstances which required exceptional government borrowing did continue to occasionally arise, such as the borrowing of £20 million to compensate slave owners on the abolition of slavery in 1833 (Anson and Bennett, 4; Gross 1980, 73), £8 million to relieve the famine in Ireland in the 1840s (Kanter 2012, 1130), over £30 million to fund Britain's involvement in the Crimean War of 1853-56 (Anderson 1963, 318), and £10 million to fund the nationalisation of Britain's telegraph industry in 1868 (Perry 1997, 424). However, these expenses were relatively minor compared with Britain's eighteenth century wars. The addition of £150 million to the national debt during the Second Boer War of 1899 to 1902 proved to be the exception to this rule, foreshadowing the significant expansions of the national debt which would fund the total wars of the twentieth century (Kynaston 2017, 245-247; Yakutiel 1989, 246; Slater 2018, 98-112). However, the relative peace and prosperity Britain enjoyed throughout much of the period from 1815 to 1913 was accompanied by significant declines in the national debt as a percentage of GDP, as can be seen in Figure 2, from from a peak of 194 per cent in 1822 down to 28 per cent in 1913.[36] Needless to say, this was partly a result of the significant growth of the economy amidst the ongoing Industrial Revolution; by some estimates, Britain's GDP was more than 6.5 times larger by 1913 than it had been in 1815 (Thomas and Dimsdale 2017, Chart A1, Column F). However, the national debt did also decline in absolute terms, from around £889 million at the end of 1815 to around £707 million by the end of 1813 (Ibid. Chart A1, Columns BU and BV). The interest and management costs of the debt to the government were also declining to some degree by the end the nineteenth century, and while these rose in absolute terms as a result of the need for borrowing during the Second Boer War (1899-1902), they continued to decline as a percentage of total government expenditure, due in part to the rise in expenditure related to that war and the early development of the welfare state in Britain prior to the First World War (Wormell 1999, xxvi; Boyer 2018, 195; Lee 2012, 55-59).[37]

1800 to 1913: Key Developments and Subdivision into Different Periods

While the primary goal of the next chapter is to assess the relationship between the term structure of interest rates and the business cycle between the years of 1800 and 1913, it may be useful to subdivide that long timeframe into a number of different sub-periods, to reflect relevant changes in economic factors and institutional arrangements and assess how they might affect the

[36] The time lag between the conclusion of hostilities in 1815 and the 1822 peak of Britain's national debt as a percentage of GDP was the result of a number of factors, including the implementation of politically motivated tax cuts shortly after the end of the war, which resulted in a post-war deficit (Slater 2018, 90). Expectations of a return to the gold standard after the war also resulted in a period of deflation between 1817 and 1822, which was accompanied by a recession in 1818 and 1819 (Broadberry, Chadha, Lennard, and Thomas 2022, 73-74).

[37] The interest and management cost of the national debt was £23.5 million in 1874/5, 32 per cent of central government spending. This fell to £17.6 million (15 per cent) by 1898/9, rose to £22.2 million (12 per cent) in the aftermath of the Boer war in 1902/3, before falling again to £18.7 million (9 per cent) by 1913/14 (Wormell 1999, xxvi).

topic under consideration. The first such period which suggests itself would be the years between 1800 and 1821, during which time the convertibility of the pound into gold was suspended. This was a period characterised by the economic uncertainty of war, a rapid growth in the number of small, note issuing country banks, wide swings in price levels, and a high and growing government debt-to-GDP ratio, as illustrated by Figures 2 and 3. These factors all indicate a relative lack of credibility in the monetary regime at the time, a fact which might lead us to expect that the predictive relationship between the term structure of interest rates and the business cycle was particularly strong during this early period, according to the insights of previous authors such as Bordo and Haubrich (2004), and Baltzer and Kling (2007). The period of suspension also coincided with the Bullionist controversy, a loose and overlapping series of ongoing debates concerning the desirability of resuming the convertibility of the pound into gold, involving numerous important economic thinkers of the time, including David Ricardo, James Mill, and Henry Thornton (see Laidler 2000).

Following the passage of the Resumption of Cash Payments Act of 1819 (59 Geo. 3., c.49),[38] which established the timeframe and process for the resumption of the pound's convertibility into gold, and the eventual resumption of gold payments in May of 1821, Parliament also passed the Negotiation of Notes and Bills Act of 1822 (3 Geo. IV., c. 70),[39] which amended the timeframe set out by the former law, pushing back the date at which new issues of banknote denominations of less than £5 would be prohibited in England from 1823 to 1833. This decision was later argued to have caused an almost immediate £4 million increase in the circulation of small denomination notes (Duncan 1857, 112), followed by a more general growth in the supply of money and credit. This in turn stimulated a speculative boom which eventually culminated in the Panic of 1825, arguably Britain's most severe economic crisis of the first half of the nineteenth century, and

[38] This law is often referred to as 'Peel's Bill'.

[39] This law is often referred to as 'the Small Notes Act'.

the most severe banking crisis Britain would experience until 2007 (Turner 2014, 66; Kynaston 2017, 119). Given the increases in the circulation of country bank notes prior to the Panic (Coppieters 1955, 154; Turner 2014, 69) and the particular susceptibility of the country banks to runs due to their minimal gold reserves (Barclay 1978, 10), it was argued at the time that the large number of small, note-issuing country banks was partly to blame for the crisis (Hickson and Turner 2004, 914; Cramp 1962, 102; Andréadès 1909, 255). As a result, the government of Lord Liverpool was able to successfully pass the Country Bankers Act of 1826 (7 Geo. 4., c.6), which partly repealed the Bank of England Act of 1708 (7 Ann. c.30) by permitting the establishment of unlimited liability joint-stock banks throughout England and Wales.[40] The later Bank of England Privileges Act of 1833 (3 & 4 Will. 4, c.98) clarified that joint-stock banks could be established within a 65 mile radius of London, an area within which the Bank of England had formerly maintained a monopoly on joint-stock banking, provided they did not issue their own bank notes (Turner 2014, 38; Mathias 1983, 321). This legislative change contributed to an increasing concentration of Britain's banking activity in London, which was ongoing throughout the remainder of the period before 1913 (Michie 1999, 66). The 1826 law also permitted the Bank of England to establish branches of its own in any part of England, allowing the Bank to begin competing with the discount houses and correspondent city banks by facilitating the flow of credit and its own notes into the provinces (Fletcher 1976, 13-14; Mathias 1983, 151). This was followed by the granting of legal tender status to Bank of England notes in 1834 (Born 1983, 7). Another significant legal change in this period was the 1825 repeal of the Bubble Act of 1720 (6 Geo. 1., c.18), which had

[40] In addition to lifting the six partner limit, the 1826 law also permitted the trading of the shares of the newly-formed joint-stock banks, which had not previously been possible. However, certain restrictions on this trade remained, with sellers of bank shares remaining liable for the bank's debt for up to three years after the sale of their shares, and transfer of shares generally requiring the authorisation of the bank's directors. Hickson and Turner argue that such restrictions created incentives for a bank's shares to remain concentrated in the hands of a relatively small group of individuals, and limited the incentives for banks to dilute the value of their shares by excessive issues of new shares (Hickson and Turner 2004, 914).

forbidden the formation of any new joint-stock companies without permission from Parliament (Michie 1999, 17).[41]

The severe Panic of 1825 and its legislative aftermath led to a slow decline in the number of 'private' banks during what we could consider the second period of our broader timeframe, from 1821 to 1844, while the reach and influence of the Bank of England and the new, larger joint-stock banks grew. By 1836, just ten years after their establishment had been legally permitted, over 100 joint-stock banks existed throughout England and Wales, many of which had previously been private banks (Turner 2014, 39; Crouzet 1982, 323). Indeed, some estimates suggest that these banks exceeded the dwindling number of smaller private banks as early as 1838 (Mathias 1983, 322; Crouzet 1982, 323).[42] By 1844, five joint-stock banks had even taken advantage of the 1833 law which permitted them to establish themselves in London, although their integration into the London money market was not without opposition. In reaction to this incursion into what had formerly been its monopoly territory, the Bank of England refused to extend credit or its rediscounting services to these new London joint-stock banks, and all the new joint-stock banks were refused membership in the London Bankers Clearing House until 1854 (Levi 1872, 206/7; Arch 2021, 28). Nevertheless, the new joint-stock banks were able to secure their existence thanks in part to the larger number of partners they were legally permitted to have, which enabled them to accumulate larger stocks of capital more quickly, and in part due to their willingness to offer higher interest rates to depositors and discount bills from less creditworthy borrowers, while maintaining lower reserves (Fletcher 1976, 12; Mathias 1983, 322). This growth in the number and activity of

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[41] It was also in 1826 that the ancient practice of accounting for loans to the government using wooden tally sticks came to an end, with the tallies being phased out in favour of paper debt instruments. Having been taken out of circulation, the tally sticks were stored in the Houses of Parliament until 1834, when the decision was made to dispose of them in the furnaces under the House of Lords, which consequently overheated and caused a fire which burned the Houses of Parliament to the ground (Shenton 2012; Apostolou and Crumbley 2008, 61).

[42] Hunt (1935, 345) offers the more conservative estimate that there were still 321 non-joint-stock private banks in existence by 1841, down from 521 in 1821, compared with 115 joint-stock banks in 1841.

joint-stock banks seems to have been followed by significant credit expansion from 1834-37 and again from 1838-39, as seen in increases in the circulation of bills of exchange during those periods (Newmarch 1851, 160; Williams 2017), followed by two economic crises in 1836 and 1839 (Crouzet 1982, 324; Turner 2014- 71-72).

This economic upheaval ignited a significant public debate concerning whether or not explicitly defined limits should be placed on the ability of the rapidly evolving banking system to create new money. This debate, which continued certain themes from the Bullionist controversy of the 1810s (Crouzet 1982, 324), was waged between the so called Banking and Currency schools. The Currency School, amongst whose chief proponents was banker and politician Lord Overstone, was chiefly concerned with maintaining the stability of the currency. To this end, it advocated the separation of the Bank of England's money creation function from its other roles, and the establishment of an explicit, widely-understood rule concerning the minimum quantity of gold the Bank would be required to keep in its reserves as backing for a given quantity of Bank note issues (Goodhart and Jensen 2015, 2-4; Crouzet 1982, 325). In contrast, the Banking School, whose chief advocate was the banker and economist Thomas Tooke, advocated for a discretionary policy whereby the Bank of England would be at liberty to alter the quantity of its bank notes in circulation in such a way as to best accommodate business demand (Crouzet 1982, 325; Rothbard 1995, 243-5). Both sides generally agreed that the power to issue bank notes should be monopolised by the Bank of England (Crouzet 1982, 324/5). Ultimately, the government of Sir Robert Peel was persuaded by the Currency School view that the recent financial instability had been a result of excessive issues of bank notes, and responded by passing of the Bank Charter Act of 1844 (7 & 8 Vict. c.32). This highly important piece of legislation limited the Bank of England's note issues to £14 million of 'uncovered' notes, after which any additional Bank note issues would be required to be backed by a 100 per cent bullion reserve. This restriction only applied to the Bank's creation of physical bank notes and did not restrict the component of the money supply made up by deposits, which had been a comparatively small part of the British money supply prior to 1826 (Selgin 1992, 184). The 1844 Act also put in place measures to promote the gradual development of a Bank of England monopoly on note issues, forbidding any new or existing bank from beginning to issue notes, and encouraging existing banks to cease their issues (Crouzet 1982, 326). In this way, the Bank Charter Act of 1844 accelerated the decline in the circulation of non-Bank of England notes in England, and the general demise of the country banking system, a development which was hastened along by the rapid development of railway infrastructure during the same period, which deepened the interconnectedness of Britain's internal markets and diminished the reliance of provincial businesses on tiny local banks (Pressnell 1956, 2). The changing proportions of Bank of England notes to private bank notes in circulation after 1844 starkly illustrate this trend: in 1850 there were three Bank notes in circulation for every one non-Bank note, already a rise from the roughly 1:1 ratio which had prevailed in 1826 (Turner 2014, 68; Coppieters 1955, 154). However, in the aftermath of the 1844 Bank Charter Act this ratio rose to 9:1 by 1880, and to 27:1 by 1901. By 1881, only 151 private banks continued to issue their own notes, of which only 60 remained by 1901. The final note issuing private bank in England and Wales, Fox, Fowler and Co. of Wellington, Somerset, ceased issuing its own bank notes in 1921 when it was taken over by Lloyds Bank (Born 1983, 8).

The 1844 Bank Charter Act technically remained in place until the convertibility of the pound into gold was finally suspended due to Britain's entry into the First World War in August of 1914. In reality, the restriction concerning the quantity of bullion reserves the Bank had to keep to back its notes was suspended during the crises of 1847, 1857 and 1866 to permit the Bank to extend credit to the banking system during these periods of distress (Smith 2003, 55). However, the 1844 Act remained important despite this fact, as it signalled to the market that the government was unlikely to directly interfere with the money supply to a significant extent, and meant increases in Britain's money supply were relatively limited during the latter half of the nineteenth century compared with other major economies (Crouzet 1982, 327/8; Born 1983, 9). The separation of the Bank's note issuing and bill discounting branches after 1844 also led the Bank to more actively utilise variations in its discount rate as a tool both for influencing the availability of credit throughout the banking system and for attracting private borrowers in such a way as to procure profits for its shareholders. Indeed, the Bank began vigorously pursuing discount business almost as soon as the new law was passed, cutting its discount rate to a historic low of 2.5 per cent in September of 1844, which was well below market rates at the time. This encouraged similar rate cuts amongst the private banks, setting in motion a credit expansion and speculative boom which culminated in the Panic of 1847 (Mathias 1983, 327; Kynaston 2017, 143-145; Fletcher 1976, 15; Turner 2014, 73). In the years after the Bank Charter Act of 1844 the British financial system continued its slow drift toward a more recognisably modern form, while the broader economy saw a shift toward greater free trade, exemplified by the abolition of the Corn Laws in 1846 (Schonhardt-Bailey 2006). The provision of banking services continued to concentrate in the hands of a smaller number of larger firms, during these years. The Joint Stock Banks Act of 1858 (21 & 22 Vict., c.90) permitted joint-stock banks to be formed on the basis of limited liability, an option which was taken by Barclays in 1862 and Lloyds in 1865, although a broader shift to limited liability did not occur until confidence in unlimited liability banking was shaken by the collapse of the City of Glasgow Bank in 1878 (Mathias 1983, 323; Acheson and Turner 2008a). The British economy also experienced arguably its most severe crisis since 1825 in this period, in the form of the Panic of 1866, during which the largest of the discount houses, Overend, Gurney & Co., collapsed (Fletcher 1976, 23; Sowerbutts et al. 2016).

Several significant developments from the 1870 onwards suggest that the period from 1870 to 1913 could be regarded as its own distinct sub-period for the purposes of this thesis. The year 1870 has been pointed to as the beginning of the amalgamation movement in England and Wales, which saw a dramatic fall in the number of banks throughout the country as the largest joint-stock banks sought to absorb their competitors while expanding their own branch networks (Mathias 1983, 323). This movement saw the emergence of a 'Big Five' of dominant joint-stock banks by the end of the century: Barclays Bank, Lloyds Bank, London Joint City and Midland Bank, London County Westminster and Parr's Bank, and National Provincial and Union Bank of England (Capie and Rodrik-Bali 1982; Turner 2014, 42-43). The process of amalgamation was already underway by the early 1880s, at which time there were more than 120 joint-stock and 200 private banks throughout England and Wales, with the joint-stock banks holding more than half of the nations' deposits. However, by 1918 this number had fallen to 16 joint-stock banks and only six remaining private banks, with Lloyds alone having absorbed 164 different banks by 1923. As early as 1915, 40 per cent of deposits in the UK were held by the 'Big Five' joint-stock banks, rising to as much as 80 per cent by 1923. The very last country bank, Gunner & Co. of Hampshire, was finally absorbed by Barclays in 1953, but country banks had become rare enough to be regarded as anachronistic curiosities as early as 1900 (Turner 2014, 41-46; Mathias 1983, 323; Grossman 1999, 323/4).

In addition to this concentration of banking activity, the period after 1870 saw the Bank of England increasingly adopt the characteristics of a modern central bank. A series of influential writings by Walter Bagehot following the Panic of 1866, culminating in the publication of *Lombard Street* in 1873, are often cited as having influenced the Bank once and for all toward an unambiguous understanding of itself as a public institution with an obligation to act as lender of last resort and otherwise support the banking system, rather than merely acting in the interest of its shareholders (Bignon et al. 2012, 582; Grant 2019, 266-280; Schneider 2022, 595-597). The commitment of the Bank to its responsibility to act as lender of last resort was tested by the Panic of 1890, during which the major London accepting house Baring Brothers and Company came close to collapse as a result of the default of the government of Argentina on loans underwritten by Barings. A broader panic throughout the British banking system was averted when the Bank of England organised a consortium — which included the Bank of France, the State Bank of the Russian Empire, and a large group of London financial institutions led by N. M. Rothschild & Sons — to pool £17.3 million, which enabled Barings to meet its obligations and avoid collapse (Austin 2007, 191-193; Mitchener and Weidenmier 2008, 464-467). This effective bank rescue, and the lack of any other major British bank failure between the years of 1878 and 2007 (Acheson and Turner 2008a, 235), tends to suggest a growing effectiveness in the toolset of the Bank of England for maintaining the stability of the British financial system during the period from 1870-1913. From 1873 onwards, the Bank also began conducting open market operations as a matter of routine, although these had also occasionally been used in the early nineteenth century as a tool for constricting the supply of money and credit when the Bank Rate was already at its maximum legal limit (Capie et al. 1994, 129). This represented a significant modernisation of its approach to expanding and contracting the availability of liquidity and credit in the economy, although adjustment of the Bank rate remained its primary tool for effecting monetary policy until after the First World War (Crouzet 1982, 329; Davutyan and Parke 1995, 1101).

As a result of these developments, the familiar phenomenon of the banking panic, which had so regularly struck the British economy throughout the late eighteenth and early nineteenth centuries, largely became a thing of the past. After the run on Overend, Gurney & Co. during the Panic of 1866, no other full-scale bank run occurred in Britain for over 140 years, until the run on

Northern Rock in 2007 (Gilbert and Wood 1986, 5-8; Crouzet 1982, 329).[43] Of course this drought of bank runs does not imply that economic crises as a whole ceased, as can be seen in the banking crisis of 1878 (Collins 1989; Turner 2014, 84-88) and the aforementioned Baring Crisis of 1890 (Mitchener and Weidenmier 2008). The British economy was also exposed to the effects of the international Panics of 1873 (Barreyre 2011) and 1907 (Bruner and Carr 2007; Rodgers and Payne 2015). However, with the exception of the 1878 and 1890 crises, these economic downturns failed to threaten to undermine the stability of the British banking system to the same extent as as those from earlier in the nineteenth century (Flandreau and Ugolini 2014, 76). Innovations in extralegal shareholder protections may have also contributed to the relative stability of British financial markets in the late nineteenth century, as compared with the earlier sub-periods outlined above, and no doubt contributed to the advantages of London as a financial centre from the perspective of investors (Campbell and Turner 2011; Acheson et al. 2019). The period from approximately 1870 to 1895 was also characterised by an ongoing secular deflation, as can be seen illustrated in Figure 3, which has led some economists to argue that there was a 'Long Depression' from 1873 to 1896 (Beales 1934; Friedlander 1992; Johannessen 2016, 89-109). However, other studies have questioned the use of the word depression to refer to this period given that, despite the deflation, Britain's national income, real wages, production, trade, and standards of living all continued to rise rapidly (Giffen 1904, 108; Marshall 1926, 99; Musson 1959, 199-201; Friedman and Schwartz 1982, Table 4.9; Saul 1985; Selgin 1997, 49-53). This period of secular deflation combines with the aforementioned modernisation and amalgamation of the banking system, not to mention the growth of international trade and the emergence of the international "Classical Gold Standard" (Bordo

[43] The last failure of a major British commercial bank prior to 2007 was the failure of the City of Glasgow Bank in 1878, although its failure was not accompanied by a bank run. The impact of the failure of this unlimited liability bank on its shareholders played a significant role in spurring the conversion of the majority of Britain's remaining unlimited liability banks to limited liability within the subsequent five year period (Acheson and Turner 2008a, 236; Goodhart and Postel-Vinay 2024; Collins 1989; Rosenbaum 1933).

1992), to characterise the years from 1870-1913 as their own distinct period within the broader timeline of 1800-1913.

This leaves us with four distinct sub-periods within the broader 1800 to 1913 timeframe, between which the results of later chapters might be compared: the period from 1800 to 1821, which was characterised by the suspension of specie payments, high government spending during the Napoleonic Wars, and a high debt-to-GDP ratio, and the transition back to a peacetime economy after 1815 (O'Brien 1989); the period from 1821 to 1844, during which specie payments were resumed and the economy adjusted to the consequent deflation and the legislative aftermath of the Panic of 1825; the period from 1844 to 1870, which followed the introduction of the Bank Charter Act of 1844, included the Panics of 1847, 1857, and 1866, and saw Britain turn toward free trade with the 1846 repeal of the Corn Laws; and finally the period from 1870 to 1913, which saw increasing amalgamation of the British banking system and a concentration of banking activity in London, a decisive adoption of the role of lender of last resort by the Bank of England, and the cementing of the City of London as the centre of an increasingly integrated international financial system.

Over the course of this chapter, an overview has been provided of the key developments in the British financial and monetary system between the years of 1800 and 1913, with particular attention to the components and markets of the national debt, the development of the powers and goals of the Bank of England, and the development of London as a financial centre. Four sub-periods have also been outlined, and a case for their meaningful distinctiveness made, between which the results of later chapters will be compared. The next chapter will now turn to the question of the extent to which a predictive relationship existed between the term structure of interest rates and future economic conditions in Britain between the years of 1800 and 1913, and how that relationship varied between the different sub-periods.

Chapter Three: The Yield Curve and the Business Cycle in Britain, 1800 - 1913

I - Data and Methodology

The goal of this chapter is to analyse the extent to which yield curve inversions reliably signalled oncoming recessions in Britain between the years of 1800 and 1913, as they seem to have done in the United States in the latter half of the twentieth century, and more generally the extent to which a positive association appears to have existed between the slope of the yield curve (i.e. the level of long-term relative to short-term interest rates) and future economic growth. A range of methodological approaches are employed in the pursuit of these goals, with the data sources used being cited alongside the presentation of the results. However, there are three data series of particular significance to the analysis of this and subsequent chapters, which therefore warrant detailed discussion in this first section of the chapter: namely, data series for long-term and short-term interest rates, which can be compared to illustrate the term structure of interest rates, and chronologies of the dates of turning points in the business cycle.

Interest Rate Data

As was discussed in the previous chapter, the operation and institutional arrangements of capital markets in nineteenth century Britain were significantly different than in the late twentieth century United States, which has been the time and place most often investigated in prior studies of the predictive qualities of the term structure of interest rates. In studies of the post-1945 American experience, the interest rates on a wide range of different debt instruments have been available for use in constructing yield curves to analyse. The focus amongst financial commentators has often been the yield curve between two year and ten year U.S. Treasury Bills, with the former being taken as an indicator of the stance of monetary policy while the latter is argued to offer insight into the sentiments of bond market investors regarding the long-term prospects for the economy. Academic studies of the predictive qualities of the term structure of interest rates have more often compared the spread between three month and ten year U.S. Treasury Bills, given the strong performance of this yield curve as a predictor of future recessions and economic activity in the United States since the mid-twentieth century, while the spread between the current and six-quarters-ahead forward rates on three month U.S. Treasury Bills has also been highlighted as offering insight into the expected path of monetary policy in the short-term (on all this see Bauer and Mertens 2018b). Therefore, if it were possible to find widely-traded bonds of equivalent quality and duration for Britain between the years of 1800 and 1913, these would seemingly offer the most straightforward approach to arriving at results which could easily be compared with those from the prior literature. However, the much more limited number and type of debt instruments which circulated in nineteenth century Britain precludes this approach. As was noted in the previous chapter, the great majority of commercial loans in nineteenth century Britain were made by discounting short-term bills of exchange, with the durations of these loans rarely exceeding three to six months. In cases in which banks wished to lend for longer periods, they would occasionally extend the duration of these loans on an ad hoc basis, after the loan had initially been made for a short duration (Mathias 1983, 156-159). As a result, no nineteenth century British equivalent exists to, for example, the ten-year U.S. Treasury Bill which previous studies have often taken as their representative of long-term interest rates. Further complications arise from the fact that, as previously discussed, the usury laws of the early nineteenth century limited the extent to which the Bank of England was able to use adjustments of its Bank rate as a tool for contracting the supply of credit. To compensate for this constraint, the Bank often aimed to influence the supply of credit by adjusting the maximum length to maturity of the short-term bills it was willing to discount, with alterations in the Bank rate only gradually becoming its primary tool to this end from the 1830s onwards, and particularly after the passage of the Bank Charter Act of 1844 (Dutton 1984, 177; Kynaston 2017, 120, 143-145). The Bank of England also occasionally resorted to credit rationing, an approach which was also taken by private banks aiming to contract credit despite the usury laws of the time (Bordo and White 1991, 311; Temin and Voth 2005; Anson et al. 2019). All of these factors complicate the task of finding consistent data series for short-term and long-term interest rates directly comparable with those of the late twentieth century United States, for Britain between the years of 1800 and 1913.

Despite these limitations, however, prior studies have established common methods for assessing the relative levels of long-term and short-term interest rates during this period which, though they may not entirely overcome the inherent limitations of the available data, nevertheless offer an illuminating picture of the term structure of interest rates in nineteenth century Britain. As Siegel (1992, 35-36) explains, the common practice amongst economic historians of this period has been to take the yield on consols as representative of long-term interest rates, while the open market discount rate on high quality commercial paper has often been taken as representative of the level of short-term interest rates. While these are not direct counterparts to the long-term and short-term U.S. Treasury Bills often compared in prior studies of the term structure of interest rates in the United States since the mid-twentieth century, adhering to the common use of these as representative of long-term and short-term interest rates in nineteenth century Britain may nevertheless facilitate comparison of results with the insights of prior studies of this period.

In the case of the market discount rate on high quality commercial paper, our representative of short-term interest rates in nineteenth century Britain, a considerable amount of useful data has already been collected into the Bank of England's well known and widely cited 'A Millennium of UK Data' dataset (Thomas and Dimsdale 2017). This invaluable resource includes monthly data series from a number of different sources on the interest rates on prime or first-class commercial bills, including a spliced series which extends throughout the timeframe under investigation in this thesis.[44] A number of factors combine to suggest this spliced series as an appropriate selection to represent the level of short-term interest rates in Britain between the years of 1800 and 1913. It is primarily comprised of the interest rates on bills with a three-month term to maturity, which aligns with the duration of the three-month Treasury Bills most commonly used to represent short-term interest rates in scholarly studies of the term structure of interest rates in the twentieth century United States. The data is monthly throughout most of that timeframe, a relatively fine frequency compared to the annual data available for many macroeconomic variables in nineteenth century Britain. The fact that it is featured in a freely available and widely cited dataset should also contribute to the transparency of the results achieved, and allow for easier comparison with the results of the one prior study of the relationship between the yield curve and the business cycle in nineteenth century Britain by Capie et al. (2019), which uses the same dataset, as well as with the findings of future studies on this topic or existing studies on related topics. Furthermore, the relative consistency of employing this single series, rather than a range of different sources for different points throughout the 1800 to 1913 timeframe, allows for a more straightforward comparison of results between the different sub-periods outlined in the previous chapter. This is not to say, of course, that this data series is entirely without limitations of its own which should be considered when analysing the results produced through its use. Notably, a break exists between the pre- and post-1825 data in this spliced series, in terms of its original sources and their methods. To

[44] Thomas and Dimsdale (2017), Sheet M1, Column M.

compensate for the dearth of available data, the pre-1825 interest rates in this series were taken from the yields on six-month East India Company bonds, originally presented by Heim and Mirowski (1987), and were interpolated from an annual frequency. After 1825, the series continues with the rate on three-month prime or first-class commercial bills at a monthly frequency, originally sourced from *The Economist* and from Nishimura (1971). The extent to which this inconsistency might have affected the results achieved, particularly for the 1800 to 1821 sub-period, will be discussed further as those results are analysed later in this chapter. However, the aforementioned advantages of this spliced series of the market discount rate on high quality commercial paper nevertheless suggest it as likely the best available representative of short-term interest rates for the purposes of this study, particularly given the wide use of similar series for that purpose in the prior literature on nineteenth century Britain (Siegel 1992, 36).

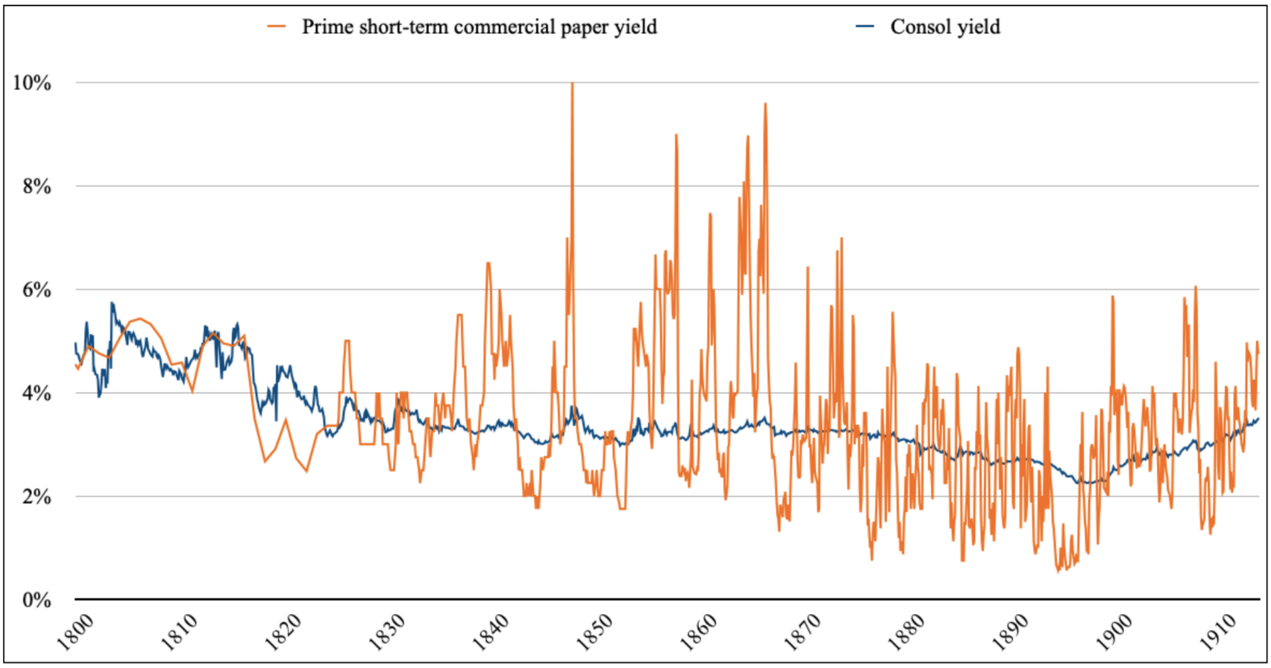
Although the aforementioned lack of medium- and long-term debt instruments in wide circulation at the time precludes the use of a direct analogue to the ten-year Treasury Bills commonly commonly taken as representative of long-term interest rates in studies of the term structure of interest rates in the United States since the mid-twentieth century, it has nevertheless become common practice amongst many prior studies to regard the yields on consols as representative of long-term interest rates in nineteenth century Britain (see for example Barro 1987, 228; Barsky and Summers 1988, 531; Berument et al. 2017, 28; Capie et al. 2019, 8). First introduced in 1751 as a consolidation of a number of previously existing government bonds, consols were perpetual annuities whose coupon rate remained at 3 per cent between the years of 1800 and 1888, before being reduced to 2.75 per cent by the National Debt Conversion Act of 1888, and then reduced again to 2.5 per cent in 1903 (Harley 1976, 101/2). Not only were consols essentially the only widely-traded debt instrument other than short-term bills of exchange during the time period under consideration in this thesis (Ellison and Scott 2020, 229/30), but their prominent place in the British money market resulted in consol prices being amongst the most significant asset prices in the global economy throughout the nineteenth century (Klovland 1994, 165) and the influence of other factors such as inflation (Barsky and Summers 1988, 528) and the short-term Bank Rate (Berument et al. 2017, 27) on the level of consol yields appears to have been limited. All of these factors, along with the ready availability of monthly data on consol yields,[45] combine to suggest the suitability of this metric as a measure of the level of long-term interest rates, for the purposes of this study.[46]

Having selected measures of long-term and short-term interest rates, the question of how to compare them to one another in such a way as to illustrate the term structure of interest rates may be addressed. The methodology surrounding the construction of yield curves has been a matter of some debate in the prior literature, with particular complications arising from the question of how best to interpolate between the yields of bonds with different maturities in order to arrive at a smooth curve, especially when plotting yield curves including three or more different bonds (see Hagan and West 2006; du Preez 2011, 14-23). However, the goal of this thesis is simply to use yield curve data to illustrate the difference between long-term and short-term interest rates in order to assess whether or not their levels relative to one another predicted future economic activity in Britain between the years of 1800 and 1913, rather than attempting to use this yield curve data to infer the yields of hypothetical medium-term bonds. For this purpose, a straightforward comparison of long-term and short-term interest rates via a subtraction of the latter from the former should provide an illustration of the term structure of interest rates sufficient to the goals of this thesis.

[45] Thomas and Dimsdale (2017), Sheet M1, Column U.

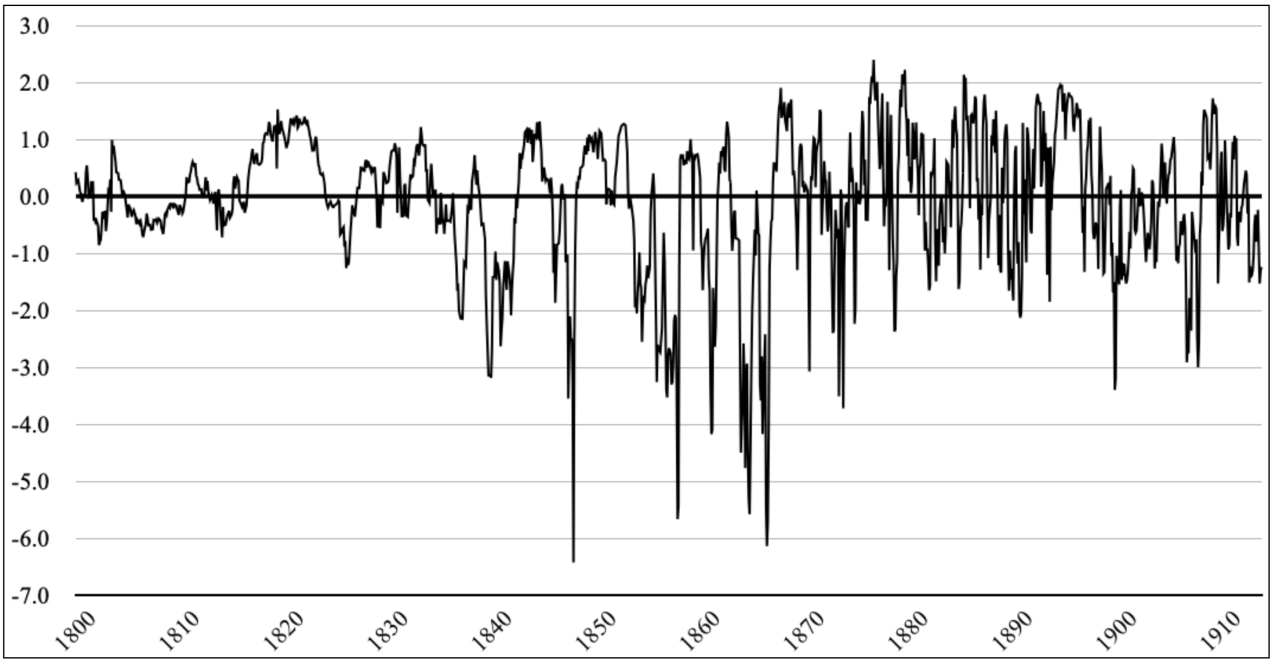
[46] Complications stemming from the nature of consols at perpetual annuities, in terms of the determination of their yields and their theoretical relation to short-term interest rates in the term structure of interest rates, are discussed in the next chapter of this thesis.

Figure 4. Short-Term and Long-Term Interest Rates, January 1800 - December 1913



Source: Thomas and Dimsdale (2017 Sheet M1, Columns M and U)

Figure 5. The Slope of the Yield Curve, January 1800 - December 1913



Source: Calculated from the data in Figure 4. A lower or negative number indicates a flatter or inverted yield curve.

Figures 4 and 5 present the interest rate and yield curve data which will be used in this chapter, with lower or negative values for the slope of the yield curve indicating a flatter or inverted yield curve. Presenting the data in this manner, with such a long time period represented in a relatively small graph, naturally has its limitations; while it somewhat effectively illustrates the broad trends in interest rate movements in Britain between the years of 1800 and 1913, the squashed scale also gives the impression that fluctuations in the yield curve were even more volatile than they in fact were. The data will be analysed and presented in more readable forms in the next section of this chapter. In the meantime, the question of how best to define the dates of the most relevant economic downturns of the period from 1800 to 1913 will be addressed.

Recession dates

The question of how best to define an economic recession is one around which disagreement exists even at the best of times (Abberger and Nierhaus 2008; Gaski 2012; Morgan 2022), and the matter is all the more complicated in the historical context of Britain between the years of 1800 and 1913 due to the limitations of the available data. In the United Kingdom, as in most other countries, national income accounting and the systematic collection of economic statistics did not begin in earnest until after the Second World War (Vanoli 2005, 15-26; Tooze 2001), meaning that GDP figures and other national economic aggregates for Britain between the years of 1800 and 1913 take the form of estimates. Despite this limitation, a number of influential estimates have been made of British national income, output, and other significant macroeconomic variables during the time period under consideration here (for example Deane and Cole 1962; Feinstein 1972; Crafts 1985; Crafts and Harley 1992; Broadberry et al. 2015). However, these have generally been at no finer than an annual frequency, which would limit any prospects for identifying recessions in nineteenth century Britain by, for example, the commonly cited definition of a recession as any period of two or more consecutive quarters of negative real GDP growth.[47] Capie et al. (2019), in their study of the relationship between the yield curve and the business cycle in Britain between the years of 1822 and 2016, overcame this limitation in the nineteenth century data by using monthly real GDP data interpolated from annual GDP estimates, and identified recessions during the periods when this data fell below the linear trend of long-term real GDP growth, while also identifying peak and trough months in the interpolated GDP estimates. However, given the very limited extent of the existing literature on this subject, additional insights into the relationship between the yield curve and the business cycle in nineteenth century Britain might better be gained by presenting results which used a chronology of recession dates arrived at by a different method, rather than by trying to replicate the results of a prior study. For this reason, this chapter will aim to identify the peak and trough months of the business cycle in nineteenth century Britain by reference to the insights of a number of different prior studies on this subject, rather than attempting to derive them anew from estimated macroeconomic variables.

A number of noteworthy studies have offered estimates of the peak and trough years of nineteenth and early twentieth century British business cycles, using a variety of different methods. Burns and Mitchell (1946, 79) offered an influential early chronology of peak and trough dates from 1792 to 1938 (annual before 1854, monthly afterwards), based on a broad range of different variables, including measures of production, construction, prices, interest rates and so forth. A similar approach was taken by Rostow (1948, 33), whose annual chronology extended from 1788 to 1914. Gayer, Rostow and Schwartz (1975, 348) offer a monthly chronology of British business cycles, in their magisterial study of British macroeconomic trends between the years of 1790 and 1850. A number of more recent studies have also offered their own peak and trough date estimates,

[47] The limitations of this popular rule of thumb definition of recessions have been analysed by a number of scholarly studies, including those of Layton and Banerji (2003) and Abberger and Nierhaus (2008), the latter of whom identify the definition as having originated in a 1974 *New York Times* article by the economist Julius Shiskin.

often arriving at these estimates through analysis of macroeconomic aggregates such as GDP, as opposed to the overview of a broad range of disaggregated variables favoured by the aforementioned older studies. Capie and Mills (1991, 41) suggest a chronology of the peak and trough years in the British business cycle from 1871 to 1908, based on deviations from the estimated trend in real GDP. Klovland (1998, 49-63) arrived at a series of peak and trough months from 1851 to 1912 by constructing a composite cyclical indicator composed of import and export volumes, rail freight volumes, bank clearing activity, and other weighted variables, and then distinguishing between the long-term trend of this indicator and its cyclical fluctuations using a Hodrick-Prescott filter. Chadha, Janssen and Nolan (2000) employ a somewhat similar method, using a range of different bandpass filters to determine the long-term economic trend, and then using deviations from that trend in investment, narrow money balances, exchange rates and the current account balance to arrive at a monthly series of business cycle peak and trough dates stretching from 1854 to 1992. More recently, Broadberry, Campbell, Klein, Overton and van Leeuwen (2022) built upon their prior sweeping work in British macroeconomic history (Broadberry et al. 2015) with their own annual chronology of business cycle peak and trough dates extending all the way from 1272 to 1870, arrived at by applying a Hodrick-Prescott filter to separate the cyclical components from the secular trend in their own series of GDP estimates.

Although the dates suggested by these various chronologies vary in the extent to which they overlap with one another (see Broadberry, Chadha, Lennard and Thomas 2022, 5), they nevertheless all contribute to a broad but illustrative picture of the course of the business cycle in Britain between the years of 1800 and 1913. Indeed, aside from the fact that some of these studies do not cover the entire period under consideration in this thesis, their varying but arguably generally robust methodologies and basis in clearly important economic variables, despite the limitations of the available data on such variables, suggests that any one of them could arguably provide a relatively useful and realistic representation of the dates of Britain's most important economic fluctuations of the period. However, given the advantages of simplicity and consistency which would come from selecting a single pre-existing chronology spanning the entire 1800 to 1913 timeframe, the recent study by Broadberry, Chadha, Lennard and Thomas (2022)[48] suggests itself as arguably the best suited to the purposes of this thesis. The strength of this particular chronology stems not only from the fact that it extends throughout the full 1800 to 1913 timeframe, but also from the fact that it was constructed to directly address some of the issues which had arguably undermined the reliability of previous estimates. First and foremost, the recent date of this study enabled it to draw from data sources which were not previously available, a significant advantage given that certain influential prior chronologies have arguably suffered from the limitations of the available data at the time.[49] Furthermore, this study uses aggregated data, a choice made to avoid the "deliberately vague" and "subjective" (Romer 1994, quoted in Broadberry, Chadha, Lennard, and Thomas 2022, 6) methods to which older chronologies resorted when the numerous disaggregated variables they drew from did not all suggest the same peak and trough dates. In order to avoid this, Broadberry, Chadha, Lennard, and Thomas (2022) base their chronology up to the year 1870 on the output series suggested by a previous study (Broadberry et al. 2015), with the 1870 to 1913 turning points being drawn from the balanced real GDP series presented by Solomou and Weale (1991). Interpreting this data in consultation with "a UK Business Cycle Dating Committee [assembled by the National Institute of Economic and Social Research, comprised] of leading academics and policymakers"

[48] In order to avoid confusion with the study of the same year by Broadberry, Campbell, Klein, Overton and van Leeuwen (2022), also cited in this thesis, the abbreviation 'Broadberry et al. (2022)' will not be used except in cases when it is both obvious from the context of the preceding few sentences that the study by Broadberry, Chadha, Lennard, and Thomas (2022) is being discussed and when the reference is not to a specific detail of their work or to any particular one of its pages.

[49] A number of authors, including Friedman and Schwartz (1982, 308), have argued that the UK business cycle dates suggested by the National Bureau of Economic Research (for example Mitchell 1930, 390) were not as reliable as the NBER's influential chronology of the American business cycle, because of the limitations of the British data.

(Broadberry, Chadha, Lennard, and Thomas 2022, 3), the authors arrived at the annual chronology of British business cycle peaks and troughs summarised in Table 1.

Table 1. Annual Turning Points in the U.K. business cycle, 1800-1913

Peak	Trough	Peak	Trough
	1797	1846	1847
1802	1804	1849	1850
1805	1806	1854	1855
1807	1808	1857	1858
1810	1812	1860	1862
1813	1814	1878	1879
1815	1816	1883	1885
1817	1819	1891	1893
1825	1826	1899	1900
1836	1837	1902	1903
1838	1839	1907	1908
1840	1842	1918	

Source: Broadberry, Chadha, Lennard, and Thomas (2022, 21).

Despite these merits of this chronology of the dates of British business cycles, its primary limitation from the perspective of the goals of this chapter is its annual, rather than monthly, frequency. This would limit the prospects for inferences to be drawn concerning questions which have featured prominently in the prior literature on the predictive qualities of the term structure of interest rates, such as how many months or quarters in advance of a recession the yield curve tended to flatten or invert. In order to overcome this limitation, two different approaches are taken to estimating a monthly chronology of business cycle peak and trough dates, based on the annual chronology suggested by Broadberry, Chadha, Lennard, and Thomas (2022, 21), allowing for the comparison of the two different sets of results arrived at using the two chronologies.

The first and more straightforward approach to converting this annual set of peak and trough dates into a monthly chronology involves simply assuming that each recession began at a particular, unchanging point in each peak year, and ended at a particular point in each trough year. Specifically, it will be assumed that each recession began at the mid-point (July) of each peak year, and ended in June of the trough year, making each recession some multiple of twelve months long. Obviously this assumption is arbitrary and simplistic, and does not claim to offer the most accurate possible account of the months in which any given recession in fact began or ended. However, despite the likely inaccuracy of identifying the peak and trough months of the business cycle by this method, a number of factors combine to justify the inclusion of the results achieved using this simplistic, 'unadjusted' chronology in a secondary capacity, as a supplement and point of comparison to the primary set of results arrived at using the 'adjusted' chronology detailed in the next paragraph. Firstly, the unadjusted chronology more directly reflects the annual chronology of Broadberry, Chadha, Lennard, and Thomas (2022); the adjusted chronology is also primarily based on this source, but differs from it in certain key respects as a result of its aim to incorporate the insights of a range of other sources.[50] The systematic nature of the rule by which the unadjusted chronology is derived, assuming all recessions to have begun at the midpoints of the business cycle peak years identified by Broadberry et al., also means the actual recession start months have an approximately equal likelihood of having fallen either earlier or later in the year than the unadjusted chronology would suggest, limiting the potential for a systematic skew in the results.[51] Furthermore, the simple

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[50] See Appendix A.

[51] This assumes that the true start dates of recessions were randomly distributed amongst the months of the year, likely an unrealistic assumption given the agriculture-related strains typically experienced by the money market in the spring and autumn months in Britain between the years of 1800 and 1913. Several authors have argued that this made it more likely for economic crises to have begun in the spring and autumn months during that period (Jevons 1884, 160-193; Andrew 1906; Kemmerer 1910, 232; Miron 1986). However, given the fact that the arbitrarily chosen recession start month of July is more-or-less equidistant between these spring and autumn strain periods, and given that the goal of the unadjusted chronology is to offer a monthly series of business cycle peak and trough dates simply and closely related to the annual chronology of Broadberry, Chadha, Lennard, and Thomas (2022), inclusion of the results of the unadjusted chronology in a supplementary capacity may nevertheless offer a worthwhile point of comparison with the results of the primary, adjusted chronology.

and consistent rule by which the unadjusted chronology is derived excludes the possibility of any inaccuracies which might have unknowingly been allowed to affect the adjusted chronology, due to either unnoticed systematic errors in the supplementary sources from which the adjusted chronology is partly derived, or possible errors of judgment made in the course of interpreting and weighing the qualitative insights of those sources. For these reasons, a straightforward conversion of the annual peak and trough dates suggested by Broadberry, Chadha, Lennard, and Thomas (2022) into an 'unadjusted' monthly chronology via this simplistic method may produce results which, despite their acknowledged limitations, may nevertheless somewhat contribute to a fuller picture of the relationship between the term structure of interest rates and the business cycle in nineteenth century Britain, through comparison with the results achieved using the primary, adjusted monthly chronology of business cycle peak and trough dates.

Table 2. Monthly Turning Points in the U.K. Business Cycle, 1800 - 1913

Peak	Trough	Peak	Trough
May 1803	April 1804	August 1850	December 1850
August 1806	January 1807	March 1854	February 1855
December 1807	May 1808	September 1857	March 1858
July 1810	September 1811	December 1860	November 1862
April 1814	December 1814	April 1866	November 1868
July 1815	September 1816	October 1878	July 1879
September 1818	August 1820	April 1883	June 1886
May 1825	November 1826	September 1890	February 1893
May 1836	August 1837	June 1900	September 1901
April 1839	December 1839	November 1902	October 1903
August 1841	November 1842	June 1907	November 1908
April 1847	September 1848		

Source: Adjusted from the annual chronology of Broadberry, Chadha, Lennard, and Thomas (2022, 21), in combination with the information presented in Appendix A.

In contrast, the 'adjusted' business cycle chronology presented in Table 2 aims to more accurately reflect the actual dates of business cycle turning points in Britain between the years of

1800 and 1913, by supplementing the annual chronology of Broadberry, Chadha, Lennard, and Thomas (2022, 21) with contextualising historical details and the insights of a range of other recent and contemporary sources, including a number of the other studies of the business cycle in Britain mentioned earlier in this section. The specific details of the sources considered and the reasoning behind the selection of the peak and trough months listed in Table 2 as representing such consensus as existed amongst them is detailed in Appendix A of this thesis.

Having described two contrasting methods for arriving at at two different monthly chronologies of estimated business cycle peak and trough dates, the following subsection will now address the question of how best to compare the yield curve and business cycle data in such a way as to illustrate the extent to which a flattening or inversion of the yield curve tended to precede downturns in the business cycle in Britain between the years of 1800 and 1913.

Assessing the data

A number of possible approaches suggest themselves for assessing the data described in the previous subsections in such a way as to best illustrate the relationship between the yield curve and the business cycle in Britain between the years of 1800 and 1913. Given the limitations of the available data and the necessary reliance on estimates by many of the prior studies which have sought to construct series of macroeconomic variables for nineteenth century Britain, it is doubtful that any single approach could allow for a definitive or completely accurate assessment of this relationship. Instead, employing a number of different approaches and evaluating their results alongside one another may offer the best opportunity to gain an impression of the extent to which yield curve inversions tended to precede recessions in Britain during that timeframe, and more generally whether a predictive association existed between the slope of the yield curve and future economic conditions.

Firstly, the reliability of yield curve inversions as signals of oncoming recessions will be assessed, including a presentation of the numbers of yield curve inversions and recessions in the full 1800 to 1913 timeframe and in each of the sub-periods, how many inversions were followed by the start of a recession within 18 months, how many were not, and so forth. 18 months is selected as an appropriate window after a yield curve inversion within which the start of a recession could be regarded as having been accurately predicted by that yield curve inversion due to having been the standard used by the one prior study of the predictive qualities of the yield curve in nineteenth century Britain (Capie et al.) and by others (for example Estrella and Mishkin 1996).[52] Precision-recall curves will also be presented for the full timeframe and each of the sub-periods, and for both business cycle chronologies, illustrating the predictive power of yield curve inversions as reliable signals of recessions between 0 and 215 months hence, with results beyond 215 months not being included because no single month in the 1800 to 1913 timeframe occurred more than 215 months before the start of the next recession. The precision values on the y-axis represent the proportion of true positives relative to false positives, in other words the number of yield curve inversions which were followed by a recession within a given number of months compared with those which were not. The recall values on the x-axis represent the proportion of true positives to false negatives, in other words the number of yield curve inversions which were followed by a recession within a given number of months compared to the number of months in which a yield curve inversion did not occur but a recession nevertheless followed within the same number of months. Precision-recall curves were chosen rather than the closely related receiver operating characteristic curves due to the

[52] The reasons for relying on this precedent of the prior literature rather than arriving at a different number of months or years through another method are discussed early in the next section of this chapter.

imbalanced nature of the data set in terms of the much higher number of months in which a yield curve inversion did not begin than months in which a yield curve inversion did begin.

Having assessed the ability of yield curve inversions, as discrete events, to predict oncoming recessions, the rest of the chapter will analyse the relationship between the slope of the yield curve, as a continuous variable, and future economic conditions. One of the approaches taken to illustrate this relationship consists of a series of regressions, with the slope of the yield curve as the independent variable and monthly and annual GDP estimates between 0 and 2 years hence as the dependent variables. Thomas and Dimsdale (2017, Sheet A8) provide a range of annual GDP series which extend throughout the 1800 to 1913 timeframe, with real GDP at market prices and real GDP at factor costs offering the potential to gain insights into the varying extent to which a positive association existed between the level of long-term relative to short-term interest rates and the subsequent prices of goods at different stages of the structure of production. The extensiveness, relatively recent dates, and widespread use of the data series presented by Thomas and Dimsdale (2017) all contribute to justify their selection for this chapter's analysis. However, the annual frequency of these GDP data series nevertheless presents a challenge when attempting to assess its correlation with the monthly yield curve data used throughout this thesis. Two possible approaches could be taken to address this issue: either the monthly yield curve data could be averaged out to an annual frequency, for comparison with the annual real GDP estimates, or an attempt could be made to convert the annual GDP data series to a monthly frequency, for comparison with the monthly yield curve data. In order to broaden the range of results which might be analysed to illustrate the relationship between the business cycle and the yield curve in nineteenth century Britain, both approaches will be taken, and their results evaluated alongside one another.

For the comparison of annual yield curve and real GDP data, regressions will be conducted between the annual mean of the monthly yield curve values as the independent variable, and the real

GDP at factor cost and real GDP at market prices data as the dependent variables, expressed in terms of their percentage change from the previous year, for each year between 0 and 2 years subsequent to the given value of the slope of the yield curve. By regressing the slope of the yield curve against GDP values up to two years hence, it should be possible to illustrate the extent to which a significant association existed between the level of long-term relative to short-term interest rates and the subsequent level of real GDP, with the existence of such an association suggesting the existence of a similar predictive relationship between the yield curve and future economic activity as appears to have existed in the United States since the mid-twentieth century. Two years is selected as an appropriate window when data of an annual frequency is used given that it is the next whole year after the commonly cited 18 month window after a yield curve inversion within which the start of a recession could be regarded as having been accurately predicted by that inversion. The short gaps in time between many of Britain's nineteenth century recessions, as indicated by the adjusted chronology of business cycle peak and trough dates summarised in Table 2., further suggests that analysing the influence of the slope of the yield curve on subsequent movements in GDP and other variables more than two years hence would be unlikely to offer a significantly clearer or more robust understanding of the predictive qualities of the term structure of interest rates in Britain between the years of 1800 and 1913. Results will also be compared for each of the four sub-periods defined in the previous chapter of this thesis: 1800 to 1821, 1821 to 1844, 1844 to 1870, and 1870 to 1913.

Monthly yield curve data will also be regressed against monthly estimates of real GDP at market prices and at factor cost derived from Thomas and Dimsdale's annual GDP series, between 0 and 18 months hence. Given that the original annual GDP data are compiled from a range of estimates, it is not specified that the annual values consistently reflect the level of real GDP in a particular month of each year. Therefore, in order to arrive at a monthly series, the annual data is placed at the mid-point of each year, specifically July, and then the values for the other months are estimated by linear interpolation between these values. Needless to say, this relatively simple approach can only be assumed to offer limited insight into the actual monthly course of real GDP, as it may have occurred, and can be expected to particularly obscure any sharp fluctuations in real GDP which might have taken place within a given year but been short enough to be obscured in the annual data. However, such attempts to arrive at a monthly series of British real GDP for the years between 1800 and 1913 are necessarily estimates derived from still other estimates, inherently limited in their accuracy to some extent as a result of the underlying limitations of the available data. Therefore, unless and until an accurate monthly series becomes available, this interpolated series of monthly GDP estimates may suffice, despite its limitations, to provide a broad and somewhat informative impression of the relationship between the slope of the yield curve and real GDP between 0 and 18 months hence.

Having presented the regression results concerning the association between the slope of the yield curve and real-GDP up to 18 months hence, or two years hence in the case of the annual estimates, a similar approach may be taken to analysing the relationship between the yield curve and other important macroeconomic variables. While few such macroeconomic data series exist at a finer than annual frequency for Britain throughout the entire 1800 to 1913 timeframe, Thomas and Dimsdale (2017) do present monthly indices of wholesale/producers prices and share prices. Illustrating the association between the slope of the yield curve, as the independent variable, and the levels of share prices and wholesale/producers prices each month between 0 and 18 months hence, as the dependent variables, offers the chance to gain insight into the extent to which the yield curve moved with, or predicted movements in, some key economic variables other than real GDP estimates.

Having assessed the reliability of yield curve inversions as discrete events, and having illustrated the association between the slope of the yield curve as a continuous variable and the subsequent movement of other key macroeconomic variables, the predictive relationship between the slope of the yield curve and the two monthly business cycle chronologies will be analysed. This will involve performing independent samples t-tests to gauge to what extent, and to what degree of statistical significance, the average slope of the yield curve a given number of months before the first month of a recession tended to be flatter or more inverted than the slope of the yield curve the same number of months before an average non-recession month, both during the full 1800 to 1913 timeframe and in each of the sub-periods. This approach should illustrate the extent to which the expected decline in long-term relative to short-term interest rates, or rise in short-term relative to longterm interest rates, tended to occur prior to the onset of recessions, even if these movements were not sufficient to reliably cause outright inversions of the yield curve prior to each recession. If true, this would not only tend to reinforce the idea that the slope of the yield curve offered predictive insight into the future course of the business cycle in nineteenth century Britain, as it is generally accepted to have done in the United States since the latter half of the twentieth century, but would also illustrate how far in advance of the onset of a recession this flattening or inversion of the yield curve tended to occur. Despite the potential of this approach to offer valuable insights, it nevertheless suffers from some limitations. In particular, the relatively small number of recessions under consideration, and therefore the small sample size from which the average level of the yield curve a given number of months before the start of a recession will be calculated, could be expected to amplify the impact on these results of potential inaccuracies in the business cycle peak and trough date estimates used. The adjusted chronology of recession peak and trough months suggests, for example, that there were only four recessions between 1821 and 1844, and hence the average level of the yield curve a given number of months before the start of a recession in that sub-period would be calculated from only four values. It is easy to imagine, therefore, that if a strong pattern did exist in the actual facts of history (for example, if the yield curve consistently became significantly flatter or more inverted precisely nine months before the start of each recession in that sub-period) it would only take a slight inaccuracy in the estimated start months of a few of those recessions for that pattern to be largely obscured. In order to help overcome this potential issue and increase the number of observations from which these averages are calculated, a second set of results will also be presented wherein a similar t-test approach will compare the average slope of the yield curve a given number of months before any month which is indicated to have been a recession month by one of the recession chronologies, as opposed to just the start month of the recession, with the average slope of the yield curve that same number of months before a non-recession month. This second approach will not necessarily offer as much insight into whether or not a flattening or inversion of the yield curve tended to signal the start of a recession a given number of months in advance, but the larger sample size of recession months compared with recession start months should allow this method to offer a more accurate illustration of the tendency for the yield curve to have been flatter or more inverted prior to recessions than at other times in nineteenth century Britain, minimising the impact of potential inaccuracies in the business cycle chronologies used.

Having outlined the key details of the data which this chapter will employ, and the methodological approaches which will be taken to assessing the relationship between the slope of the yield curve and future economic conditions in Britain between the years of 1800 and 1913, the following section will now present the results of these methods.

II - Results

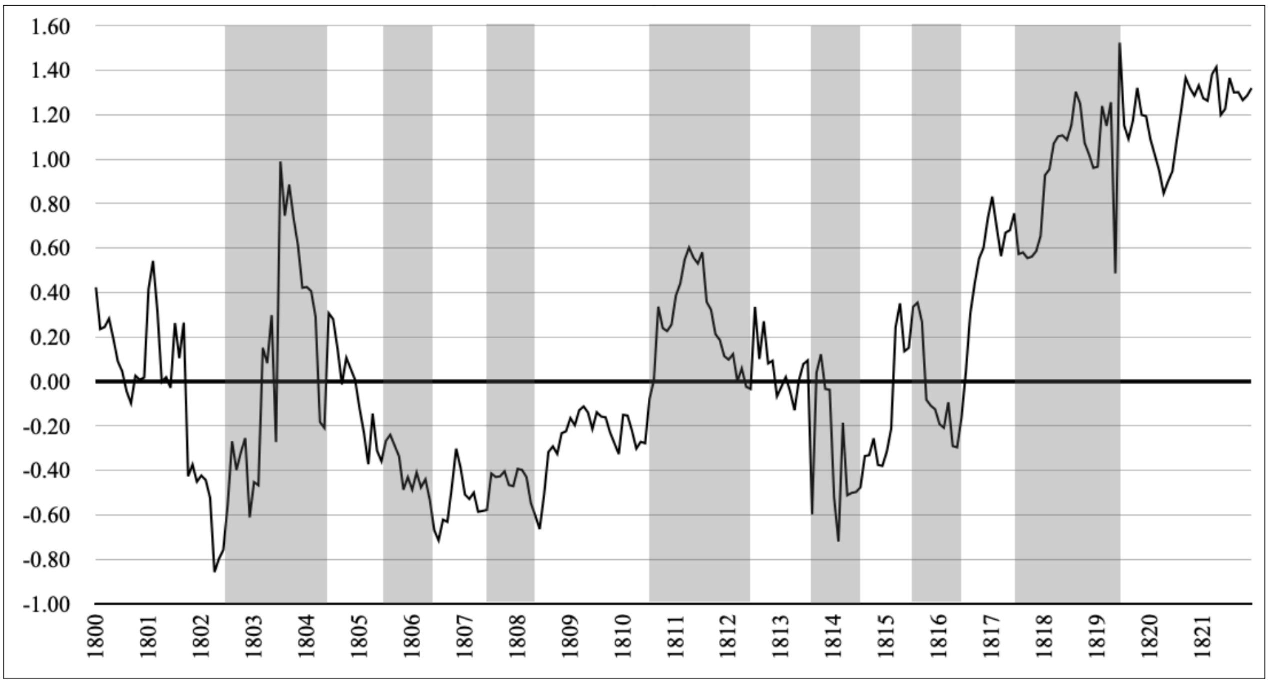
Figures 6 to 13 illustrate the fluctuating slope of the yield curve and the dates of the recessions, with the recessions being represented by the vertical grey bars, for each of the four sub-periods outlined previously, and for both the adjusted and unadjusted recession peak and trough date chronologies. Note the differing y-axis scales for the different sub-periods. The yield curve data is the same as was presented for the full 1800 to 1913 timeframe in Figure 5. The relationship between yield curve inversions and recessions is summarised by Table 3.

Table 3. Yield Curve Inversions Overview

	1800 - 1821	1821 - 1844	1844 - 1870	1870 - 1913	1800 - 1913
Total number of recessions	7	4	6 (5)	6	23 (22)
Total number of yield curve inversions	11	7	10	33	60
Number of false positive yield curve inversions not followed by the start of a recession within 18 months	6 of 11 (1 of 11)	5 of 7	7 of 10 (6 of 10)	21 of 33	40 of 60 (33 of 60)
Number of recessions which were preceded by the start of a yield curve inversion within the prior 18 months.	1 of 7 (3 of 7)	2 of 4 (1 of 4)	3 of 6 (3 of 5)	5 of 6	11 of 23 (12 of 22)
As above, excluding recessions which began during the same ongoing yield curve inversion as the prior recession	1 of 5 (3 of 5)	2 of 3 (1 of 4)	3 of 6 (3 of 5)	5 of 6	11 of 20 (12 of 20)
Number of recessions which were preceded by a period of yield curve inversion within the prior 18 months, even if that yield curve inversion had begun more than 18 months prior.	6 of 7 (7 of 7)	4 of 4	5 of 6 (5 of 5)	6 of 6	21 of 23 (22 of 22)
Average number of months since the start of the most recent prior yield curve inversion at the start of a recession, excluding recessions which began during the same yield curve inversion as the previous recession	20.8 (13.2)	13.7 (26.5)	26.5 (19.0)	10.2	18.3 (16.4)

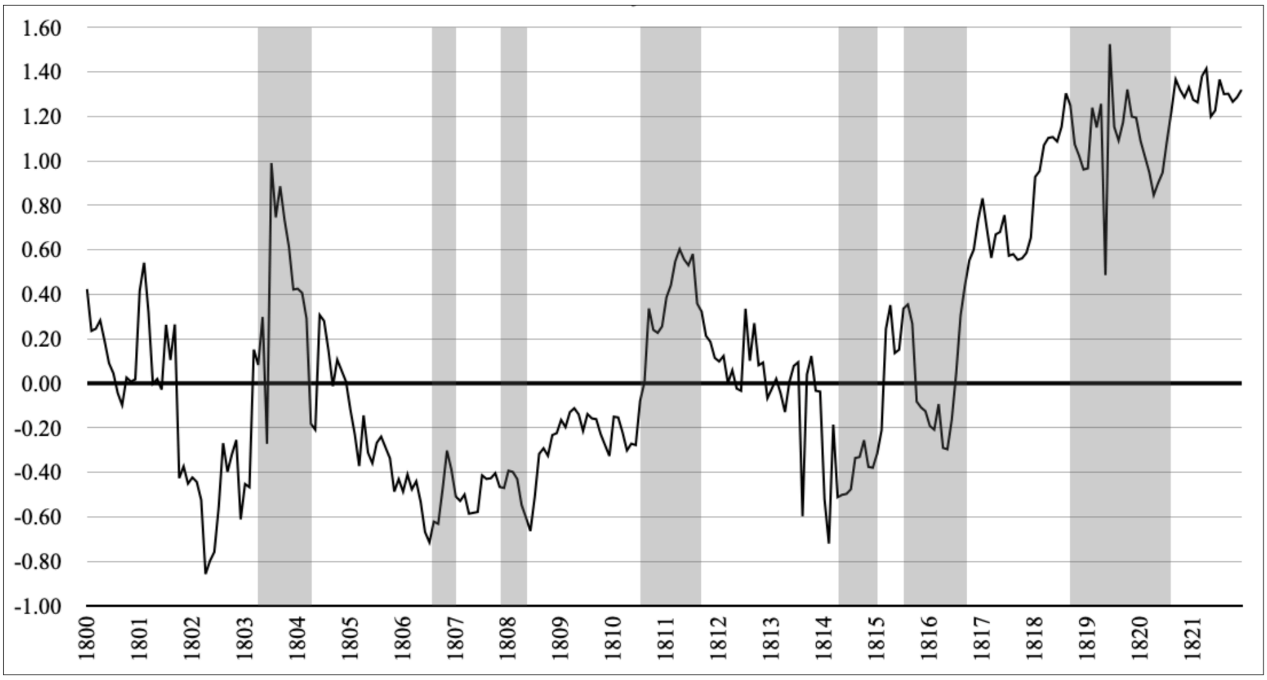
Note: Values in brackets are the results when using the unadjusted recession dates, only shown if the adjusted and unadjusted dates produce different results. If the slope of the yield curve turned negative this was only counted as an inversion in its own right if it had not already been negative at some point in the previous three months; this was done to avoid over-counting inversions in situations which might better be thought of as ongoing periods of inversion with brief peaks of long-term rates back above short-term rates. The yield curve inversion which occurred in July and August of 1870 is included in both the 1844-1870 and 1870-1913 sub-periods, hence the fact that the total number of inversions for the whole period 1800-1913 is less than the sum of the four sub-periods.

Figure 6. The Slope of the Yield Curve and Unadjusted Recession Dates, January 1800 - December 1821



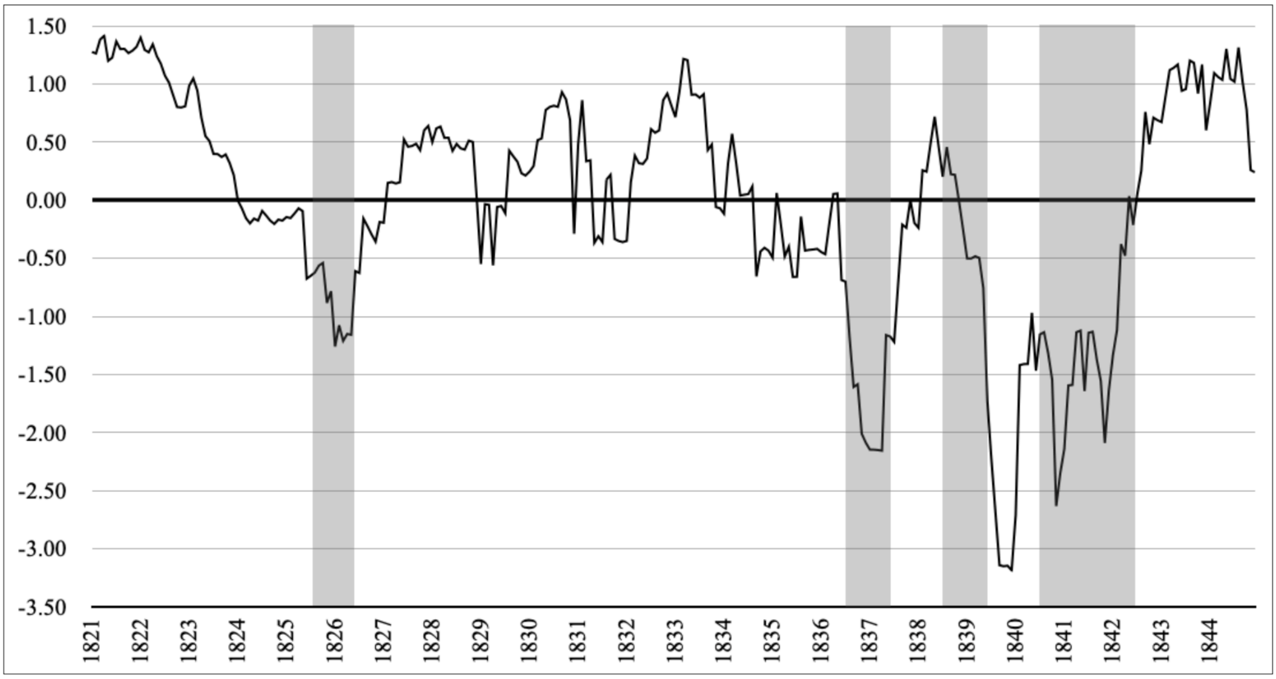
Source: Recession dates from Broadberry, Chadha, Lennard, and Thomas (2022, 21). Yield curve data calculated from the data in Figure 4, with a lower or negative number indicating a flatter or inverted yield curve.

Figure 7. The Slope of the Yield Curve and Adjusted Recession Dates, January 1800 - December 1821



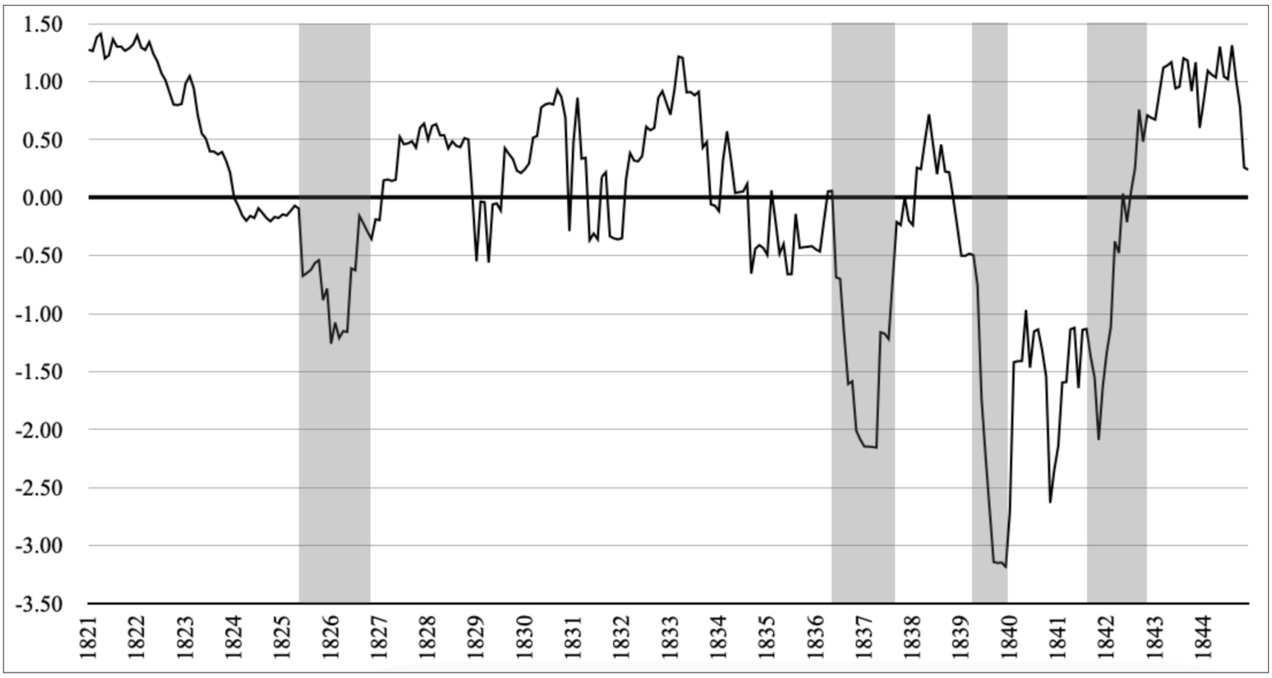
Source: Recession dates adjusted from the chronology of Broadberry, Chadha, Lennard, and Thomas (2022, 21) in combination with the sources outlined in Appendix A. Yield curve data calculated from the data in Figure 4, with a lower or negative number indicating a flatter or inverted yield curve.

Figure 8. The Slope of the Yield Curve and Unadjusted Recession Dates, January 1821 - December 1844



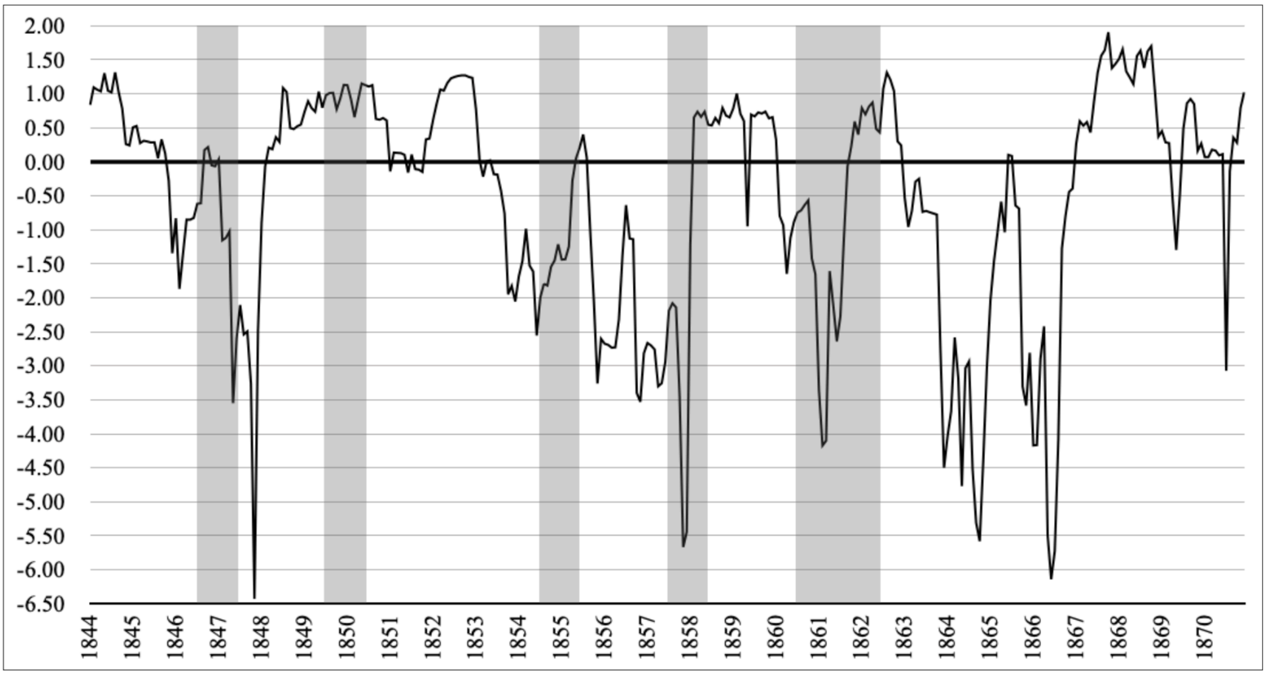
Source: Recession dates from Broadberry, Chadha, Lennard, and Thomas (2022, 21). Yield curve data calculated from the data in Figure 4, with a lower or negative number indicating a flatter or inverted yield curve.

Figure 9. The Slope of the Yield Curve and Adjusted Recession Dates, January 1821 - December 1844



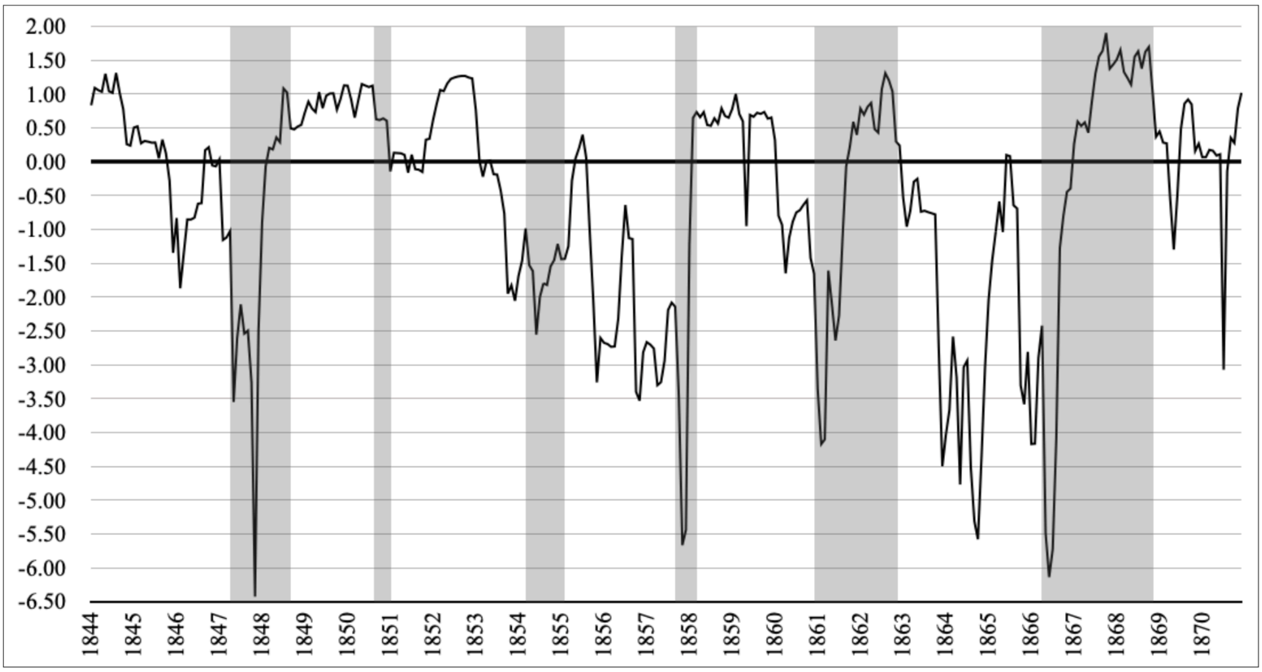
Source: Recession dates adjusted from the chronology of Broadberry, Chadha, Lennard, and Thomas (2022, 21) in combination with the sources outlined in Appendix A. Yield curve data calculated from the data in Figure 4, with a lower or negative number indicating a flatter or inverted yield curve.

Figure 10. The Slope of the Yield Curve and Unadjusted Recession Dates, January 1844 - December 1870



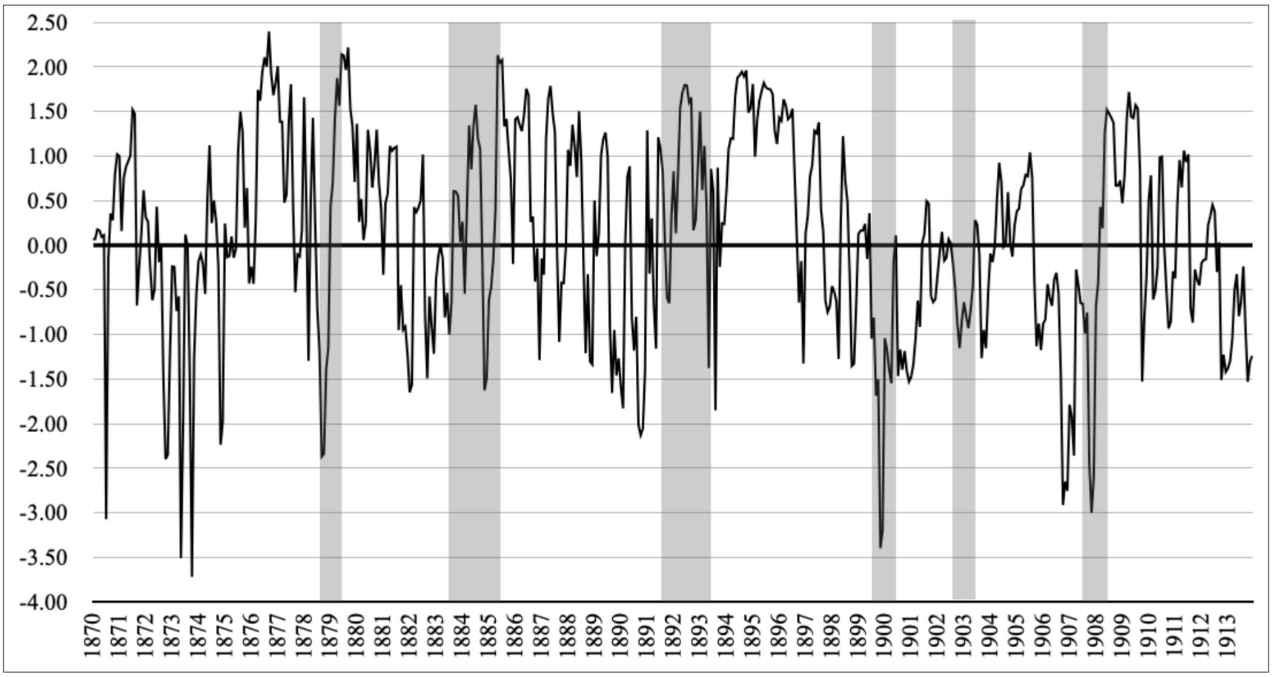
Source: Recession dates from Broadberry, Chadha, Lennard, and Thomas (2022, 21). Yield curve data calculated from the data in Figure 4, with a lower or negative number indicating a flatter or inverted yield curve.

Figure 11. The Slope of the Yield Curve and Adjusted Recession Dates, January 1844 - December 1870



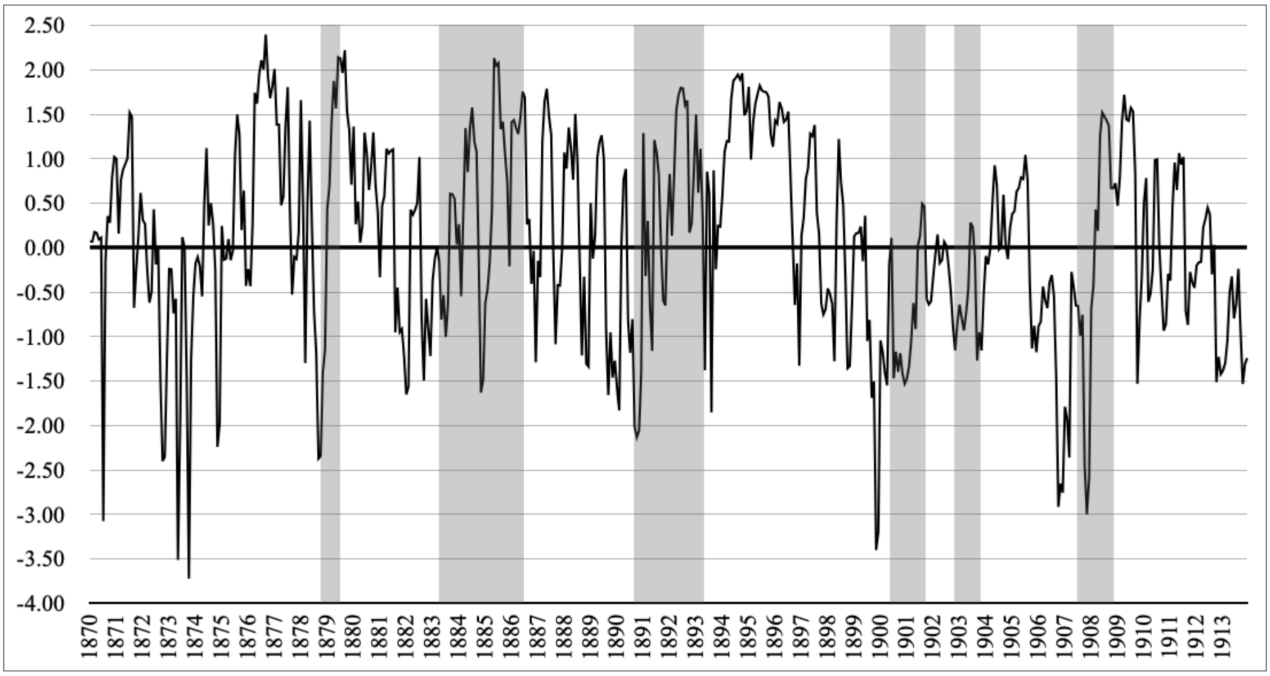
Source: Recession dates adjusted from the chronology of Broadberry, Chadha, Lennard, and Thomas (2022, 21) in combination with the sources outlined in Appendix A. Yield curve data calculated from the data in Figure 4, with a lower or negative number indicating a flatter or inverted yield curve.

Figure 12. The Slope of the Yield Curve and Unadjusted Recession Dates, January 1870 - December 1913



Source: Recession dates from Broadberry, Chadha, Lennard, and Thomas (2022, 21). Yield curve data calculated from the data in Figure 4, with a lower or negative number indicating a flatter or inverted yield curve.

Figure 13. The Slope of the Yield Curve and Adjusted Recession Dates, January 1870 - December 1913

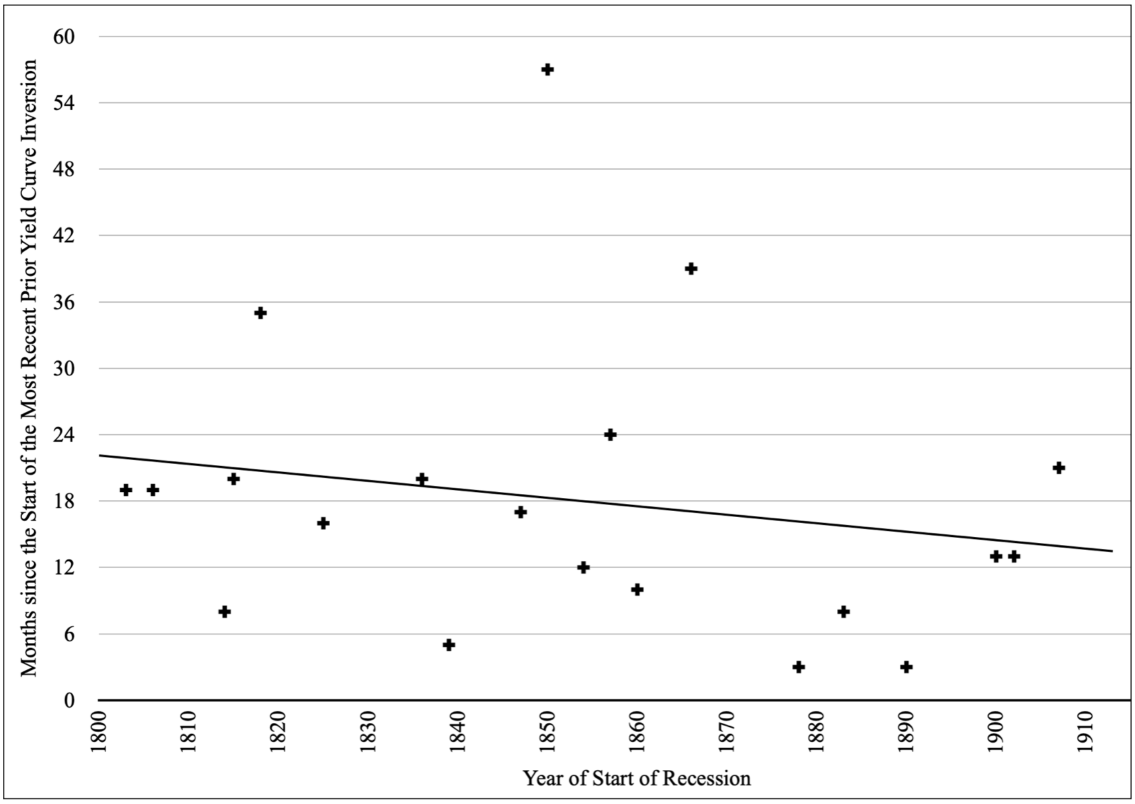


Source: Recession dates adjusted from the chronology of Broadberry, Chadha, Lennard, and Thomas (2022, 21) in combination with the sources outlined in Appendix A. Yield curve data calculated from the data in Figure 4, with a lower or negative number indicating a flatter or inverted yield curve.

As is illustrated by Figures 6 to 13, and by Table 3, yield curve inversions, as discrete events, do not appear to have reliably signalled the onset of recessions within the next 18 months in Britain between the years of 1800 and 1913. A total of 60 yield curve inversions occurred during the full 1800 to 1913 timeframe, with 23 recessions occurring in that same period, and only 20 of those yield curve inversions were followed by the start of a recession within the next 18 months, while only 11 of the recessions were preceded by a yield curve inversion within the prior 18 months. In other words, only a third of all yield curve inversions could be seen as having accurately predicted the onset of a recession within 18 months, and slightly fewer than half of all recessions were preceded by a yield curve inversion, or slightly more than half if recessions which began during the same ongoing yield curve inversion as the previous recession are discounted. A modest decline can be seen over the course of the full 1800 to 1913 timeframe in the average number of months between the start of a recession and the start of the most recent prior yield curve inversion, with this decline being illustrated by Figure 14. A delay of 21 months separated the average recession from its most recent prior yield curve inversion in the 1800 to 1821 sub-period, with this gap falling to 14 months in the 1821 to 1844 sub-period, and down to a low of just over 10 months by the final 1870 to 1913 sub-period.[53] This can be seen reflected in the rising tendency for a yield curve inversion to have begun within the 18 months prior to a recession, with only one of the seven recessions of the 1800 to 1821 sub-period having been preceded by a yield curve inversion within the prior 18

[53] The 1844 to 1870 sub-period is the outlier in this regard, with an average time of 26.5 months between the start of a recession and the start of the most recent prior yield curve inversion. This partly reflects the fact that the recessions with the two longest time gaps of this kind occurred during this sub-period, namely the recession of August to December 1850, which began 57 months after the start of the most recent prior yield curve inversion, and the recession of April 1866 to November 1868, which began 39 months after the start of the most recent prior yield curve inversion. However, both of these examples could be argued to be questionable inclusions in our chronology of recession dates. The 1850 recession is not recognised by most chronologies of British business cycles other than Broadberry, Chadha, Lennard, and Thomas (2022), who themselves characterise it as a brief and mild recession. The 1866 to 1868 recession is not recognised by Broadberry, Chadha, Lenard, and Thomas (2022), upon whose work the chronology of business cycle dates employed in this thesis is primarily based, but was nevertheless included in the adjusted chronology to reflect the historical significance of the Panic of 1866 and the fact that many other chronologies do recognise 1866, 1867, and 1868 as recession years. If these two questionable recessions had been excluded from the adjusted chronology, the average length of time between the start of a recession and the start of the most recent prior yield curve inversion in the 1844 to 1870 sub-period would have been 15.8 months.

Figure 14. Number of Months Between the Start of a Recession and the Most Recent Prior Yield Curve Inversion, 1800-1913



Source: Recession dates adjusted from the chronology of Broadberry, Chadha, Lennard, and Thomas (2022, 21) in combination with the sources outlined in Appendix A. Yield curve data calculated from the data in Figure 4

months, compared with half of all recessions between 1821 and 1870, and finally up to five of the six recessions in the final 1870 to 1913 sub-period. Figure 14 also illustrates that, while only 11 of the 23 recessions in the full 1800 to 1913 timeframe were preceded by the start of a yield curve inversion within the prior 18 months, a further six recessions occurred between 19 and 24 months after the start of their most recent prior yield curve inversion, bringing the figure up to 17 of 20 recessions having been preceded by the start of a yield curve inversion up to two years prior, if recessions which began during the same ongoing yield curve inversion as the previous recession are discounted.[54] An unduly generous interpretation might suggest that this indicates a shift in the

[54] Although this thesis has selected 18 months as an appropriate window after a yield curve inversion within which a recession would have to occur for the inversion to be regarded as having accurately predicted it, which reflects the standard selected by the one prior study of the predictive qualities of the yield curve in nineteenth century Britain by Capie et al. (2019), other studies have argued that yield curve inversions predict recessions up to two years ahead, with two years arguably also being the timeframe most often suggested in non-academic discussions of the predictive qualities of yield curve inversions (Bauer and Mertens 2018a; Aramonte and Xia 2019).

predictive relationship between the yield curve and the business cycle in Britain between the years of 1800 and 1913, with that relationship becoming gradually somewhat more similar to that seen in the late twentieth century United States, inasmuch as that recessions later in the timeframe were more often preceded by a yield curve inversion, and the amount of time between the recession and its most recent prior yield curve inversion declined. However, this seeming rise in the likelihood that a given recession would have been preceded by a recent yield curve inversion more likely simply reflects the large number of yield curve inversions in the final sub-period of 1870 to 1913. In the 44 years between the start of 1870 to the end of 1913, 33 yield curve inversions occurred, an average of one yield curve inversion every 16 months, with 21 of those 33 inversions not being followed by a recession within 18 months. This increasing frequency of yield curve inversions by the later nineteenth and early twentieth century seems to have partly been a result of the high demand for consols by that time, due to their status as a widely traded low risk asset, which caused them to change hands close to or even above their face value throughout much of the 1870 to 1913 sub-period, as was noted in Chapter 2 and can be seen illustrated in Figure 4 (Checkland 1957; Brown et al. 2004). This high demand placed a ceiling of sorts on consol yields, suppressing them closer to the relatively lower level which short-term interest rates are regarded as tending towards, but traders were simultaneously disincentivised from pushing consol yields so low as to offset the attractiveness of their safety and liquidity. As a result, the measure of long-term interest rates employed by this and other studies of nineteenth century Britain fluctuated within a relatively constrained window by the last sub-period of 1844 to 1870, allowing yield curve inversions to be triggered by relatively small movements in short-term interest rates relative to the low level of consol yields. The slower movement of consol yields by the late nineteenth century, as illustrated by Figure 4, may also reflect the relative institutional stability of the 1870 to 1913 sub-period, which arguably lacked any single legislative change as impactful on Britain's financial system as Peel's Bill of 1819, the various legislative changes which followed the Panic of 1825, or the Bank Charter

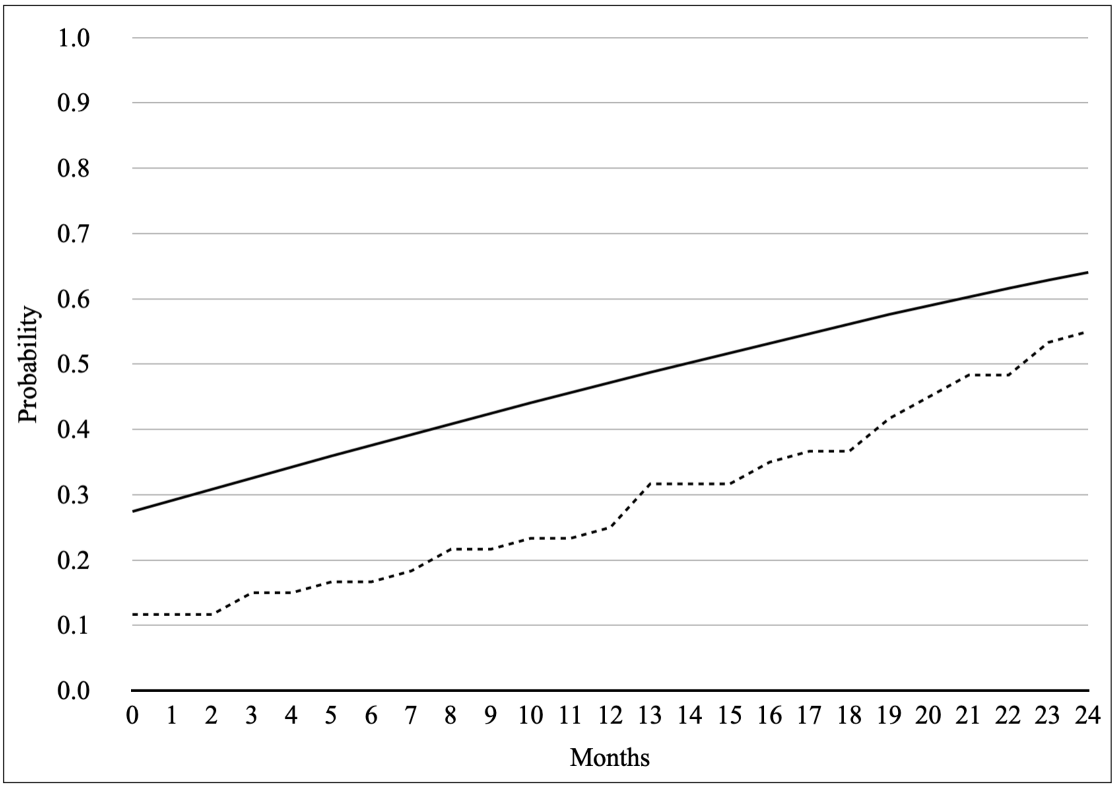
Act of 1844. This, in combination with the high demand for consols, may have contributed to the particularly low responsiveness of long-term compared to short-term interest rates to changes in monetary policy,[55] with this contributing to the higher number of yield curve inversions in that sub-period.

The high false positive rate throughout the 1800 to 1913 timeframe strongly tends to undermine the idea that yield curve inversions were reliable signals of oncoming recessions. In each of the four sub-periods, and in the full 1800 to 1913 timeframe, more than half of all yield curve inversions were false positives not followed by a recession, with the 1800 to 1821 sub-period boasting the lowest false positive rate of 55 per cent, and the 1821 to 1844 sub-period the highest of 71 per cent. Figure 15 indicates that the probability of a recession occurring within between 0 and 24 months of a yield curve inversion was consistently lower than the probability of a recession occurring within the same timeframe after the average month which did not feature a yield curve inversion, suggesting that a randomly selected non-inversion month would have offered a more reliable signal of an oncoming recession than a yield curve inversion, for the overall 1800 to 1913 timeframe.

Figure 16 presents precision-recall curves testing the reliability of yield curve inversions as predictors of oncoming recessions between 0 and 215 months hence, for the full timeframe and for each of the sub-periods, and for both chronologies of business cycle peak and trough dates. If there were some number of months after yield curve inversions within which they reliably signalled oncoming recessions, the slopes might be expected to take a concave down, decreasing shape. In other words there would be some number of months which would generate relatively high values of both precision and recall, indicating a high probability that a yield curve inversion would be followed by a recession within that timeframe, and a relatively lower probability that a non-

[55] This issue is discussed further in the next chapter.

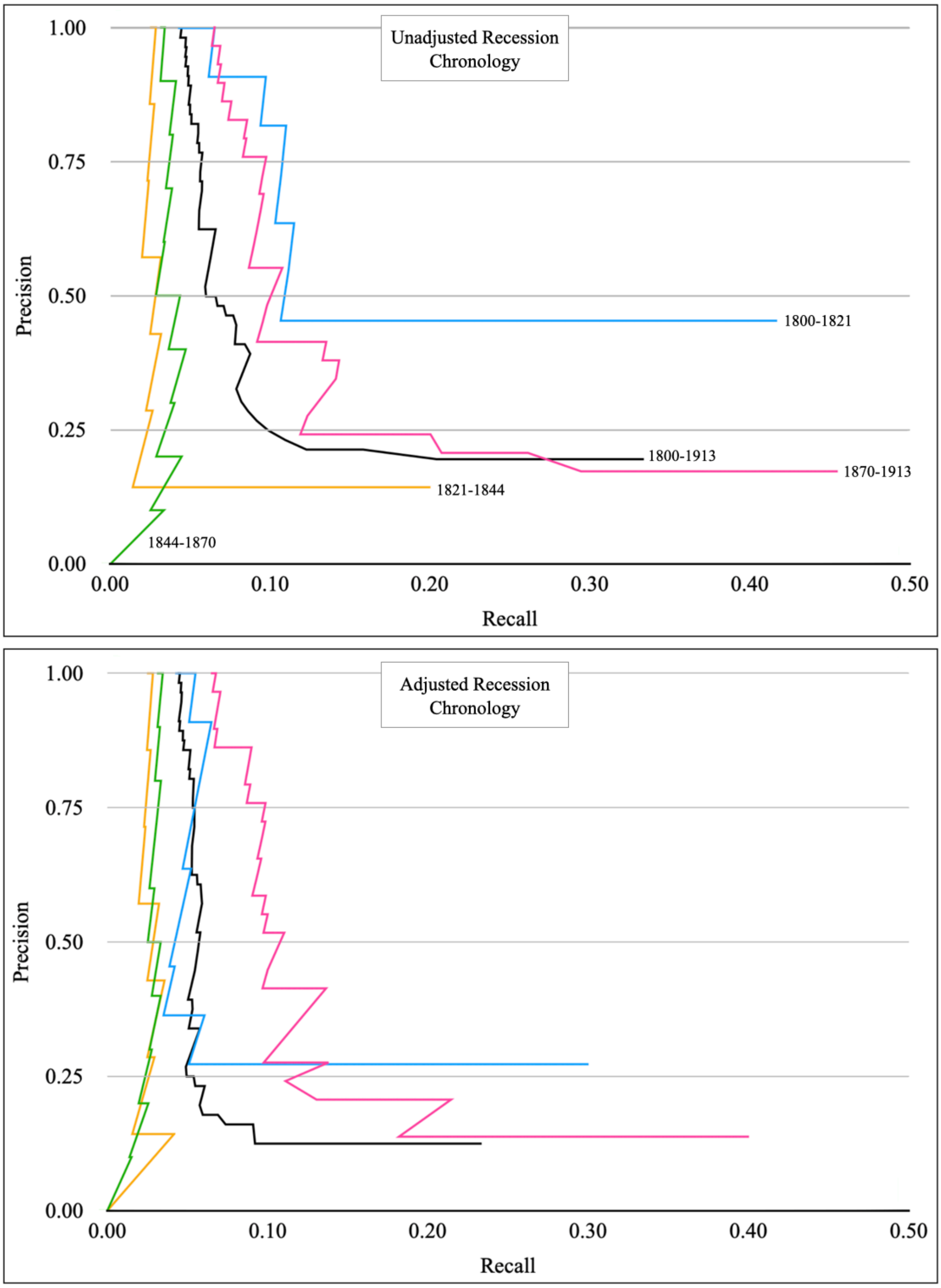
Figure 15. Probability of a Recession after Inversion and Non-Inversion Months, 1800-1913



Note: The dotted line indicates the probability of a recession occurring within a given number of months after a month in which a yield curve inversion occurred. The solid like indicates the probability of a recession occurring within a given number of months after a month in which a yield curve inversion did not occur. Recession dates adjusted from the chronology of Broadberry, Chadha, Lennard, and Thomas (2022, 21) in combination with the sources outlined in Appendix A. Yield curve data calculated from the data in Figure 4

inversion month would be followed by a recession within the same timeframe. Instead, the absence of any results with both high precision and recall values indicates that, regardless of the number of months allowed after a yield curve inversion within which one might choose to regard a recession as having been accurately predicted, the likelihood of an accurate prediction would still be low relative to the likelihood of a false positive or the likelihood that a randomly selected non-inversion month would have predicted a recession within the same timeframe, or both. The decision made throughout the rest of this chapter to follow Capie et al. (2019) in selecting 18 months as the timeframe after a fluctuation or inversion of the yield curve within which to investigate the subsequent movement of other variables, rather than deciding on this timeframe based on the predictive horizon of yield curve inversions suggested by the data presented in this thesis, reflects

Figure 16. Yield Curve Inversions as Recession Signals at Different Time Horizons, 1800-1913



Note: Precision-recall curves charting the capabilities of yield curve inversions as signals of oncoming recessions between 0 and 215 months hence, in the full timeframe and for each of the sub-periods, and for both of the recession chronologies. A higher precision value indicates a higher ratio of true positives to false positives at a given time horizon, in other words a greater proportion of yield curve inversions which were followed by a recession within a given number of months than were not. A higher recall value indicates a higher ratio of true positives to false negatives, in other words a greater proportion of yield curve inversions which were followed by a recession within a given number of months compared to non-yield curve inversion months which were followed by a recession within the same number of months. Sources of yield curve data and recession dates as in Figure 15.

this apparent absence of any timeframe after a yield curve inversion within which its accuracy as a signal of oncoming recessions exceeds that of a randomly selected non-inversion month. However, Figure 16 does at least indicate that yield curve inversions seem to have been relatively less unreliable as signals of oncoming recessions in the 1800 to 1821 and 1870 to 1913 sub-periods, as indicated by the relatively greater area under the curves representing those sub-periods, with this result holding when using both the adjusted and unadjusted chronologies. Overall however, all of these results strongly tend to suggest that yield curve inversions, as discrete events, were not reliable predictors of oncoming recessions in Britain between the years of 1800 and 1913, or in any of the four sub-periods of that timeframe, as they seem to have been in the United States since the late twentieth century.

Having assessed the reliability of yield curve inversions as signals of oncoming recessions, Tables 4, 5, 6, and 7 present the regression results concerning the association between the slope of the yield curve and the subsequent movement of real GDP at market prices and at factor cost, between 0 and 2 years hence in the case of the annual real GDP estimates considered in Tables 4 and 5, and between 0 and 18 months hence in the case of the monthly real GDP estimates considered in Tables 6 and 7. The large number of dependent variables in the cases of the monthly data required the arrangement of those dependent variables as the rows, rather than the columns, of Tables 6 and 7.

Tables 4 and 5 both return regression coefficients of more than 0.5 for real GDP at factor cost and at market prices one year hence, both to a significance level of les than 0.05, suggesting that an increase of one per cent in long-term relative to short-term interest rates (i.e. a steeper yield curve, as opposed to a flatter or more inverted one) was associated with an increase of more than 0.5 per cent in the annual growth rate of real GDP one year later, for the full 1800 to 1913

Table 4. The Slope of the Yield Curve and Subsequent Real GDP at Factor Cost, Annual

	Real GDP at Factor Cost, % change from previous year (Dependent Variable)			
	0 Years	1 Year	2 Years	DF
1800-1913	0.031 (0.269)	0.549 ** (0.263)	0.297 (0.269)	112
1800-1821	-0.711 (0.969)	0.266 (0.967)	-0.207 (0.969)	20
1821-1844	1.358 * (0.691)	1.419 * (0.697)	1.327 * (0.717)	22
1844-1870	0.256 (0.345)	0.566 * (0.314)	0.236 (0.331)	25
1870-1913	-0.212 (0.513)	0.722 (0.463)	0.598 (0.474)	42

Note: GDP data from Thomas and Dimsdale (2017, Sheet A8). Annual average of monthly yield curve values.
Standard errors in brackets under regression coefficient figures.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5. The Slope of the Yield Curve and Subsequent Real GDP at Market Prices, Annual

	Real GDP at Market Prices, % change from previous year (Dependent Variable)			
	0 Years	1 Year	2 Years	DF
1800-1913	0.018 (0.263)	0.524 ** (0.258)	0.292 (0.262)	112
1800-1821	-0.711 (0.969)	0.266 (0.967)	-0.207 (0.969)	20
1821-1844	1.336 * (0.683)	1.378 * (0.690)	1.303 * (0.707)	22
1844-1870	0.239 (0.331)	0.541 * (0.302)	0.218 (0.317)	25
1870-1913	-0.221 (0.485)	0.687 (0.440)	0.645 (0.440)	42

Note: GDP data from Thomas and Dimsdale (2017, Sheet A8). Annual average of monthly yield curve values.
Standard errors in brackets under regression coefficient figures.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6. The Slope of the Yield Curve and Subsequent Real GDP at Factor Cost, Monthly

		1800-1913	1800-1821	1821-1844	1844-1870	1870-1913
Real GDP at Factor Cost, % change from previous month (Dependent Variable)	0 Months	0.021*** (0.005)	0.016 (0.036)	0.118 *** (0.013)	0.018 *** (0.007)	0.012 (0.008)
	1 Month	0.024 *** (0.005)	0.010 (0.036)	0.119 *** (0.013)	0.021 *** (0.007)	0.017 ** (0.008)
	2 Months	0.026 *** (0.005)	0.007 (0.036)	0.120 *** (0.013)	0.023 *** (0.006)	0.019 ** (0.008)
	3 Months	0.026 *** (0.005)	-0.002 (0.036)	0.116 *** (0.014)	0.023 *** (0.006)	0.021 *** (0.008)
	4 Months	0.027 *** (0.005)	-0.005 (0.036)	0.110 *** (0.014)	0.025 *** (0.006)	0.024 *** (0.008)
	5 Months	0.028 *** (0.005)	-0.005 (0.036)	0.104 *** (0.014)	0.028 *** (0.006)	0.027 *** (0.008)
	6 Months	0.029 *** (0.005)	-0.006 (0.036)	0.098 *** (0.014)	0.031 *** (0.006)	0.028 *** (0.007)
	7 Months	0.030 *** (0.005)	-0.005 (0.036)	0.091 *** (0.014)	0.034 *** (0.006)	0.028 *** (0.007)
	8 Months	0.029 *** (0.005)	0.004 (0.036)	0.088 *** (0.014)	0.034 *** (0.006)	0.024 *** (0.007)
	9 Months	0.028 *** (0.005)	0.013 (0.036)	0.083 *** (0.015)	0.035 *** (0.006)	0.021*** (0.007)
	10 Months	0.028 *** (0.005)	0.024 (0.036)	0.082 *** (0.015)	0.037 *** (0.006)	0.018 ** (0.007)
	11 Months	0.029 *** (0.005)	0.040 (0.036)	0.081 *** (0.015)	0.037 *** (0.006)	0.016 ** (0.008)
	12 Months	0.028 *** (0.005)	0.052 (0.036)	0.079 *** (0.015)	0.035 *** (0.006)	0.015 ** (0.008)
	13 Months	0.028 *** (0.005)	0.074 ** (0.035)	0.080 *** (0.015)	0.033 *** (0.006)	0.017 ** (0.008)
	14 Months	0.027 *** (0.005)	0.086 ** (0.035)	0.079 *** (0.015)	0.029 *** (0.006)	0.018 ** (0.008)
	15 Months	0.029 *** (0.005)	0.103 *** (0.035)	0.085 *** (0.015)	0.026 *** (0.006)	0.023 *** (0.008)
	16 Months	0.029 *** (0.005)	0.115 *** (0.035)	0.087 *** (0.015)	0.024 *** (0.006)	0.024 *** (0.008)
	17 Months	0.027 *** (0.005)	0.125 *** (0.035)	0.087 *** (0.015)	0.021 *** (0.006)	0.021 *** (0.008)
	18 Months	0.026 *** (0.005)	0.131 *** (0.035)	0.086 *** (0.015)	0.017 *** (0.006)	0.021 *** (0.008)
	DF	1366	262	286	322	526

Note: GDP data from Thomas and Dimsdale (2017, Sheet A8), interpolated from annual data with annual figures placed at July as mid-point of year. Standard errors in brackets under regression coefficient figures.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 7. The Slope of the Yield Curve and Subsequent Real GDP at Market Prices, Monthly

		1800-1913	1800-1821	1821-1844	1844-1870	1870-1913
Real GDP at Market Prices, % change from previous month (Dependent Variable)	0 Months	0.020 *** (0.005)	0.016 (0.034)	0.116 *** (0.013)	0.017 *** (0.006)	0.011 (0.007)
	1 Month	0.023 *** (0.005)	0.010 (0.036)	0.117 *** (0.013)	0.020 *** (0.006)	0.015 ** (0.007)
	2 Months	0.024 *** (0.005)	0.007 (0.036)	0.117 *** (0.013)	0.022 *** (0.006)	0.018 ** (0.007)
	3 Months	0.024 *** (0.005)	-0.002 (0.036)	0.113 *** (0.013)	0.022 *** (0.006)	0.019 *** (0.007)
	4 Months	0.025 *** (0.005)	-0.005 (0.036)	0.107 *** (0.014)	0.024 *** (0.006)	0.022 *** (0.007)
	5 Months	0.027 *** (0.005)	-0.005 (0.036)	0.102 *** (0.014)	0.027 *** (0.006)	0.025 *** (0.007)
	6 Months	0.028 *** (0.005)	-0.006 (0.036)	0.095 *** (0.014)	0.030 *** (0.006)	0.027 *** (0.007)
	7 Months	0.028 *** (0.005)	-0.005 (0.036)	0.089 *** (0.014)	0.032 *** (0.006)	0.026 *** (0.007)
	8 Months	0.028 *** (0.005)	0.004 (0.036)	0.085 *** (0.014)	0.032 *** (0.006)	0.024 *** (0.007)
	9 Months	0.027 *** (0.005)	0.013 (0.036)	0.080 *** (0.014)	0.033 *** (0.006)	0.021 *** (0.007)
	10 Months	0.028 *** (0.005)	0.024 (0.036)	0.079 *** (0.014)	0.035 *** (0.006)	0.019 *** (0.007)
	11 Months	0.028 *** (0.005)	0.040 (0.036)	0.078 *** (0.014)	0.035 *** (0.006)	0.017 ** (0.007)
	12 Months	0.027 *** (0.005)	0.052 (0.036)	0.077 *** (0.014)	0.034 *** (0.006)	0.017 ** (0.007)
	13 Months	0.027 *** (0.005)	0.074 ** (0.035)	0.077 *** (0.014)	0.031 *** (0.006)	0.019 *** (0.007)
	14 Months	0.026 *** (0.005)	0.086 ** (0.035)	0.076 *** (0.014)	0.027 *** (0.006)	0.020 *** (0.007)
	15 Months	0.028 *** (0.005)	0.103 *** (0.035)	0.079 *** (0.014)	0.025 *** (0.006)	0.024 *** (0.007)
	16 Months	0.028 *** (0.005)	0.115 *** (0.035)	0.083 *** (0.014)	0.023 *** (0.006)	0.025 *** (0.007)
	17 Months	0.027 *** (0.005)	0.125 *** (0.035)	0.085 *** (0.014)	0.020 *** (0.006)	0.022 *** (0.007)
	18 Months	0.026 *** (0.005)	0.131 *** (0.035)	0.085 *** (0.014)	0.016 *** (0.006)	0.023 *** (0.007)
	DF	1366	262	286	322	526

Note: GDP data from Thomas and Dimsdale (2017, Sheet A8), interpolated from annual data with annual figures placed at July as mid-point of year. Standard errors in brackets under regression coefficient figures.
* p < 0.1, ** p < 0.05, *** p < 0.01

timeframe. This result conforms with the findings of much of the prior literature on the predictive qualities of the yield curve in other countries and at other times, which have generally found a positive association between the slope of the yield curve and future real GDP growth. However, none of the results returned in the cases of the sub-periods achieved a significance level of less than 0.05. This is likely a result of the small number of observations from which these results are drawn given the annual frequency of the data and the relatively short length of the sub-periods, resulting in higher standard errors.

The results presented in Tables 6 and 7 aimed to overcome this sample size issue through the use of data at a monthly frequency, allowing greater insight to be gained into the relationship between the slope of the yield curve and subsequent real GDP growth in the sub-periods of the 1800 to 1913 timeframe. In the case of both GDP at factor cost and GDP at market prices, for the full 1800 to 1913 timeframe, a statistically significant but relatively modest positive association can be seen between the slope of the yield curve and subsequent real GDP growth at every time lag from 0 to 18 months hence. A regression coefficient of 0.030 at a time lag of seven months, the highest returned for the full 1800 to 1913 timeframe, indicates that a 1 per cent rise in the level of long-term relative to short-term interest rates was associated with GDP at factor costs having grown by 0.03 per cent more from the previous month than it otherwise would have done seven months hence, equivalent to a 0.36 per cent increase in the annual growth rate. Similarly modest but statistically significant results were achieved for the latter two sub-periods of 1844 to 1870 and 1870 to 1913, at every time lag from 0 to 18 months and for both GDP at factor cost and GDP at market prices. The strongest association between the variables is evident in the first sub-period of 1800 to 1821, in the case of real GDP at both factor cost and market prices, with a 1 per cent increase in the level of long-term relative to short-term interest rates being associated with a 0.13 per cent increase in the monthly growth rate of real GDP 18 months hence, equivalent to an almost 1.6 per cent increase in the annual rate. An almost equally strong predictive association seems to have existed between the slope of the yield curve and the growth rate of real GDP in the 1821 to 1844 sub-period, although with a much shorter predictive horizon: a regression coefficient of 0.12 at a time lag of two months for real GDP at factor cost was the strongest result returned for this sub-period. Overall, the results for real GDP at factor cost and at market prices do not greatly diverge, but slightly higher regression coefficients generally seem to have been returned for the association between the slope of the yield curve and real GDP at factor cost, conforming with what might be expected based on the theoretical insight that the prices of capital goods and other higher-order goods will tend to be more sensitive to changes in interest rates than consumer goods due to their further remove from final consumption in the time structure of production (Foldvary 2015, 283).

Overall, these results tend to suggest that there was a positive association between the slope of the yield curve and future real GDP growth up to 18 months hence, both for the full 1800 to 1913 timeframe and to varying extents in each of the sub-periods, with the relationship seeming to have been at its strongest in the 1800 to 1821 sub-period, and to a lesser extent in the 1821 to 1844 sub-period. This tends to suggest that a flatter or more inverted yield curve likely did precede periods of slower or negative growth in nineteenth century Britain, even if yield curve inversions as discrete events were not reliable harbingers of oncoming recessions.

A somewhat similar picture of the predictive qualities of the slope of the yield curve is suggested by the results presented in Table 8, which indicates the extent to which increases in the slope of the yield curve were associated with subsequent increases in share prices. A positive association can be seen between the slope of the yield curve and subsequent share prices in the full timeframe and for each sub-period, although it appears to have been at its weakest in the 1821 to 1844 sub-period, with a one per cent increase in the level of long-term relative to short-term interest rates in that sub-period being associated with an immediate 0.17 per cent increase in the monthly

Table 8. The Slope of the Yield Curve and Subsequent Share Prices, Monthly

		1800-1913	1800-1821	1821-1844	1844-1870	1870-1913
Share prices, % change from previous month (Dependent Variable)	0 Months	0.088 ** (0.045)	0.266 (0.233)	0.171 ** (0.078)	0.044 (0.073)	0.201 ** (0.078)
	1 Month	0.076 * (0.045)	0.227 (0.232)	0.154 * (0.079)	0.058 (0.073)	0.154 * (0.079)
	2 Months	0.129 *** (0.045)	0.499 ** (0.231)	0.136 * (0.080)	0.151 ** (0.072)	0.163 ** (0.079)
	3 Months	0.175 *** (0.044)	0.435 * (0.231)	0.097 (0.080)	0.215 *** (0.072)	0.255 *** (0.078)
	4 Months	0.143 *** (0.045)	0.444 * (0.231)	0.067 (0.082)	0.142 * (0.073)	0.267 *** (0.078)
	5 Months	0.129 *** (0.045)	0.338 (0.232)	0.070 (0.082)	0.074 (0.073)	0.328 *** (0.077)
	6 Months	0.141 *** (0.045)	0.395 * (0.232)	0.105 (0.082)	0.103 (0.073)	0.315 ***
	7 Months	0.095 ** (0.045)	0.406 * (0.231)	0.156 * (0.082)	0.083 (0.073)	0.177 ** (0.078)
	8 Months	0.100 ** (0.045	0.392 * (0.231)	0.148 * (0.082)	0.141 * (0.073)	0.117 (0.078)
	9 Months	0.101 ** (0.045)	0.330 (0.231)	0.131 (0.082)	0.155 ** (0.073)	0.129 (0.078)
	10 Months	0.046 (0.045)	0.313 (0.231)	0.129 (0.086)	0.075 (0.073)	0.077 (0.078)
	11 Months	0.007 (0.045)	0.328 (0.230)	0.124 (0.088)	0.009 (0.073)	0.040 (0.078)
	12 Months	0.008 (0.045)	0.292 (0.227)	0.095 (0.088)	0.031 (0.073	0.023 (0.081)
	13 Months	0.027 (0.045)	0.303 (0.227)	0.087 (0.088)	0.004 (0.073)	0.097 (0.081)
	14 Months	0.046 (0.045	0.260 (0.225)	0.075 (0.088)	0.059 (0.073)	0.085 (0.081)
	15 Months	0.089 ** (0.045)	0.173 (0.225)	0.074 (0.088)	0.132 * (0.072)	0.122 (0.081)
	16 Months	0.109 ** (0.045)	0.154 (0.225)	0.079 (0.089)	0.126 * (0.072)	0.173 ** (0.080)
	17 Months	0.115 ** (0.045)	0.125 (0.226)	0.138 (0.088)	0.068 (0.072)	0.238 *** (0.080)
	18 Months	0.120 *** (0.045)	0.134 (0.225)	0.189 ** (0.088)	0.070 (0.072)	0.258 *** (0.081)
	DF	1366	262	286	322	526

Note: Share price index weighted by market capitalisation from Thomas and Dimsdale (2017, Sheet M13). Standard errors in brackets under regression coefficient figures.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 9. The Slope of the Yield Curve and Subsequent Wholesale/Producers' Prices, Monthly

		1800-1913	1800-1821	1821-1844	1844-1870	1870-1913
Wholesale/ Producers' prices, % change from previous month (Dependent Variable)	0 Months	0.133 ***	-0.153	0.115	0.279 ***	0.013
		(0.042)	(0.258)	(0.139)	(0.059)	(0.044)
	1 Month	0.108 ***	-0.250	0.107	0.209 ***	0.048
		(0.042)	(0.256)	(0.139)	(0.060)	(0.043)
	2 Months	0.077 *	-0.419	0.117	0.184 ***	0.023
		(0.042)	(0.255)	(0.139)	(0.060	(0.043)
	3 Months	0.096 **	-0.455 *	0.124	0.205 ***	0.029
		(0.041)	(0.254)	(0.139)	(0.060)	(0.043)
	4 Months	0.116 ***	-0.419	0.136	0.203 ***	0.083 *
		(0.041)	(0.254)	(0.139)	(0.060)	(0.043)
	5 Months	0.100 **	-0.467 *	0.140	0.170 ***	0.084 *
		(0.041)	(0.254)	(0.139)	(0.060)	(0.043)
	6 Months	0.090 **	-0.430 *	0.140	0.127 **	0.118 ***
		(0.041)	(0.256)	(0.139)	(0.060)	(0.043)
	7 Months	0.050	-0.562 **	0.143	0.077	0.095 **
		(0.041)	(0.256)	(0.139)	(0.061)	(0.043)
	8 Months	0.038	-0.434 *	0.126	0.045	0.090 **
		(0.041)	(0.256)	(0.140)	(0.061)	(0.045)
	9 Months	0.041	-0.347	0.174	0.062	0.042
		(0.041)	(0.251)	(0.139)	(0.061)	(0.045)
	10 Months	0.033	-0.271	0.151	0.080	0.002
		(0.041)	(0.252)	(0.140)	(0.061)	(0.045)
	11 Months	0.026	-0.242	0.189	0.076	-0.019
		(0.041)	(0.249)	(0.139)	(0.061)	(0.045)
	12 Months	0.030	-0.168	0.185	0.086	-0.029
		(0.041)	(0.248)	(0.139)	(0.060)	(0.045)
	13 Months	0.032	-0.273	0.203	0.079	0.001
		(0.041)	(0.246)	(0.139)	(0.060)	(0.046)
	14 Months	0.035	-0.169	0.216	0.072	0.007
		(0.041)	(0.248)	(0.138)	(0.060)	(0.047)
	15 Months	0.033	-0.230	0.208	0.072	0.021
		(0.041)	(0.250)	(0.138)	(0.060)	(0.047)
	16 Months	0.028	-0.214	0.197	0.067	0.018
		(0.041)	(0.247)	(0.138)	(0.060)	(0.047)
	17 Months	0.019	-0.103	0.164	0.046	0.025
		(0.041)	(0.245)	(0.138)	(0.060)	(0.047)
	18 Months	0.032	-0.176	0.120	0.092	0.022
		(0.041)	(0.245)	(0.137)	(0.060)	(0.047)
	DF	1366	262	286	322	526

Note: Wholesale/Producers' price index from Thomas and Dimsdale (2017, Sheet M1). Standard errors in brackets under regression coefficient figures.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

rate of change of share prices. Regression coefficients of between 0.21 and 0.33 between three and five months hence suggest a slightly stronger and more predictive relationship in the 1844 to 1870 and 1870 to 1913 sub-periods, but the strongest result is again to be found in the 1800 to 1821 sub-period, with a 1 per cent increase in the level of long-term relative to short-term interest rates being associated with an increase of 0.5 per cent in the monthly rate of change of share prices two months hence.

The predictive relationship between the slope of the yield curve and wholesale/producers prices, summarised in Table 9, differs somewhat from the positive associations between the slope of the yield curve and subsequent real GDP and share prices, which seem to have existed in each sub-period and been strongest between 1800 and 1821. A positive association does seem to have existed between the slope of the yield curve and the level of wholesale/producers' prices in the same month during the 1844 to 1870 sub-period and the full 1800 to 1913 timeframe, while a weaker but more predictive relationship can be seen in the 1870 to 1913 sub-period. However, no statistically significant relationship between the variables appears to have existed in the 1821 to 1844 sub-period, and a significant relationship in the opposite direction can be seen in the 1800 to 1821 sub-period, indicating that a 1 per cent increase in the level of long-term relative to short-term interest rates was associated with the monthly growth rate of wholesale/producers' prices being more than 0.5 per cent lower than it otherwise would have been, seven months hence. This might reflect the transition away from a wartime economy which characterised the latter part of the 1800 to 1821 sub-period, with a significant steepening of the yield curve from 1816 onwards, seen in Figures 6 and 7, coinciding with a decline in demand for wholesale and producers which had previously been required for the war effort (O'Brien 1989). While further investigation into the causes of this contrary result might add a further dimension to our understanding of the predictive qualities of the term structure of interest rates, the results presented in Table 9 nevertheless tend to support the view that there was a positive association between the slope of the yield curve and wholesale/producers' prices in Britain between 1844 and 1913, and to some extent during the full 1800 to 1913 timeframe.

Having assessed the predictive relationship between the slope of the yield curve as a continuous variable and a number of other macroeconomic variables available at a monthly frequency in Britain between the years of 1800 and 1913, the extent to which the yield curve tended to be flatter or more inverted prior to recessions than at other times will now be investigated. This question is approached via a series of t-tests gauging the extent to which a statistically significant difference existed between the average slope of the yield curve a given number of months before recessions and the average slope of the yield curve the same numbers of months before non-recession months. The results of these tests are summarised in Table 10 and graphically represented by Figures 17 to 21. Note the differing y-axis scales of Figures 17 to 21. Figures 17 to 21 represent the results achieved using the adjusted chronology of recession dates; the full results of these t-tests, including graphical representations of the results achieved using the unadjusted chronology, can be found in Appendix B of this thesis.

The results achieved by this method indicate that there was indeed a tendency for the slope of the yield curve to have been significantly flatter or more inverted on average prior to recessions than at other times, even if yield curve inversions did not reliably precede recessions in nineteenth century Britain. In terms of the tendency for the yield curve to have been flatter or more inverted prior to the first month of a recession, the strongest result can be seen in the 1870 to 1913 sub-period and during the full 1800 to 1913 timeframe, with a weaker bust still significant tendency being seen in the 1800 to 1821 and 1821 to 1844 sub-periods. No significant tendency in this regard appears in the 1844 to 1870 sub-period, but this likely in part reflects the low number of recessions

Table 10. Summary of the T-Test Results (Adjusted Chronology)

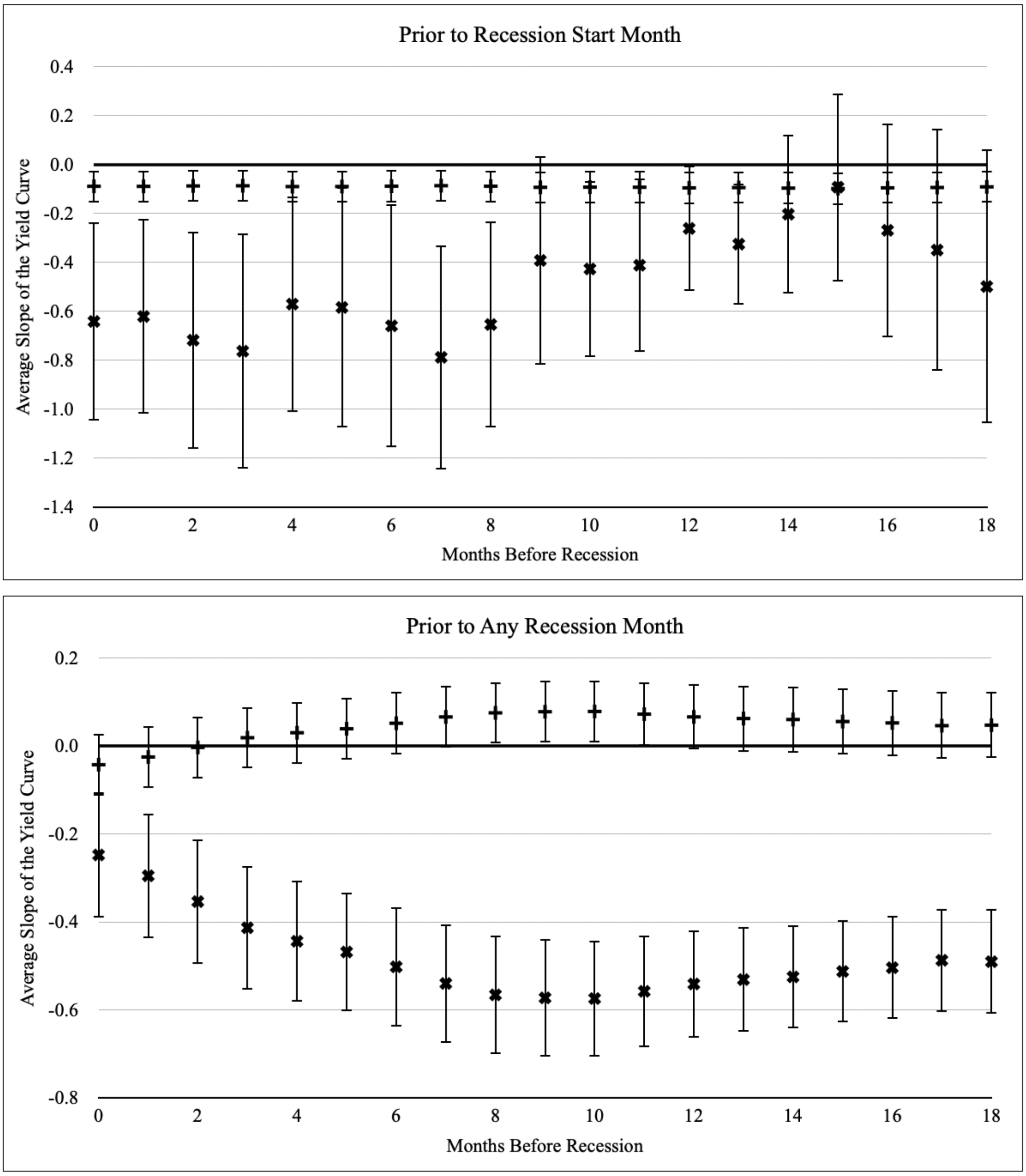
	1800-1913	1800-1821	1821-1844	1844-1870	1870-1913
Was the yield curve significantly flatter or more inverted on average prior to the start of a recession?	Yes, between 0 and 3 months and between 6 and 8 months prior. Peak difference: -0.702 on average 7 months before the start of recessions. ***	Yes, between 11 and 14 months prior. Peak difference: -0.409 on average 12 months before the start of recessions. **	Yes, 3 months prior. Peak difference: -0.524 on average 3 months before the start of recessions. *	No.	Yes, between 0 and 3 months prior, and 7 months prior. Peak difference: -1.911 on average 7 months before the start of recessions. ***
Was the yield curve significantly flatter or more inverted on average prior to recession months in general, not just the start month of a recession?	Yes, between 0 and 18 months prior. Peak difference: -0.652 on average 10 months before recessions. ***	Yes, 18 months prior. But the slope of the yield curve was significantly steeper between 0 and 1 months prior to recessions. Peak difference: +0.223 on average during recessions. ***	Yes, between 0 and 18 months prior. Peak difference: -1.315 on average during recessions. ***	Yes, between 3 and 18 months prior. Peak difference: -0.985 on average 10 months before recessions. ***	Yes, between 4 and 18 months prior. Peak difference: -0.745 on average 11 months before recessions. ***

Note: 'Peak Difference' numbers show the difference between the average slope of the yield curve (i.e. the level of long-term relative to short-term interest rates) a given number of months before a recession and the same number of months before a non-recession month, in whichever month between 0 and 18 that difference was greatest. Results achieving a significance level less than 0.1 but more than 0.05 were not summarised except for the 1821-1844 result in the first row, as this was the most significant result achieved in that case.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

in that sub-period, which could be expected to exaggerate the impact of possible inaccuracies in the adjusted chronology of recession peak and trough dates on these results.

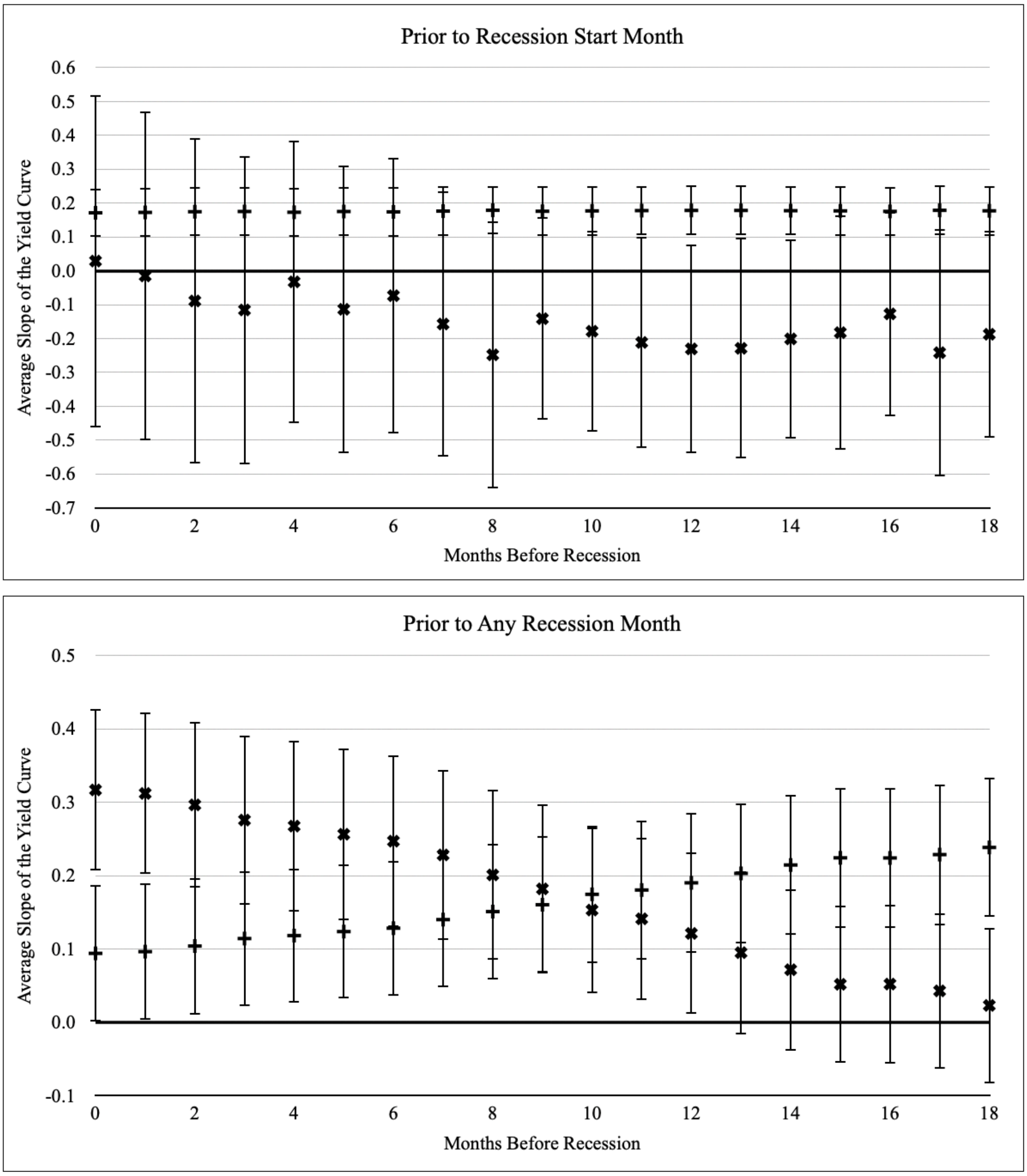
When aiming to increase the sample sizes of these averages by assessing the average slope of the yield curve a given number of months before any recessions month, rather than just before the start month of a recession, compared with its average level the same number of months before a non-recession month, the tendency of the yield curve to have been flatter or more inverted prior to recessions than at other times in most sub-periods appears more clearly. A strong tendency is seen in the 1821 to 1844 sub-period for the level of long-term relative to short-term interest rates to have been significantly lower during recessions than at other times, and in the overall 1800 to 1913 timeframe as well the latter two sub-periods a clear tendency can be seen for the slope of the yield curve to have been flatter or more inverted on average prior to recessions than at other times. The outlier in this regard is the 1800 to 1821 sub-period, during which the slope of the yield curve appears to have been significantly more steeply sloping during recessions than at other times, on average. This result is particularly counterintuitive given the relatively strong association

Figure 17. Average Slope of the Yield Curve Prior to Recessions and at Other Times, 1800 - 1913



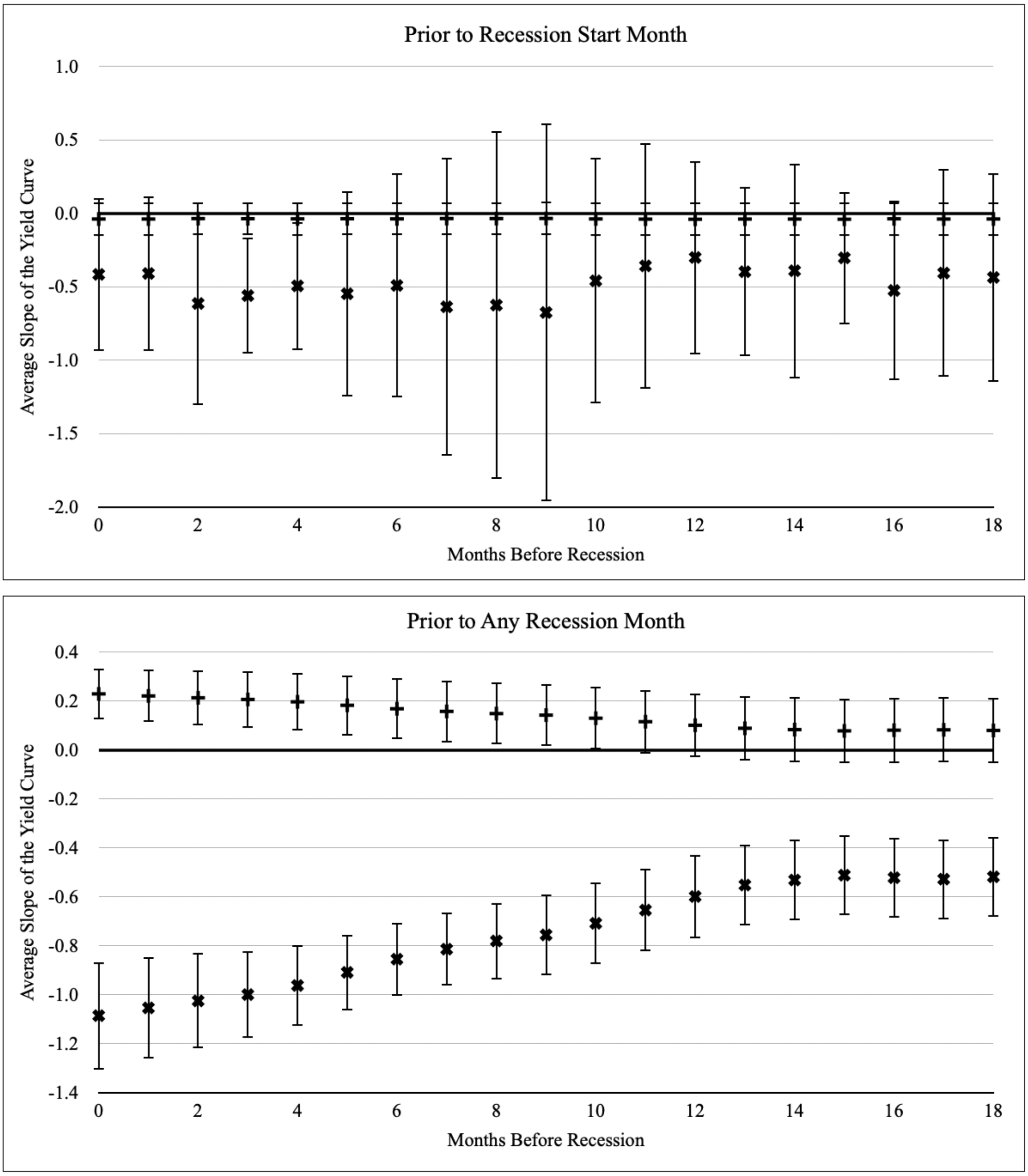
Note: ✖ = Mean slope of the yield curve a given number of months before a recession.
✚ = Mean slope of the yield curve when not a given number of months before a recession.
'Candlesticks' represent 95% confidence intervals.

Figure 18. Average Slope of the Yield Curve Prior to Recessions and at Other Times, 1800 - 1821



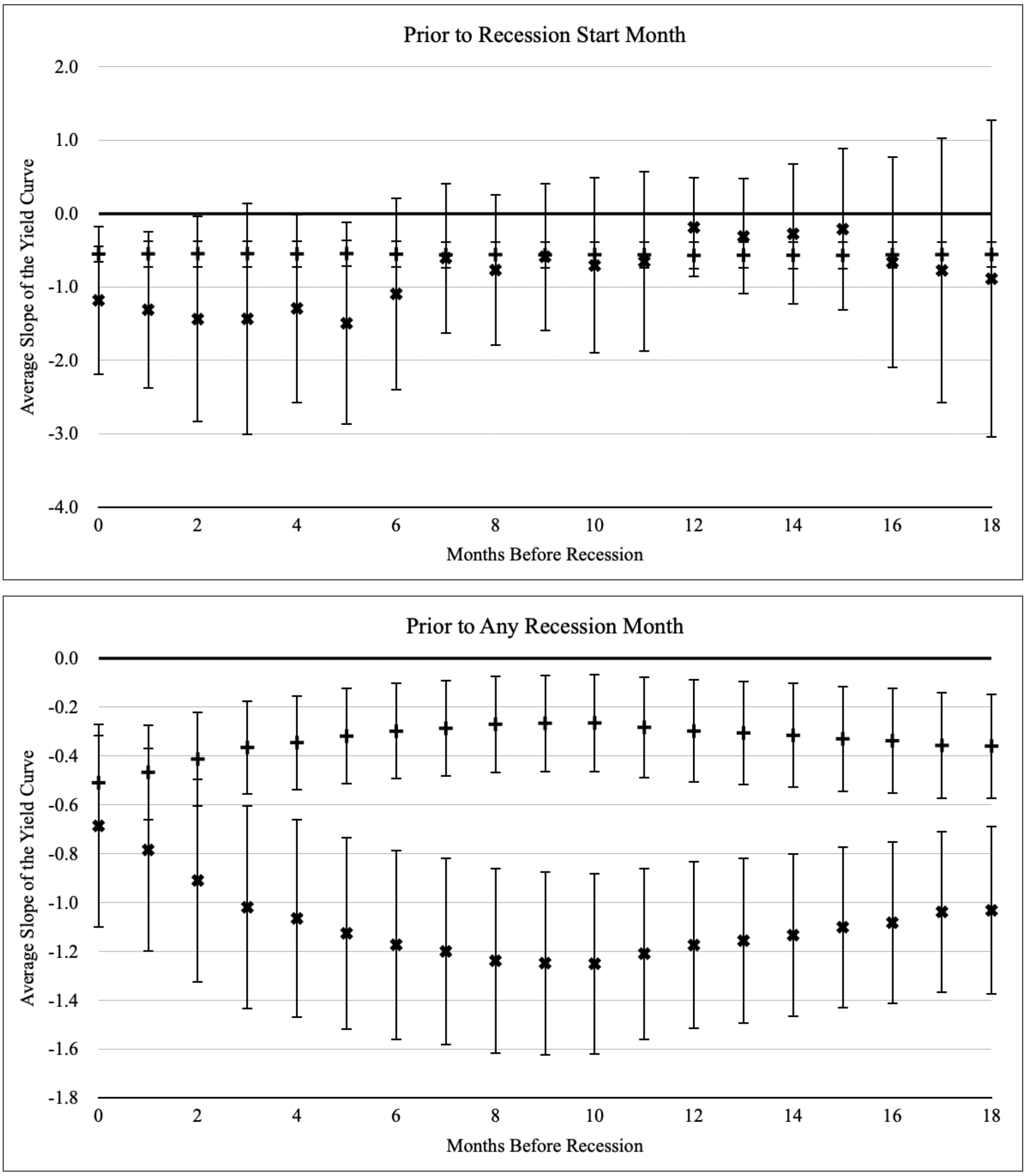
Note: ✖ = Mean slope of the yield curve a given number of months before a recession.
✚ = Mean slope of the yield curve when not a given number of months before a recession.
'Candlesticks' represent 95% confidence intervals.

Figure 19. Average Slope of the Yield Curve Prior to Recessions and at Other Times, 1821 - 1844



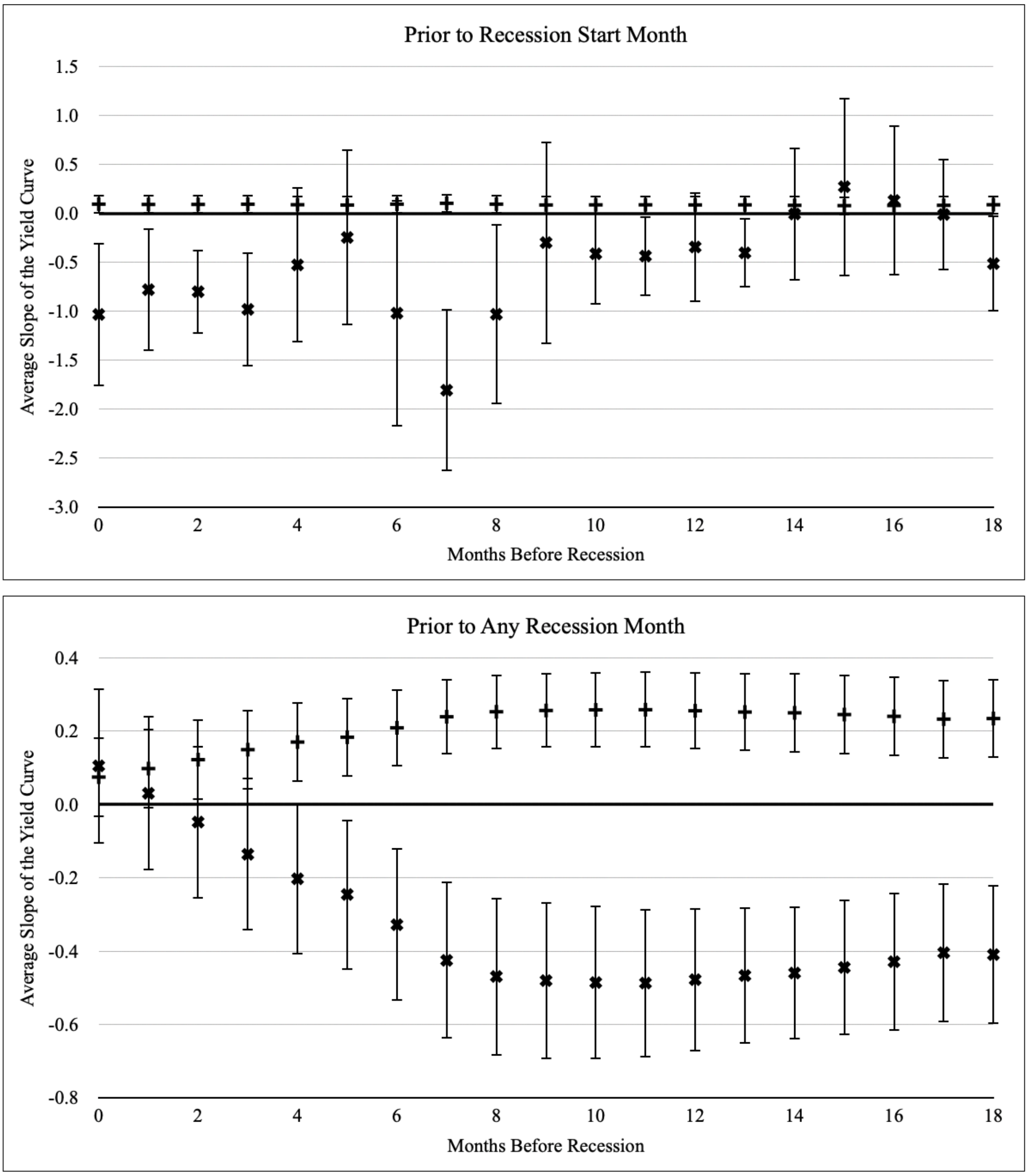
Note: ✖ = Mean slope of the yield curve a given number of months before a recession.
✚ = Mean slope of the yield curve when not a given number of months before a recession.
'Candlesticks' represent 95% confidence intervals.

Figure 20. Average Slope of the Yield Curve Prior to Recessions and at Other Times, 1844 - 1870



Note: ✖ = Mean slope of the yield curve a given number of months before a recession.
✚ = Mean slope of the yield curve when not a given number of months before a recession.
'Candlesticks' represent 95% confidence intervals.

Figure 21. Average Slope of the Yield Curve Prior to Recessions and at Other Times, 1870 - 1913



Note: ✖ = Mean slope of the yield curve a given number of months before a recession.
✚ = Mean slope of the yield curve when not a given number of months before a recession.
'Candlesticks' represent 95% confidence intervals.

between the slope of the yield curve and future levels of real GDP and share prices in that sub-period. The cause may lie in the generally higher and more variable long-term interest rates in this sub-period than in others, as can be seen illustrated in Figure 4, partly reflecting the long-term economic uncertainty stoked by the Napoleonic Wars. These higher long-term interest rates in this sub-period appear to have resulted in steeply upward sloping yield curves during the recessions of 1803 to 1804, 1810 to 1811, and 1818 to 1820, as can be seen illustrated in Figure 7. Despite this counterintuitive result, these results generally tend to support the view that the yield curve tended to be significantly flatter or more inverted on average prior to recessions than at other times, both in the full 1800 to 1913 timeframe and to varying extents in each of the sub-periods.

In conclusion, the results presented in this chapter clearly do not indicate that yield curve inversions, as discrete events, were reliable signals of oncoming recessions in Britain between the years of 1800 and 1913, in the sense that they appear to have been in the United States since the mid-twentieth century. However, despite the limitations of the available data, there is evidence for the existence of positive associations between the slope of yield curve and the subsequent rate of growth of real GDP and share prices, with these predictive relationships appearing to have been most pronounced in the 1800 to 1821 sub-period. A positive association can also be seen between the slope of the yield curve and subsequent growth of wholesale/producers' prices in the years after 1844, with the association between the yield curve and share prices also having been relatively strong in that later part of the timeframe. Furthermore, there does seem to have been a tendency for the yield curve to have been flatter or more inverted on average prior to recessions than at other times, both in the full 1800 to 1913 timeframe and to varying extents in each of the sub-periods. Despite the failure of yield curve inversions to have reliably predicted recessions in Britain between 1800 and 1913, these results generally align with those of much of the prior literature on the predictive qualities of the term structure of interest rates, in the sense that they indicate the existence of a positive association between the slope of the yield curve and future economic growth.

The finding that yield curve inversions were unreliable signals of oncoming recessions contrasts with the conclusions of the prior study of the predictive qualities of the term structure of interest rates in nineteenth century Britain, by Capie et al. (2019, 11), who found "reasonably strong support" for the hypothesis that yield curve inversions had predicted recessions in the United Kingdom between the years of 1822 and 1913. This divergence likely reflects the different approach taken by their study for arriving at a monthly chronology of business cycle peak and trough dates. While the chronologies employed in this chapter were based on historical details and insights drawn from a range of sources, Capie et al. derived their series of estimated recession dates by isolating the cyclical component of interpolated monthly real GDP estimates, with their results indicating lower long-term relative to short-term interest rates prior to downturns in their GDP series. In this sense, their results arguably compare most directly not with the analysis of the relative numbers of true positive and false positive yield curve inversions presented earlier in this chapter, but rather with the analysis of the association between the slope of the yield curve and subsequent real GDP growth, which conformed with their finding of a positive association between these two variables. The t-test results presented above also generally conform with the conclusion of their study that the yield curve tended to be flatter or more inverted on average in the 18 months prior to recessions than at other times. In these senses, while the findings of this chapter that yield curve inversions were not reliable predictors of oncoming recessions seem to contrast with the spirit of the conclusions of Capie et al. (2019), the aspects of its methodology which aligned more closely with theirs produced results which tended to support their view of the slope of the term structure as having exhibited a positive association with future economic growth in nineteenth century Britain.

Another noteworthy sense in which these results align with those of the prior literature concerns the relatively stronger association between the slope of yield curve and future growth of GDP and share prices in the 1800 to 1821 sub-period. Given the suspension of the convertibility of the currency into specie throughout most of this sub-period, the results achieved seem to align with the findings of Baltzer and Kling (2007), whose research suggested that the predictive qualities of the term structure of interest rates were at their strongest in Germany during periods when the monetary regime was less credible and inflation expectations were higher, such as the period between the two World Wars and to a lesser extent under the floating exchange rate regime following the dissolution of the Bretton Woods international monetary system. Bordo and Haubrich (2004) also argued that the predictive qualities of the term structure of interest rates could be expected to be most pronounced during periods of higher inflation expectations, due to the disproportionately greater impact of real than inflationary shocks on the slope of the yield curve under such circumstances. The strong results achieved in a sub-period during which the convertibility of the currency into specie was suspended, and during which war-related external shocks appear to have played a role in several of the recessions,[56] tends to support this view. The relatively smaller association between the slope of the yield curve and subsequent real GDP growth in the years after 1844 arguably also lends support to this view, given the senses in which the Bank Charter Act of 1844 and adherence to the international classical gold standard arguably functioned as commitment mechanisms and signals of credibility which can be expected to have lowered inflation expectations (Bordo and Kydland 1995). The results of the 1800 to 1821 sub-period also align with the findings of Wood (1983), who observed higher interest rates and more frequent yield curve inversions in the United States during the period of unconvertible paper currency from 1862 to 1878 which he attributed to higher inflation expectations resulting in a higher ‘normal’ level to

[56] See Appendix A.

which interest rates were expected to return. The yield curve inverted on average once every two years from 1800 to 1821, more frequently than in any other sub-period except for 1870 to 1913.

There are a number of senses in which the results presented in this chapter also suggest that the changing extent of the predictive relationship between the yield curve and other variables may have been driven in part by changes in the historical and institutional context outlined in Chapter 2. The strengthening association between the slope of the yield curve and future share prices after 1844 may in part reflect the more active use of variations in the Bank rate to influence short-term interest rates after the passage of the Bank Charter Act of 1844 (Kynaston 2017, 143-145), and the increasing use of open market operations for the same purpose after 1873 (Capie et al. 1994, 129). This increasing shift to a more active use of the Bank rate to manage the supply of credit is likely to have both contributed to driving fluctuations in the yield curve, due to the seemingly greater influence of fluctuations in the Bank rate on short-term than long-term interest rates in this period (Berument et al. 2017), while also being amongst the monetary influences on stock prices (Campbell, Quinn, Turner, and Ye 2018). This apparent increase in the impact of interest rates on share prices likely also stems in part from the substantial increase in the liquidity of the London stock market over the course of the nineteenth century. A range of factors contributed to the increasing liquidity of the market for shares in London, including the growth in the number of joint-stock banks as a result of the legislative aftermath of the Panic of 1825, the emergence and development of increasing numbers of large publicly traded companies including railways from the 1830s onwards, and the general increase in the number of investors, including small investors, trading stocks and shares in Britain by the late nineteenth century (Campbell, Turner, and Ye 2018; Acheson and Turner 2008b; Rutterford et al. 2011; Michie 1999, 95). This increasingly brisk trade of shares, and the decline in transaction costs generally associated with a more liquid market, likely contributed to an increasingly close association between interest rates and share prices by the later nineteenth century, as declines in short-term interest rates could be expected to have resulted in increasingly immediate and substantial rises in the demand for equities compared to the demand for fixed-income assets like bonds. This effect is seemingly reflected in the increasingly positive association between the slope of the yield curve (i.e. the level of long-term relative to short-term interest rates) and share prices in the sub-periods after 1844.

The decline in the strength of the association between the slope of the yield curve and real GDP in the later sub-periods may also reflect the high demand for and consequently suppressed yields of consols, discussed above, which could be expected to have limited the extent to which long-term interest rates might otherwise have risen relative to short-term interest rates during or prior to periods of growth, or fallen relative to short-term interest rates prior to recessions.

There are a number of potential avenues for future research on this topic which might be hoped to contribute to a fuller and more accurate understanding of the predictive qualities of the term structure of interest rates in nineteenth century Britain. Needless to say, any new and improved data series of real GDP or other relevant macroeconomic variables at a finer than annual frequency which might become available could be incorporated into future studies to arrive at a wider and more robust range of results. This chapter primarily aimed to consider the relationship between the yield curve and the subsequent movements of other variables available at a monthly frequency, with limitations in the available data in this regard constraining the number of variables which could be considered. However, the relatively illuminating regression results achieved using interpolated monthly GDP estimates suggests that further insights might be gained by assessing the relationship between the monthly yield curve data and other macroeconomic variables interpolated from annual data available for the full 1800 to 1913 timeframe, such as estimates of unemployment, wages, trade volumes, and so forth. A closer comparison with the results of influential prior studies might also be enabled by future efforts to replicate their methods to as close an extent as the nineteenth century

British data allows, with this potentially opening the door to further analysis of the predictive qualities of the yield curve in comparison with other leading indicators (Estrella and Mishkin 1998).

However, given the limitations of the available data and given the paucity of the prior literature, the results presented in this chapter nevertheless offer an illuminating insight into the predictive qualities of the term structure of interest rates in Britain during the broad and significant 1800 to 1913 timeframe. These results indicated that yield curve inversions were not reliable signals of oncoming recessions in nineteenth century Britain, as they appear to have been in the late-twentieth century United States. However, a predictive relationship does seem to have existed between the slope of the yield curve and subsequent real GDP, share prices, and wholesale/producers' prices, and there does seem to have been a tendency for the yield curve to have been flatter or more inverted prior to recessions than at other times, with these results aligning with the positive association found between the slope of the yield curve and future economic activity throughout much of the prior literature. Chapter 4 will now turn to the question of the causes of yield curve fluctuations in nineteenth century Britain.

Chapter Four: Causes of Yield Curve Fluctuations in Britain, 1800-1913

In the previous chapter of this thesis, evidence was presented which suggested that there was a positive association between the slope of the yield curve and future growth in Britain between the years of 1800 and 1913, although the extent and timing of this relationship varied over the course of that period. A tendency also seems to have existed for the yield curve to have been flatter or more inverted prior to recessions than at other times. This chapter will evaluate two commonly discussed explanations of the causes of the predictive relationship between the term structure of interest rates and future economic growth, in terms of the extent to which they seem to explain the nineteenth century British data. The first of these potential explanations is the policy anticipations hypothesis, which holds that the tendency of yield curve inversions to occur prior to recessions is a result of the fact that investors foresee the oncoming recession and expect future short-term interest rates during the recession to be lower than their present pre-recession levels, which causes long-term interest rates to decline relative to short-term interest rates in the present. A contrasting view will also be considered, that pre-recession yield curve inversions instead reflect rises in short-term relative to long-term interest rates as a result of efforts to contract the supply of money and credit to counteract the inflation and outflows of bank reserves which tend to occur toward the peak of the business cycle, with the predictive association between the yield curve and the business cycle being a result of the fact that such credit contraction might be expected to both raise short-term relative to long-term interest rates and contribute to a decline in borrowing, investment, and economic activity. Both of these views can be seen as offshoots of different underlying theories of interest and of the term structure of interest rates. Given the range of contrasting views on these topics and their closeness to the subject area of this thesis, this chapter will begin with an overview of a number of the most prominent and frequently discussed competing interest theories, in order to contextualise the later discussion of the competing views of the causes of the predictive relationship between the term structure of interest rates and the business cycle.

I - Literature Review

Given the breadth of the literature concerning the determinants of interest rates, and by extension the causes of fluctuations in the term structure of interest rates, it would be entirely possible for the scope of this chapter to be exceeded by too comprehensive a review of a subject which has been called "the black hole of economics" (Murphy 2003, iii). Indeed, even the logically antecedent question of the economic reasons for the existence of the phenomenon of interest has produced a literature which has been the subject of book-length reviews, notably Eugen von Böhm-Bawerk's magisterial *Capital and Interest* (1884). In the years since Böhm-Bawerk's influential critique of prior interest theories, no consensus has yet emerged concerning the nature and determinants of interest rates, and a number of theories remain in competition, amongst which the most widespread include the pure time preference theory associated with the Austrian School, the neoclassical theory of interest, the loanable funds theory developed by Knut Wicksell, and the liquidity preference theory developed by John Maynard Keynes. A brief overview of these may contribute to a fuller understanding of the competing views of the causes of the predictive qualities of the term structure of interest rates, evaluated later in this chapter.

Competing Theories of Interest

The first of the aforementioned interest theories was pioneered by Böhm-Bawerk himself, who argued that the existence of the phenomenon of interest was a result of the fact that individuals tend to value goods and services available in the present more highly than those which will not be available until some future time, a tendency which came to be referred to as 'time preference' (Böhm-Bawerk 1888, 237; Belke and Polleit 2009, 153). Böhm-Bawerk argued that this preference for present over future goods was the result of three main factors: the fact that individuals are always aware of the urgency of their needs in the present but might expect that urgency to diminish in the future due to a possible increase in income; the fact that people tend to systematically undervalue and underestimate the satisfaction they will receive from consumption in the future, for psychological reasons; and finally the fact that a good received immediately can be put to work in a long-term production process which could be expected to produce a greater value at a given future date than if the receipt of the original good had simply been delayed until closer to that date, due to the generally greater productivity of long-term than short-term production processes (Böhm-Bawerk 1888, 249-272).[57] Böhm-Bawerk's time preference theory of interest was developed by his student Ludwig von Mises into the 'pure time preference theory' commonly advocated by modern adherents of the Austrian School. Mises argued that time preference was not merely a tendency resulting from the psychological and practical factors cited by Böhm-Bawerk, but was instead a logically necessary result of the nature of human action itself: the fact that human beings act toward the attainment of desired ends implies a higher valuation of present than future satisfaction, otherwise such action would be indefinitely postponed (Mises 1949, 481). The intensity of this preference for present over future satisfaction will vary between individuals, with the equilibrium market rate of interest being determined by the utility maximising efforts of these different individuals; low time preference individuals deferring gratification by saving or lending until the marginal utility of doing so falls below the utility of having an additional marginal unit of money in the present, while high time preference individuals satisfy their present desires by spending or borrowing until the marginal utility of doing so falls below the present utility of saving or investing an additional marginal unit of money for the future (Böhm-Bawerk 1888, 278; Belke and Polleit

[57] This last explanation of the phenomenon of time preference proved controversial, sparking a debate concerning whether Böhm-Bawerk had retreated back into a productivity theory of interest of the kind which he had otherwise trenchantly critiqued (Böhm-Bawerk 1884, 111-181). The subsequent development of the 'pure time preference theory' aimed to extirpate this productivity element from Böhm-Bawerk's theory of interest (see Murphy 2003, 1-57).

2009, 160). The identification of the phenomenon of time preference as the source of interest marks this theory as a real, rather than a monetary, theory of interest; the existence of different rates of time preference amongst individuals could be expected to lead to the emergence of interest rates for the lending of non-monetary goods in a hypothetical barter economy.

The neoclassical theory of interest offers an alternative real interpretation of the determinants of interest rates. Following on from Böhm-Bawerk, the neoclassical theory agrees the market equilibrium rate of interest is determined on the demand side by the varying time preferences of different market participants and the interaction of their subjective marginal utility decisions concerning the exchange of present for future goods. However, the neoclassical view diverges from the pure time preference theory in identifying the objective marginal productivity of capital in the broader economy, as opposed to subjective time preferences of lenders, as the principal supply-side driver of interest rate fluctuations (Belke and Polleit 2009, 160-171). This view was advocated by Frank Knight (Knight 1927, 120-121; Arthmar and Castaneda 2023), and could be seen as an extension of the broader neoclassical value theory pioneered by Alfred Marshall, which holds that prices are determined by individuals' subjective marginal utility considerations on the demand side, and by costs of production on the supply side (Marshall 1890, 348; Huerta de Soto 2008, 58).

Distinct from both of these views is the loanable funds theory first advanced by Knut Wicksell, which incorporated both real and monetary elements. Wicksell distinguished between the 'natural' and 'market' rates of interest, with the natural rate being the real rate which would be arrived at in an equilibrium without banks or bank money, in which credit transactions would consist of inter-temporal payments-in-kind of capital goods. The natural rate would therefore be neutral in terms of driving neither increases nor decreases in commodity prices (Wicksell 1898, 102; Belke and Polleit 2009, 172-174; Bertocco and Kalajzić 2023, 37). In contrast to the unobservable natural rate which would be arrived at in equilibrium, the actually prevailing market rate is set by the supply of and demand for loanable funds, with supply being determined by banks based on their willingness and ability to extend credit by expanding the money supply, rather than by real factors such as the marginal productivity of capital or the time preferences of market participants. In making this distinction, Wicksell hoped to account for what he perceived to be shortcomings in the ability of the quantity theory of money to explain the causes of price level changes in the context of modern monetary arrangements. In economies where the money supply primarily consists of specie and banknotes, individuals will express their demand for money by accumulating a stock of money to finance transactions, in which case the quantity theory would suggest that price level changes are primarily caused by exogenous increases or decreases in the supply of money above or below the demand to hold money stocks. However, Wicksell argued that the widespread use of bank money and demand deposits altered this arrangement: to the extent that demand for money rose, this would now be embodied not by an accumulation of money stocks but rather by an increase in the demand for borrowing, which banks could accommodate by engaging in credit expansion, making the supply of money endogenous to the demand for money (Bertocco and Kalajzić 2023, 36-37). To the extent that banks increased, for example, the extent of their lending relative to their reserves, this would influence the market rate of interest downwards, which would stimulate an expansion of economic output and, Wicksell argued, lead to price level increases if the market rate fell below the natural rate (Belke and Polleit 2009, 172). The loanable funds theory was further developed by Bertil Ohlin, who formalised the argument such that the rate of interest is the price which equilibrates the demand for and supply of loanable funds, with the supply of loanable funds comprising both the flow of savings and the flow of new money created by banks, the latter of which is the primary driver of deviations of the market rate from the natural rate (Ohlin 1937; Bertocco and Kalajzic 2023, 38) Following the influential critiques by Friedman (1968) and Lucas and Sargent (1978) of the practical efficacy of Keynesian liquidity preference theory and the

Phillips Curve, the insights of the loanable funds theory have become increasingly widely incorporated into macroeconomic policymaking. In particular, Wicksell's distinction between the natural and market rate of interest has been incorporated into New Keynesian dynamic stochastic general equilibrium models, with which central banks aim to fix their short-term nominal interest rates to the natural rate plus an inflation target (Amato 2005, 1; van Suntan 2021, 49; Bertocco and Kalajzić 2023, 39-41).

In in response to Wicksell's original loanable funds theory, John Maynard Keynes's liquidity preference theory (Keynes 1936, 165-174) argued that interest rates are determined by purely monetary factors, namely by the interaction of the demand for money, which Keynes termed 'liquidity preference', and the supply of money (Belke and Polleit 2009, 185). Keynes identified three causes underlying individuals' demand for liquidity: the need to finance transactions, as a precaution against uncertainty, and for speculative purposes. The existence of interest rates could therefore be seen as the result of the inducement necessary for lenders to forgo their liquidity preference, rather than their time preference (Chick 2019, 251). In the Keynesian two-asset model, wherein individuals choose between holding money or investing in interest-bearing bonds, any decline in the demand to hold money below the supply of money, for example, would lead individuals to exchange money for bonds, increasing the prices of those bonds and thereby reducing their yields, which would in turn decrease the demand to hold bonds relative to the demand to hold money, returning the money market to equilibrium. The equilibrium interest rate therefore falls at the point where the money demand schedule intersects with the money supply curve (Belke and Polleit 2009, 186-187). Keynes's liquidity preference theory was subsequently developed by Hicks (1937) and Hansen (1949; 1953) into the influential IS-LM model, and significantly influenced government interest rate management policies in the period after the Second World War (Boianovsky 2004; Belke and Polleit 2009, 187).

The purpose of summarising the distinctions and areas of overlap between the major theories of interest which remain in common use is not necessarily to make a case for the superiority of one of these views above the others; given the failure of a consensus to emerge in favour of any single interest theory, such a goal would no doubt exceed the scope of what this chapter could reasonably hope to accomplish. Instead, such an overview may provide context to the separate but related question of which factors influence the term structure of interest rates, and cause it to fluctuate. The necessity of such context is underlined by the fact that many interpretations of the causes of yield curve fluctuations draw from the assumptions and terminological frameworks of one or more of these major interest theories, or are directly implied by them.

The Expectations Hypothesis

One example of an influential interest theory within which the assumptions of a common theory of the term structure of interest rates can be found is Keynes's liquidity preference theory. While elucidating this theory, Keynes argued that:

> [A] necessary condition [for the liquidity preference which causes individuals to hold money rather than interest-bearing bonds] is the existence of *uncertainty* as to the future of the rate of interest, *i.e.* as to the complex of rates of interest for varying maturities which will rule at future dates. For if the rates of interest ruling at all future times could be foreseen with certainty, all future rates of interest could be inferred from the *present* rates of interest for debts of

> different maturities, which would be adjusted to the knowledge of the future rates (Keynes 1936, 168. Emphasis original).

This passage indicates the incorporation into Keynes's own interest theory of arguably the most well-known and widely discussed theory of the term structure of interest rates, the expectations hypothesis (Longstaff 2000, 989). However, Keynes was not the originator of this view of the term structure, nor is it exclusively relevant to interpretations of the movement of interest rates based on Keynesian liquidity preference theory. In fact, the expectations hypothesis was first outlined by the eminent neoclassical economist Irving Fisher, in his influential monograph *Appreciation and Interest* (Fisher 1896, 24-29). Fisher — who broadly concurred with Böhm-Bawerk's time preference theory of interest (Fisher 1930; Arthmar and Castaneda 2023, 2) — was writing amidst the debate which preceded the final transition away from a bimetallic monetary standard by the United States in 1900 (see Friedman and Schwartz 1963, 113-119; Redish 2000, 234-237). As such, the primary goal of his monograph was not to systematically lay out a theory of the term structure of interest rates, but rather to argue against the idea that "the appreciation of gold necessarily aggravate[s] debts" (Fisher 1896, 1). The relevance of his work extended beyond the historical context of this specific issue, however, and *Appreciation and Interest* is remembered for having featured the first appearance of Fisher's well-known equation relating expected inflation to the difference between nominal and real interest rates, and for having included the first appearance of the expectations hypothesis of the term structure of interest rates.[58] Regarding the determinants of long-term interest rates, Fisher wrote:

> A government bond, for instance, is a promise to pay a specific series of future sums, the price of the bond is the present value of this series and the 'interest realized by the investor' as computed by actuaries is nothing more nor less than the 'average' rate of interest … [This fact is] attested both by the comparative

[58] On the significance and legacy of Fisher's *Appreciation and Interest*, see Dimand and Betancourt (2012).

> stability of the rate of interest realized on long time bonds as compared with the fluctuations of the rate of interest in the short time money market … and by the fact that interest realized on a very long bond, say 50 years, is often lower than on a 25 years' bond. This is explainable by the prevailing opinion that interest tends to fall, so that if the 50 years' investment were in two successive bonds of 25 years each, the interest realized in the second would be lower than in the first. The 'actuarial average' of the two is equal to the interest realized on the 50 years' bond. (Fisher 1896, 28-29)

This view of the interest rate on long-term bonds as being equivalent to the expected average of the future short-term interest rates over the course of that bond's duration was further developed by Macaulay (1938, 29), Hicks (1939, 144-145) and Lutz (1940), the latter of whom clarified that the expectations hypothesis relied on three assumptions: that "everybody concerned knows what the future short-term rates will be, … [that] there are no costs of investment, … [and that a] lender who wants to invest for, say, ten years is equally well prepared to buy a ten-year bond or to lend on a one-year contract and to re-lend ten times" (Lutz 1940, 36-37).[59]

Following these early statements, a considerable number of subsequent studies have subjected the expectations hypothesis to empirical testing, and while some of these have seemed to support its validity to some extent (Sutch 1968; Modigliani and Shiller 1973; Sargent 1979), the greater number of prior studies have found limited empirical support for the expectations hypothesis, particularly in the case of U.S. data (Sangvinatsos 2010, 7).[60] Hamburger and Platt (1975), for example, argued that the close co-movement of six-month Treasury Bills with three-

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[59] As noted by Sangvinatsos (2010, 2-3), these early statements of the expectations hypothesis were generally expressed verbally rather than in formal, mathematical terms, and were not explicitly derived from any fully specified equilibrium model. However, Campbell (1986) convincingly argues that these different statements are compatible with one another, in contrast with the mutually exclusive formulations of the stricter Pure Expectations Hypothesis (Cox et al. 1981). The Pure Expectations Hypothesis is principally distinguished by its assumptions that yield term premia, forward term premia, and expected excess returns on long-term over short-term bonds are all zero, whereas the expectations hypothesis assumes all of these are constant values.

[60] For a more extensive review of the prior literature on the expectations hypothesis, and the details of the methodological approaches taken by the key studies, see Sangvinatsos (2010) and Crump et al. (2024).

month Treasury Bills tended to undermine the idea of regressive expectations, commonly used by advocates of the expectations hypothesis (for example Wood 1983) to explain the relatively greater variation in short-term than long-term interest rates. Shiller (1979), Singleton (1980) and LeRoy and Porter (1981) found that the variance in long-term interest rates exceeded the bounds implied by the expectations hypothesis, although Flavin (1983) argued that these results may have been biased by the small sample sizes used to calculate the variance-bounds. Campbell and Shiller (1991) argued that fluctuations in the yield curve were primarily due to sudden movements in short-term interest rates, to which fluctuations in long-term rates were insufficiently responsive to accord with the predictions of the expectations hypothesis. In light of the "overwhelming empirical evidence stacked against it" (Crump et al. 2024, 1), increasing attention has been paid to the question of why the implications of the expectations hypothesis have seemingly failed to present themselves in the data. Several studies have investigated the effects of accounting for time-varying risk premia in models of the term structure (Hardouvelis 1994; Dotsey and Otrok 1995; Tzavalis and Wickens 1997; Dai and Singleton 2002), although this approach has not yet conclusively brought the expectations hypothesis in line with the empirical data (Guidolin and Thornton 2008, 12-14). Other studies have investigated the extent to which short-term interest rates are skewed away from the course which the expectations hypothesis suggests was predicted in earlier term structure data, by the actions of central banks (Mankiw and Miron 1986; Rudebusch 1995; Balduzzi et al. 1997) or by the emergence of unforeseeable new information (Guidolin and Thornton 2008).

As noted by Froot (1989, 283), the large number of studies which have unsuccessfully sought empirical evidence for the validity of the expectations hypothesis at least indicate the enduring attractiveness of the theory. Indeed, whether due to its arguable soundness as a matter of a priori economic theory (Longstaff 2000), or because it still retains a rough, imprecise ability to predict future interest rate movements (Campbell and Shiller 1991, 495), the expectations hypothesis has not been expelled from the canon of economic orthodoxy, and remains widely used both as an assumption in macroeconomic models (Crump et al. 2024, 1; Pétursson 2001, 64) and as an explanation of interest rate fluctuations in the context of financial journalism and discussions of economic issues aimed at general audiences (Krugman 2008; Krugman 2023).

As outlined above, the expectations hypothesis is directly concerned with the extent to which the interest on a long-term bond is equal to the average of the expected interest rates of a series of short-term bonds which cumulatively amount to the same length to maturity as the long-term bond, and therefore whether long-term interest rates contain predictive information about the future course of short-term interest rates. This is linked to the question of why the slope of the yield curve tends to flatten or invert prior to a recession via an inference from the expectations hypothesis which has been called the *policy anticipations hypothesis* (Haubrich and Dombrosky 1996). In the aftermath of Robert Lucas's influential application of rational expectations theory to macroeconomic policymaking (Lucas 1976), a growing number of studies began investigating the extent to which economic announcements were followed by shifts in interest rates based on the expected impact of the new information on the future decisions of monetary policymakers (Urich and Wachtel 1981; Grossman 1981; Engel and Frankel 1984; Goodhart and Smith 1985). Within the context of this literature, the tendency of interest rates to rise following announcements that inflation had been higher than expected, as a result of market participants' expectations that this would lead central banks to pursue a policy of monetary tightening, came to be known as the policy anticipation hypothesis (Peel et al. 1990). The impact of shifts in expected monetary policy on the yield curve also came under scrutiny in this literature (Cook & Hahn 1989). Ellingsen and Söderström (2001) argued that, in line with the expectations hypothesis, a tightening of monetary policy may result in either a rise or fall of long-term interest rates, depending on the interpretation of the policy change by market participants. If market participants expect that, over the course of a typical business cycle, central banks will tend to raise their policy rates to counteract inflation toward the end of the expansionary phase of the business cycle, and will then lower those rates in an attempt to stimulate spending during the subsequent economic downturn, the expectations hypothesis suggests that the average of these expected future short-term interest rates will be reflected in the current level of long-term interest rates.

Given the tendency, indicated by prior studies, of yield curve inversions to precede recessions, the implication of the expectations hypothesis is that this is a reflection of the fact that market participants foresee the arrival of a recession, and hence expect central banks to lower their target rates below current levels during the recession, which is reflected by a decline of long-term interest rates in the present (i.e. a decline in the average of expected future short-term interest rates) relative to present short-term interest rates. This explanation of the seemingly predictive qualities of yield curve inversions has also come to be referred to as the 'policy anticipations hypothesis' (Haubrich and Dombrosky 1996; Benzoni et al. 2018) although, as noted above, that name has a broader meaning in the context of the literature on the impact of new economic information on other variables. The policy anticipations hypothesis contrasts with the common view that yield curve inversions can act as predictors of oncoming recessions, instead suggesting that pre-recession inversions occur because market participants already expect a recession, and are adjusting their expectations of future interest rates accordingly. For this reason, the policy anticipations hypothesis does not in itself offer any insight into why yield curve inversions appear to have predicted oncoming recessions more reliably than other indicators in the United States since the mid-twentieth century (Harvey 1988; Estrella and Mishkin 1998), or why a predictive relationship exists between the slope of the yield curve and future economic growth. Nevertheless, this view of the seemingly predictive qualities of yield curve inversions as being driven by a decline in long-term below short-term interest rates prior to recessions offers one perspective from which to assess the predictive relationship between the term structure of interest rates and future economic conditions in Britain between the years of 1800 and 1913.

Rising Short-Term Interest Rates as a Cause of Yield Curve Inversions

If the policy anticipations hypothesis holds that inversions of the yield curve prior to recessions are the result of a decline in long-term interest rates below short-term interest rates due to expectations of expansionary monetary policy during the recession, the logical alternative to this view is that pre-recession yield curve inversions instead reflect a rise in short-term above long-term interest rates. One possible cause of such a rise in short-term interest rates is the tightening of monetary policy often pursued by central banks toward the end of the expansionary phase of the business cycle. Like the policy anticipation hypothesis, this explanation of the seemingly predictive qualities of yield curve inversions is not reliant on the framework of any single theory of interest, and has been expressed by advocates from a range of perspectives (Estrella and Mishkin 1996; Rudebusch and Williams 2009; Murphy 2021, 125). With its focus on the role of changes in short-term interest rates in driving yield curve fluctuations, this approach does not require the empirically uncertain assumptions of the expectations hypothesis to explain changes in long-term interest rates. Instead, it can be seen as a straightforward implication of the standard view of the transmission mechanism of monetary policy, which notes the more immediate, positive relationship between central banks' policy rates and short-term interest rates, compared to the lesser responsiveness of long-term interest rates to monetary policy decisions (Bank of England 1999, 162; Pétursson 2001, 63-64; Wu 2003). This, combined with the tendency for central banks to attempt to counteract inflationary pressure at the peak of the business cycle by raising their policy rates as a matter of orthodox countercyclical monetary policy (Chatterjee 2001), suggests that the seemingly predictive qualities of yield curve inversions lie in their utility as an indicator of monetary tightening, which itself may be a contributor to declines in output during recessions (Haubrich and Dombrosky 1996, 28).

While this interpretation of the predictive qualities of yield curve inversions — that they constitute an increase of short-term above long-term interest rates due to monetary tightening at the peak of the business cycle — could be viewed straightforwardly as a result of the interaction of countercyclical monetary policy with the term structure, it could equally be arrived at as an implication of a number of the more commonly discussed business cycle theories. Wicksell argued that the business cycle was the result of a decline in the market interest rate below the natural rate, which resulted in an upward spiral of increasing inflation and nominal spending until interest rates were raised back to their natural level. The British economist Ralph Hawtrey likewise argued that credit expansion could lead to a boom of consumer spending and consequently increasing prices, which would conclude in a downturn when interest rates were raised again (Dimsdale and Thomas 2019, 15-17). Perhaps the most commonly discussed business cycle theory which implies that an increase in short-term above long-term interest rates would occur at the peak of the cycle is the *circulation credit theory of the business cycle*. Developed by Ludwig von Mises (1912, 346-66) and F. A. Hayek (1931; 1933),[61] this theory holds that banks, by lending into existence new money beyond the extent of their reserves, are able to influence interest rates downwards, below the rate which would otherwise have been arrived at through the efforts of individuals to maximise their utility by borrowing or lending based on their different rates of time preference. This decline of interest rates below the level which would otherwise have prevailed initiates the expansionary phase of the business cycle by incentivising borrowing, particularly for investment in long-term and therefore interest rate sensitive projects, while simultaneously disincentivising saving in favour of

[61] The circulation credit theory of the business cycle is sometimes also called the monetary over-investment theory of the business cycle, or the Austrian business cycle theory due to the nationality and economic ‘school’ of its progenitors (Potuzak 2022, 65-79).

present consumption. Eventually, however, banks will come under pressure to raise interest rates, either due to unsustainable outflows of their reserves as a result of requests for redemption into specie of the newly created money, or due to central bank efforts to offset the inflationary pressure associated with the expansionary phase of the business cycle. When this rise in interest rates occurs, entrepreneurs will be forced to consider discontinuing marginal business endeavours which they had only expected to be profitable at the previous, lower interest rates, with this adjustment of expectations and consequent reallocation of resources constituting the contractionary phase of the business cycle.

An increasing number of studies have sought to explain the seemingly predictive qualities of yield curve inversions in light of the implications of the circulation credit theory of the business cycle, arguing that the monetary contraction as the business cycle nears its peak causes both the rise of short-term above long-term interest rates, and the onset of the contractionary phase of the cycle (Cwik 2004; Cwik 2005; Bagus and Howden 2010; Griggs and Murphy 2021). While acceptance of the circulation credit theory is not a prerequisite for arriving at this view of the relationship between the yield curve and the business cycle, the use of this framework has nevertheless resulted in some factors having been highlighted which had not been emphasised elsewhere in the literature, such as Cwik's (2005) argument that the scramble for short-term loans to complete marginal projects prior to the downturn constitutes a demand-side driver of the rise of short-term above long-term interest rates.

Incorporating the circulation credit theory of the business cycle into this view of yield curve inversions also offers one possible explanation for the tendency of yield curve inversions to have been followed by recessions, rather than mere slowdowns in growth, in the United States since the mid-twentieth century. It is not necessary to subscribe to any particular business cycle theory to come to the view that a flattening or inversion of the yield curve at the peak of the business cycle partly results from the efforts of central banks to offset the inflation which often accompanies the expansionary phase of the business cycle by raising their policy rates in such a way that short-term interest rates rise above long-term interest rates. However, since central banks are not trying to cause recessions, this leaves open the question of why they seemingly consistently overcorrect when raising short-term interest rates. Why wouldn't central banks be expected to sometimes raise short-term interest rates just enough to gently deflate potential bubbles without a recession following shortly afterwards? The circulation credit theory of the business cycle regards the 'boom' phase of the business cycle as originating from credit expansion by the banking system, which lowers interest rates below the 'natural' rates which would otherwise have prevailed. This leads entrepreneurs to undertake new marginal projects, which they would not have judged to be (eventually) profitable were it not for the lowering of interest rates to unsustainably low levels. It follows from this that when interest rates are raised again, many of these marginal projects will necessarily no longer appear profitable, forcing a widespread reevaluation and liquidation of these ventures, and a reallocation of their resources, with this constituting the contractionary phase of the business cycle. In other words, the circulation credit theory of the business cycle regards recessions as an inevitable consequence of the malinvestments stemming from the original decision to lower interest rates to unsustainably low levels, with the recession necessarily manifesting shortly after interest rates are raised again. This offers one possible explanation for the apparent tendency of recessions, rather than mere gentle slowdowns in growth, to have followed shortly after yield curve inversions in the United States since the mid-twentieth century.

Having outlined these two opposing views of the nature of yield curve inversions and the causes of their relationship with the business cycle — that yield curve inversions constitute a decline in long-term below short-term interest rates caused by expectations of a future decline in short-term interest rates during the oncoming recession, or that yield curve inversions constitute a rise in short-term above long-term interest rates toward the peak of the business cycle, which contributes to the onset of the recession — and having briefly explored the competing interest theories which underly these different perspectives, the following sections will now explore the extent to which support for either of these views can be found in the British interest rate data during the period from 1800 to 1913.

II - The Policy Anticipations Hypothesis and British Yield Curve Fluctuations, 1800-1913

As outlined in the previous section, and as detailed in more extensive literature reviews such as that by Sangvinatsos (2010), the expectations hypothesis of the term structure of interest rates has been the subject of a large number of prior studies, which have varied both in their formalisations of this theory and the methods by which they have aimed to assess its validity. Perhaps as a result of the seeming consensus that empirical support for the expectations hypothesis has so far been limited, many of these studies have aimed to refine and augment the range of methodological approaches by which the theory might be judged. While this profusion of different technical approaches indicates the extent of interest in this subject, it nevertheless presents a challenge to this chapter's attempt to judge how well the policy anticipations hypothesis could be said to explain the fluctuations of the yield curve in nineteenth century Britain.

Given the length of the period under consideration by this thesis, and the dearth of prior studies assessing the extent to which a predictive relationship existed between the yield curve and the business cycle in Britain during that time, this thesis has aimed to present the results of a range of different possible methods by which the predictive qualities of the yield curve might be assessed, with a view to contributing to the establishment of a foundation from which different aspects of this topic can be approached in the future by more narrowly-focussed studies. The significance of the expectations hypothesis as one of the most commonly discussed theories of the term structure necessitates its mention in any discussion of the possible causes of nineteenth century British yield curve fluctuations. However, given the range of methodological approaches taken in the prior literature on the expectations hypothesis, a conclusive statement concerning the role of the policy anticipations hypothesis in the relationship between the yield curve and the business cycle in nineteenth century Britain would require an appropriately thorough engagement with and assessment of the technical aspects of these different approaches, exceeding what might be satisfactorily accomplished within the context of a subsection of this chapter. Instead, this subsection will highlight an influential approach taken in the prior literature to assessing the extent to which nineteenth century British interest rates fluctuated in a manner consistent with the implications of the expectations hypothesis. Applying this approach to the data presented in the previous chapter may illustrate the contrast between the actual course of consol yields and the course suggested by one model of the expectations hypothesis.

As has been discussed in previous chapters, the number and kinds of securities traded in nineteenth century Britain contrasts with those which were available in the United States from the mid-twentieth century onwards, which has been the more commonly studied period in the prior literature on both the expectations hypothesis and the relationship between the yield curve and the business cycle. In particular, the prominence of consols (perpetuities) as the most significant long-term bond traded in Britain between the years of 1800 and 1913 complicates the matter of explaining long-term interest rates via the expectations hypothesis. As noted by Shiller (1985, 12), the conventional assumption in the expectations hypothesis literature had been that the interest rate on a long-term bond was a straightforward, unweighted average of the future course of the interest rates on a series of short-term bonds which amounted to the same length to maturity as the long-term bond, plus a constant liquidity premium. Applying this approach to very long-term bonds, or to perpetuities such as consols, counterintuitively suggests that expected short-term interest rates in the very distant future have an equal influence on buyers' valuations of long-term bonds as do expected short-term interest rates in the near future. In order to replace this assumption with one more suited to the analysis of perpetuities and other very long-term bonds, Shiller (1979, 1194) presented an expectations model based on a *weighted* average of expected future short-term interest rates, with the effect that expected short-term interest rates in the near future are modelled to have a greater influence on current long-term interest rates than do expected short-term interest rates in the more distant future.[62] Shiller's expectations model is presented below as expression (1):

$$R_t^{(n)} = \frac{1-\gamma}{1-\gamma^n} \sum_{K=0}^{n-1} \gamma^K E_t(r_{t+K}) + \Phi_n \tag{1}$$

One reason for the selection of Shiller's model is that his study, to a greater extent than most, grapples with the question of how the expectations hypothesis ought to be formulated to account for the yields of perpetuities, such as the consols of nineteenth century Britain. Rearranging the above formula into a consol-specific form, Shiller (Ibid. 1199) presents an expectations model, reproduced below as expression (2), which equates the present yield on perpetuities, with a duration to maturity of $n = \infty$, to a weighted moving average of future short-term interest rates, r_t.

$$R_t^* = (1-\gamma) \sum_{K=0}^{\infty} \gamma^K r_{t+K} \tag{2}$$

This perpetuity-specific formulation of Shiller's expectations model differs from that intended for finite-duration bonds in that it drops the liquidity premium term Φ , reflecting the fact that the holder of a perpetuity needn't forgo their liquidity any longer than the holder of a short-term bond, as there is no specified date in the more distant future when they can expect the return of their principal. The constant, γ, which falls between 0 and 1, weights the influence of expected future short-term interest rates on present long-term interest rates, discounting them by the average long-term interest rate for the period under consideration, $\bar{R}$, such that $\gamma = 1/(1 + \bar{R})$. The expectations operator in expression (1) is also dropped from expression (2), reflecting the assumption by expression (2) of perfect knowledge of future one-period rates of interest. Naturally, this assumption

[62] This model was incorporated into a number of subsequent studies on the expectations hypothesis, including those by Shiller et al. (1983) and Mills (1991), the latter of whom likewise found that U.K. interest data for the period 1871-1913 tended to reject the expectations hypothesis.

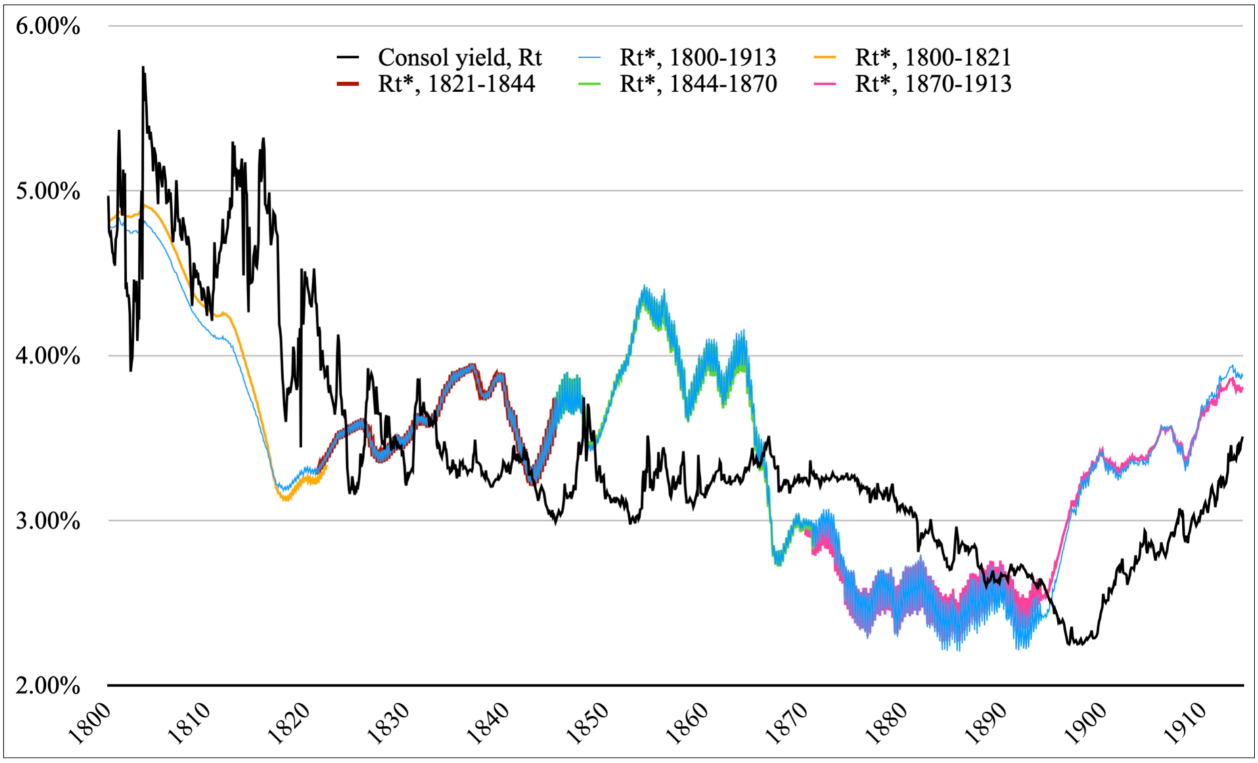
of perfect foresight on the part of those trading consols is unrealistic, but it does allow for the calculation of the "ex post rational rate" R_t^* which the model suggests should have been arrived at based on the future course of short-term interest rates r, which can be contrasted with the actual long-term rate R_t, with the difference between these two constituting the forecast error, θ_t (Ibid. 1199-1201).[63] In order to overcome the practical difficulty of having to calculate the weighted average of an infinite series of future short-term interest rates, this chapter follows Shiller (1985, 13) in assuming consols to have an effective duration to maturity of n = (1+R)/R, where R is the current consol yield. Expression (3) draws on both of the above versions of Shiller's model in such a way as to incorporate this assumption concerning the effective duration of consols, while also following Shiller's perpetuity-specific model in dropping the liquidity premium term and assuming perfect foresight of future short-term rates.

$$R_t^* = \frac{1-\gamma}{1-\gamma^n}\sum_{K=0}^{n-1}\gamma^K r_{t+K} \qquad (3)$$

Figure 22. contrasts the actual course of British consol yields, R_t , between the years of 1800 and 1913, with the ex post rational long-term interest rates, R_t^* , which the expectations hypothesis, as formalised in expression (3), suggests should have prevailed given the future course of short-term interest rates. One advantage of presenting the data in this way is that it illustrates the lack of an obvious close correlation between actual consol yields, R_t, and the various R_t^* series, with the difference between the R_t and R_t^* lines offering a clear picture of the varying forecast error, θ_t, throughout the period. This forecast error saw the ex post rational rate, R_t^*, fall below the actual consol rate in most months from 1800 to 1825 and from 1865 to 1895, whereas the ex post rational rate tended to be higher than the actual consol rate in most months from 1835 to 1865 and from

[63] The unrealistic assumption of perfect foresight with regard to future short-term rates aligns this model with most traditional models of the expectations hypothesis, which have explicitly acknowledged this as a core assumption since at least Lutz (1940, 36-37).

Figure 22. Actual and 'Ex Post Rational' Consol Yields, January 1800 - December 1913



Note: The ex post rational rates Rt* were calculated according to the expectations model presented above as expression (3), based on Shiller's model (1979, 1194-1199). The different Rt* series represent different values of γ, based on the average long-term rates $\bar{R}$ for the different specified periods. The effective duration of the consols, n, was rounded up to the nearest quarter, to reflect the three month duration of the prime short-term commercial bonds whose yields were taken as representative of short-term interest rates r_t, as in the previous chapter of this thesis (Thomas and Dimsdale 2017, Sheet M1, Column M). Consol yield data from Thomas and Dimsdale (2017, Sheet M1, Column U).

1895 to 1913. Figure 22. also illustrates the relatively modest difference (particularly in the years from 1821 to 1870) between the R_t^* value returned when the constant γ is calculated from the average long-term interest rate for the entire period 1800 to 1913, compared to the R_t^* values returned when γ is based on the average long-term interest rate within the four sub-periods 1800 to 1821, 1821 to 1844, 1844 to 1870, and 1870 to 1913. The γ values for the periods from 1821 to 1844 and from 1844 to 1870 happened to be close to the γ value for the full period 1800 to 1913, hence the close overlapping of those series.

Relatively regular quarterly fluctuations can be seen in the ex post rational rates, R_t^*, from around 1820 until around 1895, reaching their greatest extent in the periods during which the effective duration of the consols, n, was at its greatest, between around 1875 and 1895.[64] This likely reflects the potential for this method to exaggerate seasonal fluctuations in the r_t data, particularly for large values of n. Given the three-month duration of the short-term bonds whose yields were used for r_t, and the requirement that R_t^* be a weighted average of the yields on a series of short-term bonds whose combined length to maturity is equal to the effective length to maturity of the consol, n, this resulted in R_t^* for a given month being a weighted average of r_t in the same four months of each year up to n-1. For example, if n for January 1800 was 20 years (80 quarters), R_t^* for January 1800 would be the weighted average of r_t in January, April, July, and October 1800, January, April, July, and October 1801, and so forth, up until October 1819. Whereas R_t^* for February in a given year would be the weighted average of r_t in February, May, August, and November of each following year up until the end of the period dictated by the consol's effective duration, n; R_t^* for March in a given year would be the weighted average of r_t in March, June, September and December for each subsequent year up to n-1, and so forth. To the extent that a consistent difference tended to exist between the average of r_t in January, April, July and October of a typical year, compared to the average of r_t in February, May, August and November, or March, June, September and December, these differences will tend to be emphasised by the averaging inherent in the model outlined in expression (3), with larger values of n smoothing out random fluctuations and hence further highlighting any regular pattern which may exist in this regard.[65]

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[64] The effective duration of consols, n, according to Shiller's (1985, 13) assumption that n = (1+R)/R, ranged between 18 and 46 years during the full period 1800 to 1913.

[65] The quarterly fluctuation of ex post rational rates, Rt*, may also reflect the quarterly payment of dividends on government stocks. As most government balances were held at the Bank of England, reserves would flow out of the broader banking system and into the Bank of England whenever taxes were paid, with this flow being reversed each quarter with the payment of dividends on government stocks, resulting in regular quarterly fluctuations in bankers' balances and hence of market interest rates. However, in 1829 the Bank attempted to smooth these fluctuations by introducing a system of regular advances prior to the dividend payment dates, allowing institutions to borrow at close to market rates in anticipation of the regular quarterly rises in interest rates. This system of advances became available throughout the year after 1844 (Capie et al. 1994, 113-114). The fact that the quarterly fluctuations in ex post rational rates, presented in Figure 23, appear most pronounced in the mid- to late nineteenth century, suggests either that these efforts were not fully effective in counteracting these quarterly fluctuations in short-term interest rates, or that the pattern was the result of other causes.

Table 11. The Influence of Ex Post Rational Consol Yields on Actual Consol Yields

	R_t (Dependent Variable)			
	Regression Coefficient	Correlation Coefficient	Number of Observations	Average θ_t, ($\theta_t = R_t^* - R_t$)
R_t^*, 1800-1913	0.668*** (0.024)	0.605	1368	0.05%
R_t^*, 1800-1821	0.373*** (0.036)	0.538	264	-0.51%
R_t^*, 1821-1844	-0.398*** (0.072)	-0.309	288	0.14%
R_t^*, 1844-1870	-0.061*** (0.017)	-0.194	324	0.43%
R_t^*, 1870-1913	0.043 (0.028)	0.066	528	0.07%

Note: Sources as in Figure 22. Standard errors in brackets under regression coefficient figures.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 11 presents the data from Figure 22 in terms of the influence of the ex post rational long-term rate, R_t^*, (i.e. the weighted average of future short-term interest rates) on the actual level of consol yields, R_t, both for the full period 1800 to 1913 and for each of the four sub-periods. The average forecast errors, θ_t, for those periods are also included. The strongest evidence in favour of the existence of the relationship suggested by the expectations hypothesis can be seen in the movement of the variables during the full timeframe, 1800 to 1913. Over the course of this long period, a statistically significant positive relationship does appear to have existed between ex post rational and actual consol yields, although the level of the coefficient seems insufficiently high to regard this as conclusive evidence that the future course of short-term interest rates was the exclusive or primary influence on consol yields. The average forecast error for the full period is also relatively modest, although Figure 22 illustrates that this is a result of the approximately equal likelihood that R_t^* would fall either above or below R_t in a given month, rather than being a reflection of consistently low forecast errors throughout the period. The other results listed in Table

11 undermine the extent to which this first result could be regarded as providing strong support for view that the expectations hypothesis explains the course of consol yields in this period. The only sub-period in which the expected positive relationship between R_t^* and R_t presents itself to a statistically significant extent is between the years of 1800 to 1821, with the lower coefficients for this sub-period suggesting an even weaker relationship between the future course of short-term interest rates and current consol yields than appears to have existed in the overall timeframe. No significant relationship between the variables appears to have existed at all in the 1870 to 1913 sub-period, while the 1820 to 1844 and 1844 to 1870 data suggests a small but statistically significant relationship in the opposite direction to that implied by the expectations hypothesis, with a higher average of future short-term interest rates appearing to have been associated with lower consol yields on average during those sub-periods. These latter results align with the findings of Shiller (1979, 1210), who likewise found that movements in long-term interest rates tended to be in the opposite direction to what was suggested by the expectations models under his consideration.[66]

Another sense in which Shiller's results failed to align with the implications of the expectations hypothesis was in the apparent absence of a tendency for long-term interest rates to move in a manner which would equalise short-term holding yields (Ibid., 1212). Traditional expectations models suggest that long-term interest rates ought to rise on average when they are high relative to short-term interest rates, and should be expected to fall on average when low compared to short-term interest rates (Wood 1983, 17-19). Table 12 suggests that this trend is similarly difficult to identify in the nineteenth century British data. To the extent that they indicate the existence of any noteworthy relationship, the results in Table 12 suggest that when long-term

[66] Shiller (1979, 1217) assessed a range of different sets of interest rate data in his study, most of which were U.S. data ranging from the late 1950s to the mid-1970s, but one of which overlapped with the subject area of this thesis, encompassing U.K. interest rata from 1824 to 1930. Like most studies of nineteenth century British interest rates, Shiller took the yield on consols as representative of long-term interest rates. However, in contrast to the data presented in this chapter, his representative of short-term interest rates consisted of Overend and Gurney first-class three month bills prior to 1844, and three month bank bills thereafter.

Table 12. The Slope of the Yield Curve and Subsequent Consol Yields between One and 12 Months Hence

	Dependent Variables						
	$R_{t+1} - R_t$	$R_{t+2} - R_t$	$R_{t+3} - R_t$	$R_{t+6} - R_t$	$R_{t+9} - R_t$	$R_{t+12} - R_t$	No. of Observations
$R_t - r_t$, 1800-1913	-0.002 *-0.020* (0.002)	-0.001 *-0.010* (0.003)	-0.003 *-0.025* (0.003)	-0.005 *-0.031* (0.004)	-0.009 *-0.049* (0.005)	-0.009 *-0.046* (0.006)	1368
$R_t - r_t$, 1800-1821	-0.047* *-0.145* (0.020)	-0.059* *-0.156* (0.023)	-0.082** *-0.181* (0.027)	-0.104** *-0.184* (0.034)	-0.148*** *-0.207* (0.043)	-0.154** *-0.193* (0.049)	264
$R_t - r_t$, 1821-1844	-0.006 *-0.094* (0.004)	-0.010 *-0.113* (0.005)	-0.013* *-0.120* (0.007)	-0.015 *-0.094* (0.009)	-0.022 *-0.115* (0.011)	-0.028* *-0.123* (0.013)	288
$R_t - r_t$, 1844-1870	0.002 *0.068* (0.002)	0.004 *0.091* (0.002)	0.003 *0.059* (0.003)	0.004 *0.064* (0.003)	0.008* *0.112* (0.004)	0.014** *-0.166* (0.001)	324
$R_t - r_t$, 1870-1913	0.001 *0.051* (0.001)	0.004* *0.095* (0.002)	0.004 *0.076* (0.002)	0.001 *0.023* (0.003)	-0.009** *-0.128* (0.003)	-0.013*** *-0.162* (0.004)	528

Note: Monthly data. Sources as in Figure 22. Correlation coefficients in italics under regression coefficients. Standard errors in brackets under correlation coefficients.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

interest rates were high relative to short-term interest rates, this tended to be followed by slightly lower long-term interest rates between three and twelve months hence, in the years between 1800 and 1821. A similar, though even smaller, tendency seems to exist in the 1870 to 1913 sub-period, with relatively high long-term interest rates tending to be followed, between nine and twelve months hence, by a slight decline in long-term interest rates. The only example of a result with a significance level below 0.01 which aligns with the implications of the expectations hypothesis can be seen in the 1844 to 1870 period, during which time a 1 per cent excess of long-term over short-term interest rates is suggested to have been followed by a mere 0.014 per cent rise in long-term interest rates by twelve months later, on average.

As noted above, the expectations model advanced by Shiller (1979, 1199-1202) holds that

$$R_t^* = R_t + \theta_t \tag{4}$$

which in turn implies the same relationship between the variances of the three values (Flavin 1983, 933), such that

$$\mathrm{var}(R_t^*) = \mathrm{var}(R_t) + \mathrm{var}(\theta_t) \tag{5}$$

Since $\mathrm{var}(\theta_t)$ cannot be negative, this model of the expectations hypothesis therefore holds that

$$\mathrm{var}(R_t^*) \geq \mathrm{var}(R_t) \tag{6}$$

As was the case in Shiller's study, the nineteenth century British data largely fail to conform with this implication of the expectations hypothesis, as is illustrated by Table 13.

Table 13. Comparing the Sample Variance of Actual and Ex Post Rational Consol Yields

	var (R_t^*)	var (R_t)	var (R_t^*) - var (R_t)	F	Degrees of Freedom
1800-1913	4.000×10^{-5}	4.885×10^{-5}	-8.849×10^{-6} ***	1.221	1367
1800-1821	4.116×10^{-5}	1.978×10^{-5}	2.138×10^{-5}	0.481	263
1821-1844	3.552×10^{-6}	5.896×10^{-6}	-2.344×10^{-6} ***	1.660	287
1844-1870	1.840×10^{-5}	1.789×10^{-6}	1.661×10^{-5}	0.097	323
1870-1913	2.204×10^{-5}	9.354×10^{-6}	1.269×10^{-5}	0.424	527

Note: Calculated from the data presented in Figure 22.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

For the full period 1800 to 1913, and for the sub-period 1821 to 1844, var(R_t) exceeds var(R_t^*), with this result achieving a significance level below 0.001 in both cases. While var(R_t^*) exceeds var(R_t) in the other sub-periods, none of these results achieved a significance level below 0.05, limiting the extent to which they can be regarded as strongly supporting the view that the expectations hypothesis, as formalised in expression (3), accurately describes the relationship between consol yields and the subsequent course of short-term interest rates in Britain between the years of 1800 and 1913.

One noteworthy critique of this method, which regards instances in which var(R_t) exceeds var(R_t^*) as evidence against the validity of the expectations hypothesis, was advanced by Flavin (1983), who argued that the small sample sizes involved in Shiller's (1979) study tended to bias his results toward the rejection of expression (6). As mentioned above, Shiller's study assessed six different datasets covering U.S. and U.K. interest data, three of which were at an annual frequency, two of which were quarterly, and one monthly, with the number of observations in these sets ranging from 17 to 106. Given the length of the 1800 to 1913 timeframe and the monthly frequency of the data used, the number of observations from which the results in Table 13 are drawn is considerably greater than the sample sizes of Shiller's datasets, limiting the extent of this bias toward the rejection of expression (6) as a null hypothesis.

Taking all of these results in combination, it would be an overstatement to argue that they constitute definitive evidence against the applicability of the expectations hypothesis as an explanation of the movement of long-term interest rates in Britain between the years of 1800 and 1913. A more certain conclusion in this regard would first require a more comprehensive assessment of the data in light of the numerous different methodological approaches advanced in the extensive prior literature on this subject, beyond what might satisfactorily be accomplished in this chapter subsection. Further insight into the determinants of nineteenth century British interest rates might be gained by future research into the extent to which this data conforms with the predictions of other models which augment or adjust traditional models of the expectations hypothesis while retaining its core assumptions. For example, models which attempt to account for the role of regressive expectations, whereby long-term interest rates are seen to contain some information about the future course of short-term rates, but actors also factor their expectations of an eventual return to 'normal' rates into their valuations of long-term bonds (Modigliani and Sutch 1966; Modigliani and Shiller 1973; Wood 1983). Alternatively, Campbell and Shiller (1988) use a vector autoregression (VAR) approach, in which long-term and short-term interest rates follow an error-correction model in which the yield spread is the equilibrium error. Given that the divergence of the ex post rational long-term rate from actual consol yields constitutes the forecast error, as highlighted by expression (4), an advocate of the applicability of the expectations hypothesis in this case might argue that the above data could be seen as aligning with the expectations hypothesis if the varying forecast error over the period, as illustrated by Figure 22, could be shown to reflect actual changes in market participants' forecasting capabilities during the period. The extent to which historical events and other qualitative factors might have affected the ability of market participants to accurately forecast future short-term interest rates, and whether these contextual factors caused the accuracy of forecasts to wax and wane in a pattern reflective of the varying forecast error illustrated in Figure 22, could represent another potentially fruitful subject for future research.

Despite the numerous avenues which remain open for further investigation into this topic, the results in this subsection nevertheless illustrate the lack of prima facie support for the view that consol yields in Britain between the years of 1800 and 1913 were exclusively or primarily determined by the future course of short-term interest rates, to the extent that the expectations hypothesis implies they should have been. Several of the results suggest that the movements of interest rates in certain sub-periods were entirely opposite to the course they should have taken according to the expectations hypothesis, to a statistically significant degree. This, in combination with the similar absence of strong evidence for the expectations hypothesis found in the nineteenth century British data by Shiller (1979) and Mills (1991), tends to undermine the persuasiveness of the view that the predictive relationship between the yield curve and the business cycle in Britain between the years of 1800 and 1913 can be explained as a result of the policy anticipations hypothesis, which holds that a flattening or inversion of the yield curve prior to a recession reflects expectations of lower short-term interest rates during the recession, which causes an anticipatory decline in long-term interest rates relative to short-term interest rates prior to recessions.

Having failed to find persuasive evidence in favour of the view that the policy anticipations hypothesis offers a compelling explanation of the underlying causes of the predictive qualities of the term stricture of interest rates in Britain between 1800 and 1913, the next section of this chapter will assess the opposite view that flattening or inversion of the yield curve prior to recessions reflects a rise in short-term relative to long-term interest rates.

III - Yield Curve Inversions as a Rise in Short-Term Interest Rates

The goal of this section is to assess the extent to which the predictive relationship between the term structure of interest rates and future growth in nineteenth century Britain could be regarded as reflecting rises in short-term relative to long-term interest rates prior to recessions, as opposed to the decline in long-term relative to short-term interest rates suggested by the policy anticipations hypothesis.

A number of questions immediately arise when assessing this issue, including how to determine whether a change in the relative levels of two interest rates should be regarded as a rise in one or a fall in the other, or whether these are synonymous ways of describing their movement relative to one another. A superficial approach might settle on describing short-term interest rates as having risen relative to long-term interest rates if, for example, a long-term interest rate remained at the same level from one month to the next while a short-term interest rate rose during the same period. This intuitive approach might suffice for everyday conversations on the topic, but it obscures the complexity of the causes of interest rate fluctuations with which specialist assessments of economic issues ought to engage. As was noted in the first section of this chapter, no consensus yet exists amongst economists concerning the causes of interest rate fluctuations, which are variously attributed to changes in individuals' time preferences or liquidity preferences, changes in the objective marginal productivity of capital, or changes in the supply of and demand for loanable funds. Each of these is in turn influenced by many other factors, including the inscrutable and ever-changing thoughts and inner preferences of consumers.[67] Therefore it is not obviously preferable, in the example above, to describe short-term interest rates as having risen relative to long-term rates if

[67] On the idea of consumer preferences as being demonstrated through discrete economic actions and the relation of this view to the theory of revealed preference pioneered by Paul Samuelson, see Nguyen (2020).

the former rises from one month to the next while the latter remains level. It might be the case that both short-term and long-term interest rates would have risen were it not for some particularly relevant factor which caused long-term interest rates to fall relative to where they otherwise would have been, in which case it might be preferable to describe long-term interest rates as having fallen relative to short-term interest rates. Consideration of the numerous factors which influence the levels of observable variables is a key reason for the frequent use of ceteris paribus clauses in science, and particularly in economics, to qualify statements concerning cause and effect (see Rol 2012).

Given the many competing factors which cumulatively determine the levels of interest rates, merely observing the nineteenth century British data cannot be expected to provide a prima facie clear answer to the question of whether a given yield curve inversion should be regarded as having been caused by rising short-term interest rates or declining long-term interest rates. To identify a fluctuation in the yield curve as either a rise or fall in either short-term or long-term interest rates, rather than simply describing their movement relative to one another, instead reflects a judgement concerning which factors influencing interest rates are most relevant to highlight as a cause of pre-recession yield curve inversions, a judgement which must be informed by economic theory rather than induced from raw data. The policy anticipations hypothesis, explored in the previous section, argues that relative declines in long-term interest rates are the more relevant factor, a judgement based on the theoretical foundation of the expectations hypothesis. In contrast, the view that rising short-term interest rates are the more relevant factor when explaining pre-recession yield curve inversions stems from a theoretical understanding of the tendency for short-term interest rates to be raised at around the peak of a business cycle, often as part of an effort by central banks to offset the inflationary pressure which tends to accompany the peak of the business cycle (Bianchi et al. 2023).[68]

While this latter view was outlined in a previous section of this chapter, it may be worth more explicitly elucidating the mechanisms involved, in order to clarify the theoretical basis for this view of the causes of pre-recession yield curve inversions. Many studies judge these mechanisms to be well enough understood that key processes, such as the central bank's ability to influence interest rates and the money supply, are acknowledged without further explanation. However, a clear understanding of these processes is necessary to assess the influence of monetary policy on changes in the yield curve.

Uncertainty still exists concerning the range of underlying factors which influence inflation (Yellen 2017), and the reasons for the tendency of inflationary pressure to accompany the peak of a business cycle have been a matter of dispute between different schools of economic thought. Keynesian and neoclassical economists tend to view inflation as resulting from an imbalance between aggregate supply and aggregate demand (Girdzijauskas et al. 2022, 3). This being the case, the relatively low levels of unemployment and brisk economic activity at the peak of a business cycle could generally be expected to influence inflation upward both on the demand side and the

[68] While this chapter will focus on the role of central banks in influencing short-term interest rates upwards prior to a recession, due to the existence of a central bank in nineteenth century Britain and their ubiquity in the present, it should be noted that the existence of a central bank is not a necessary condition of this tendency of the banking system to raise interest rates to offset inflation. Advocates of a free banking system have argued that banks engaged in inflationary credit expansion would be forced to raise interest rates in order to offset outflows of reserves through interbank clearing and settlement mechanisms, even in the absence of a central bank (White 2011, 500). If all banks in a country without a central bank were able to avoid this constraint by somehow coordinating to expand credit, they would likewise be forced to reverse this trend and raise interest rates in order to stem the outflows of their specie or other reserves described by the theory of the price specie flow mechanism, developed by Richard Cantillon and David Hume (Murphy 2009, 88-89). In a monetary system based on a commodity money, such as the gold standard, it is possible that price inflation might occur due to an unexpected increase in the supply of the monetary commodity, for example a significant new discovery of gold. Such inflation would not be the result of an expansion of the supply of money and credit relative to banks' specie reserves, so it would not necessarily require an eventual raising of interest rates by banks to offset outflows of their reserves. However, the relevance of inflation not based in credit expansion to the business cycle is a matter of dispute between competing business cycle theories (see Dimsdale and Thomas 2019, 15-31).

supply side, as prices for factors of production are bid up, while higher wages allow consumers to increase their demand for goods. Adherents of the Wicksell, Hawtrey, and circulation credit theories of the business cycle, outlined earlier in this chapter, view the expansionary phase of the business cycle as having been initiated to begin with by the lowering of interest rates below the 'natural' rates which would otherwise have prevailed. In the case of an economy with a central bank, a lowering of the central bank's policy rate, such as the Bank of England's Bank rate, influences other interest rates downward; any commercial bank attempting to demand interest rates significantly higher than the policy rate would be at risk of having its borrowers bid away by other banks, which could offer cheaper loans by borrowing from the central bank at the lower policy rate. Demand for loans increases as a result of the new, lower interest rates, and this increase in lending activity is accompanied by a concomitant increase in the money supply, as a result of the standard process by which bank lending activity creates new money under a fractional reserve banking system (McLeay et al. 2014). Such increases in lending and in the money supply may be augmented by other policies which monetary authorities might choose to pursue, such as decreasing the reserve ratios required of commercial banks or engaging in open market purchases. This inflation of the money supply can be expected to lead to price inflation, as the receivers of the new money are able to bid up prices to higher levels than would have otherwise been possible.[69] In this sense, the Wicksell, Hawtrey, and circulation credit theories view the expansionary phase of the business cycle as inherently inflationary, with this inflation being driven by exogenous increases in the money supply.

[69] The question of whether changes in the money supply significantly impact output and production has been a subject of disagreement amongst economists since at least the seventeenth century (Wennerlind 2005, 226), and was the subject of much scrutiny during the late twentieth century debates on the Phillips curve (see Serletis and Koustas 2019, 2133-2134). 'Austrian' adherents to the circulation credit theory of the business cycle tend to particularly emphasise the redistribution of purchasing power to the first receivers of the newly created money, who are able to use it before price increases have spread throughout the economy, a view based on the insights of the early eighteenth century economist Richard Cantillon (Bordo 1983; Sieroń 2019).

Monetary authorities will be incentivised to eventually attempt to constrain the inflation associated with the expansionary phase of the business cycle, for a range of reasons. In a fixed exchange rate regime, where conversion of the money into specie or into other currencies at a fixed rate is guaranteed, holders of the money will be incentivised to convert it into a more highly valued quantity of specie or other currencies at the fixed rate, which will result in a drain of the specie or currency reserves of the country guaranteeing the fixed exchange rate.[70] Such drains of specie reserves could also be expected to be exacerbated by the high demand for imports which tends to accompany a cyclical peak, resulting in exports of specie (Dutton 1984, 176). Even in a fiat money standard, where the risk of painful drains of specie reserves is diminished, allowing high inflation to persist could lead economic actors to factor expectations of persistent inflation into their current demand to hold money, causing inflation to increase further, potentially into uncontrollable hyperinflation (Sargent and Wallace 1973). In either case, central banks will eventually be incentivised to constrain the inflation which accompanies the expansionary phase of the business cycle, with one of their key tools to accomplish this goal being to raise their policy rates. In the reverse of the inflationary mechanism outlined above, a rise in the central bank's policy rate will diminish the quantity of funds commercial banks are able to borrow from the central bank, which will in turn influence commercial banks to raise their interest rates and reduce the extent to which they extend loans and hence expand the money supply. Such credit contraction can be expected to limit aggregate demand, as consumers' ability to finance consumption through borrowing will be diminished. Aggregate supply will also be impacted: the circulation credit theory of the business cycle emphasises that credit contraction both limits the availability of funds for the undertaking of new business ventures or the expansion of existing ones, and also leads entrepreneurs to reconsider

[70] The Bretton Woods international monetary system of the mid-twentieth century was famously brought to an end by such a process, which saw unsustainable redemption of inflated U.S. dollars into gold (see Garber 1993).

the viability of marginal projects which they had only expected to become profitable at the previous, lower interest rate, potentially forcing the liquidation of these projects.

This goes some way toward illustrating the causes behind the tendency of the counter-inflationary increase in interest rates to be followed by a recession. Add to this the fact that central banks' policy rates are for short-term loans to other financial institutions, and hence are generally acknowledged to influence short-term interest rates more directly than long-term interest rates (Bank of England 1999, 162), and the basic theoretical reasoning behind the view that pre-recession yield-curve inversions should be viewed as rises in short-term above long-term interest rates becomes apparent. In summary, faced with the inflationary pressure which tends to accompany the peak of the business cycle, central banks will aim to contract or slow the growth of the supply of money and credit, using the various tools available to them. This credit contraction could be expected both to influence short-term interest rates upwards more immediately than the less-responsive long-term interest rates, causing a flattening or inversion of the yield curve, and also to constrain aggregate supply and demand, contributing to the onset of an economic downturn.

This perspective has the advantage of containing an explanation for why a flattening or inversion of the yield curve has tended to be a reliable harbinger of an oncoming recession, both in the much-studied late twentieth century U.S. data, and to some extent in the nineteenth century British data, as indicated by the results of the previous chapter and by Capie et al. (2019). This contrasts with the policy anticipations hypothesis, which explains pre-recession yield curve inversions as a result of the fact that economic actors already expect a recession, and hence their expectations of lower short-term interest rates during the recession are influencing the current level of long-term interest rates downwards, limiting the extent to which yield curve inversions could be argued to offer any predictive information not already known. However, it should be stressed that viewing pre-recession yield-curve inversions as a result of short-term interest rates rising above long-term interest rates is not necessarily incompatible with acceptance of the expectations hypothesis, or of the policy anticipations hypothesis. It could be held that both falling long-term interest rates due to expectations of accommodative monetary policy in an oncoming recession, and rising short-term interest rates due to central banks' efforts to constrain cyclical inflation, simultaneously contribute to the tendency for yield curves to flatten or invert prior to a recession. The expectations hypothesis view of long-term interest rates as being an average of expected future short-term interest rates certainly conforms with a view of long-term interest rates as being less immediately responsive than short-term interest rates to changes in central bank policy rates. This theoretical compatibility further limits the extent to which we could expect an examination of the nineteenth century British data to conclusively prove one of these two perspectives to be correct, and the other incorrect.

The difficulty of selecting a methodology for assessing the validity of the view that pre-recession flattening or inversions of the yield curve in nineteenth century Britain reflect a rise in short-term above long-term interest rates is further complicated, ironically, by the straightforward economic principles upon which this view is based. As outlined above, this view is grounded in supply and demand analysis of the likely impacts of an increase in short-term interest rates, both on the money supply and on the demand for credit to be put towards consumption or investment into new business ventures, or the expansion of existing ones. The question of whether or not empirical evidence is necessary to verify the core postulates of economic theory was the centre of considerable debate over the course of the twentieth century, during which time a methodological shift was taking place in the discipline from the literary, discursive style of earlier economic texts, to an increasing adoption of mathematical methods (see Weintraub 2002). The growing influence of logical positivism on economic methodology (Misak 2005, 55-90), as seen, for example, in Milton Friedman's influential essay on methodology (Friedman 1953, 3-16), saw an increasing emphasis on the importance of verifying economic postulates via the inductive, empirical methods previously associated with the natural sciences. In reaction to this push towards empiricism, other writers sought to reinforce and explicate the literary, deductive method upon which most economists of the nineteenth century and earlier had implicitly based their analysis: this approach was advocated by Lionel Robbins in a highly influential methodological essay (Robbins 1932), and even more trenchantly, though less influentially, by Ludwig von Mises (1933; 1949, 30-71; 1962). While inductive and mathematical methods now predominate in the fields of economics and economic history, debate still exists concerning the strengths and weaknesses of mainstream, neoclassical economic methodology, with criticisms coming both from modern advocates of the older, deductive method (Hoppe 1995; Boettke and Leeson 2006), and from more recently emerged schools of economic thought, such as behavioural economics (Schettkat 2018). In the case of fundamental economic propositions, however, such as the 'laws' of supply and demand upon which the above view of the tendency for short-term interest rates to rise toward the peak of a business cycle is based, advocates of both empirical and deductive methodologies have tended to affirm their validity as either economic laws or widely applicable generalisations. While some studies have sought to empirically assess the validity of the laws of supply and demand in general (Härdle et al. 1991), inductive studies in this area have more often sought to investigate the elasticity of supply and demand in particular markets and under particular circumstances (Bijmolt et al. 2005).

This being the case, a thorough attempt to empirically verify the supply and demand based reasoning outlined above, concerning the tendency for short-term interest rates to rise toward the peak of the business cycle, may be both beyond the scope of what could be thoroughly explored within the context of a section of this chapter, and unnecessary as an attempt to 'prove' basic economic concepts which are already widely accepted. Instead, the following subsections will attempt to provide historical context concerning the development of the institutions and monetary policy tools which could be expected to have driven this rise in short-term interest rates toward the peak of the business cycle. Data will then be presented illustrating the extent to which the correlations between the Bank rate, short-term interest rates, consol yields, and other variables reflect what might be expected based on the theoretical and historical case for viewing the Bank of England as having aimed to influence short-term interest rates upwards at around the peak of the business cycle in Britain between the years of 1800 and 1913.

The Historical Development of the Bank of England's Goals and Policy Tools

In order to begin to illustrate the plausibility of the view that rises in short-term interest rates toward the peak of the business cycle ought to be highlighted as a particularly relevant cause of the flattening or inversion of the yield curve in Britain between the years of 1800 and 1913, a number of underlying questions must first be addressed. To what extent did the Bank of England aim to influence the level of short-term interest rates in the broader economy? What channels did this influence operate through? Were actions undertaken by the Bank to raise short-term interest rates a conscious and understood effort to limit the inflation and outflows of reserves which could be expected to characterise the peak of a business cycle initiated by credit expansion, or were rises in short-term relative to long-term interest rates prior to recessions the result of some other goal of the Bank, or of entirely different factors? Did changes in the goals of the Bank of England over the course of the timeframe alter the extent to which it aimed to influence short-term interest rates upwards prior to recessions? Some of these issues were touched upon by the historical overview of the changing structure of the British financial system during this period, which was a focus of the second chapter of this thesis. However, a closer assessment of the historical developments particularly relevant to these questions may help to illustrate the senses in which pre-recession yield curve inversions in Britain between the years of 1800 and 1913 could be regarded as reflecting a rise in short-term relative to long-term interest rates.[71]

While the methods and goals of the Bank of England varied to some extent over the course of the nineteenth century, its primary goal throughout the period from 1800 to 1913 is generally regarded as having been the protection of the country's gold reserves from outflows (Capie et al. 1994, 113). Such outflows might result either from a loss of confidence in the banking system causing a significant number of domestic depositors to request redemption of their banknotes into specie, as occurred for example during the Panic of 1825 (Dawson 1990), or from unfavourable exchange rates causing official value of the pound in terms of gold to be overvalued relative to the market price of gold, leading to hoarding and exports of specie (Dimsdale and Thomas 2019, 119). In either case, a raising of interest rates and consequent contraction of the supply of money and credit could be expected to diminish the inflation of the money supply relative to specie reserves, and hence realign the official and market prices of gold, reducing the incentives for redemption into specie.

In order to argue that the flattening or inversion of the yield curve prior to recessions in Britain between the years of 1800 and 1913 could be regarded as a result of a rise in short-term relative to long-term interest rates, stemming from efforts by the Bank of England to constrain the inflation and consequent outflows of specie reserves which tend to accompany the peak of a business cycle, it must first be established that decision makers at the Bank could reasonably be assumed to have been intentionally aiming to achieve this effect by such means. After all, if they

[71] This subsection's focus on the influence and policy tools of the Bank of England reflects the central place held by the Bank in the British money market throughout the period under consideration, and is not intended to suggest that pre-recession increases in short-term interest rates could not have occurred were it not for the actions of the Bank. The mechanisms by which such increases might be driven in a financial system without a central bank were outlined in a previous footnote.

had not understood the potential for a rise in short-term interest rates to combat undesired inflation and outflows of specie reserves, they would have been no more likely to have aimed to influence short-term interest rates upwards at the peak of a business cycle than at any other time, undermining the plausibility of the view that such efforts might explain the tendency for a flattening or inversion of the yield curve to precede recessions. Naturally, an understanding of the effects of central bank policy on interest rates, and of these on the broader economy, is fundamental to most actions of central banks in the present day, but it might be objected that this understanding is based on economic theories and perceptions of the proper goals of central banking which developed over time, and therefore cannot be assumed in the case of nineteenth century central bankers.

However, an understanding of the relationship of the supply of money and credit to interest rates, and of these to the value of the currency and to outflows of specie from the Bank of England, can indeed be safely assumed to have been commonplace amongst financial professionals even in the early nineteenth century, as a result of numerous historical and theoretical developments which were already in place by that time. The economic proposition of Gresham's Law — which holds that when the values of two forms of money are officially fixed relative to one another while their relative market values continue to fluctuate, the less highly valued money (for example inflated bank notes) will remain in circulation while the more highly valued money (for example specie) will be hoarded or otherwise removed from circulation — had been outlined by the French economist Nicholas Oresme at least as early as the fourteenth century (Selgin 2020), and was the subject of detailed explication by Copernicus in the sixteenth century (Ziffer 1957).[72] A widespread understanding can be assumed of the idea that increasing the supply of money relative to the quantity of specie backing it would lead to a decline in the purchasing power of the money, thanks to the long and well-known history of coin clipping and other forms of currency debasement in

[72] Despite its early origins, this theory did not acquire the name of Gresham's Law until 1858, when the Scottish economist Henry Dunning Macleod named it after the sixteenth century English financier and founder of the Royal Exchange, Sir Thomas Gresham (Selgin 2020).

England and throughout Europe (Rolnick et al. 1996), the first recorded examples of which took place in the sixth century B.C. (Ziffer 1957, 73). Furthermore, the quantity theory of money was already well established by the start of the nineteenth century. The view that the purchasing power of money was inversely proportional to the quantity in circulation had first been adumbrated in 1556 by Martín de Azpilcueta, Spanish scholastic theologian and economist of the School of Salamanca, and a classic and influential account of the theory had been advanced by David Hume in 1752 (Dimand 2013; Wennerlind 2005). In the very same volume, Hume also popularised the theory of the price-specie flow mechanism, which linked an increase in the supply of money in one country to rising prices and a consequent decline in the competitiveness of that country's exports.[73] Particular attention was being paid at the start of the nineteenth century to the relationship between the supply of money and credit and the value of the currency, as a result of the Bullionist Controversy, which saw ongoing debate concerning the causes of the depreciation of the pound following the suspension of its convertibility into specie (Hendrickson 2018). It is true to note that the threat of specie outflows resulting from the redemption of Bank notes into gold was removed during the suspension period, which lasted from 1797 to 1821. However, a significant decline in the sterling exchange rate between 1808 and 1811 was still considered to be concerning potential evidence of an inflation of the money supply for the purpose of war finance, which was considered an intolerable enough threat to confidence in the currency that it led to the appointment of the Bullion Committee in 1810, to investigate the causes of this development. The Committee concluded that the undesirable inflation had been driven by an excessively liberal discount policy by the Bank of England, and recommended limiting the Bank's lending to the level of its specie reserves, although this advice did not result in any immediate legislative changes (Dimsdale and

[73] Although Hume popularised the theory of the price-specie flow mechanism via the publication of his *Political Discourses* in 1752, it had been developed first by Richard Cantillon in his *Essai Sur La Nature Du Commerce En Général*. This book, which was arguably the first major work to treat economics as a positive science and elucidate it in the form of a systematic treatise, was admittedly not published until 1755, but it had been completed around 1730 and circulated in manuscript form amongst intellectual circles (Cantillon 1755, 13-15; Thornton 2007).

Thomas 2019, 121-122). This conclusion by the 1810 Bullion Committee, which was discussed extensively in the contemporary press (Fetter 1955), in addition to the fact that all the aforementioned economic theories were well established by the start of the nineteenth century, all combines to suggests that there was already a relatively widespread understanding of the fact that expansion of the supply of money and credit was associated with a decline in the value of sterling and with outflows of specie. All of this strongly suggests that decision makers at the Bank of England, throughout the period from 1800 to 1913, could well be expected to have had a robust understanding of the utility of contracting the supply of money and credit as a tool to limit undesirable inflation and hence to stem outflows of reserves from the financial system.

It might be objected that several of the functions and goals characteristic of a modern central bank were not widely acknowledged to have been priorities of the Bank of England in the early nineteenth century. When asked to list the functions of the Bank of England at a Bank Charter Renewal Committee hearing in 1832, then Governor of the Bank John Horsley Palmer stated that these were "to furnish the paper money with which the public act around them, and to be a place of safe deposit for the public money, and for the money of individuals who prefer a public body like the Bank to private bankers" (Morgan 1943, 1). However, such statements obscure the increasingly active role the Bank was taking in the money market, even at that early date. For example, the Bank had arguably already been acting as de facto lender of last resort throughout the last four decades of the eighteenth century, although this role did not come to be regarded as an unambiguous public duty of the Bank until the late nineteenth century, following the Panic of 1866, the influential writings of Walter Bagehot, and the Bank-led rescue of Barings Bank during the Panic of 1890 (Dimsdale and Thomas 2019, 126; Turner 2014, 144; Kosmetatos 2019; James 2012). The early origin of this important function was admittedly obscured by a number of occasions in the early to mid-nineteenth century when the Bank appeared to flinch from the requirements of the role of lender of last resort. During the Panic of 1825, the Bank initially restricted its discounts in order to limit alarming outflows of its specie reserves, before eventually being pressured by the government to begin lending freely to distressed banks around two weeks into the Panic (Turner 2014, 144). In 1836 the Bank also declined to provide sufficient assistance to save the Northern and Central Bank of England (NCBoE) from liquidation, although the Bank had provided some assistance, and the NCBoE was widely believed to be not merely illiquid but insolvent, limiting the extent to which this could be regarded as a violation of lender of last resort principles (Turner 2014, 147; Collins 1972, 55). The passage of the Bank Charter Act of 1844 (7 & 8 Vict. c. 32) might also be pointed to as evidence of the fact that the Bank was not yet acting as a lender of last resort, due to its requirement that all Bank note issues in excess of £14 million be backed by a 100 per cent specie reserve, theoretically limiting the extent to which the Bank would be able to expand the money supply by lending freely in times of distress. In practice however, this restriction was suspended during the panics of 1847, 1857, and 1866, allowing the Bank to lend more and more freely in each one of these crises (Turner 2014, 147-151). All of this tends to suggest that the Bank of England generally, though not entirely consistently, fulfilled the role of a lender of last resort throughout the period from 1800 to 1913, a role which it even seemed to publicly acknowledge at least as early as 1819 (Morgan 1943, 4-5).[74]

Just as the Bank of England had been consciously acting as a lender of last resort to some degree since the late eighteenth century, despite the common association of this function with more

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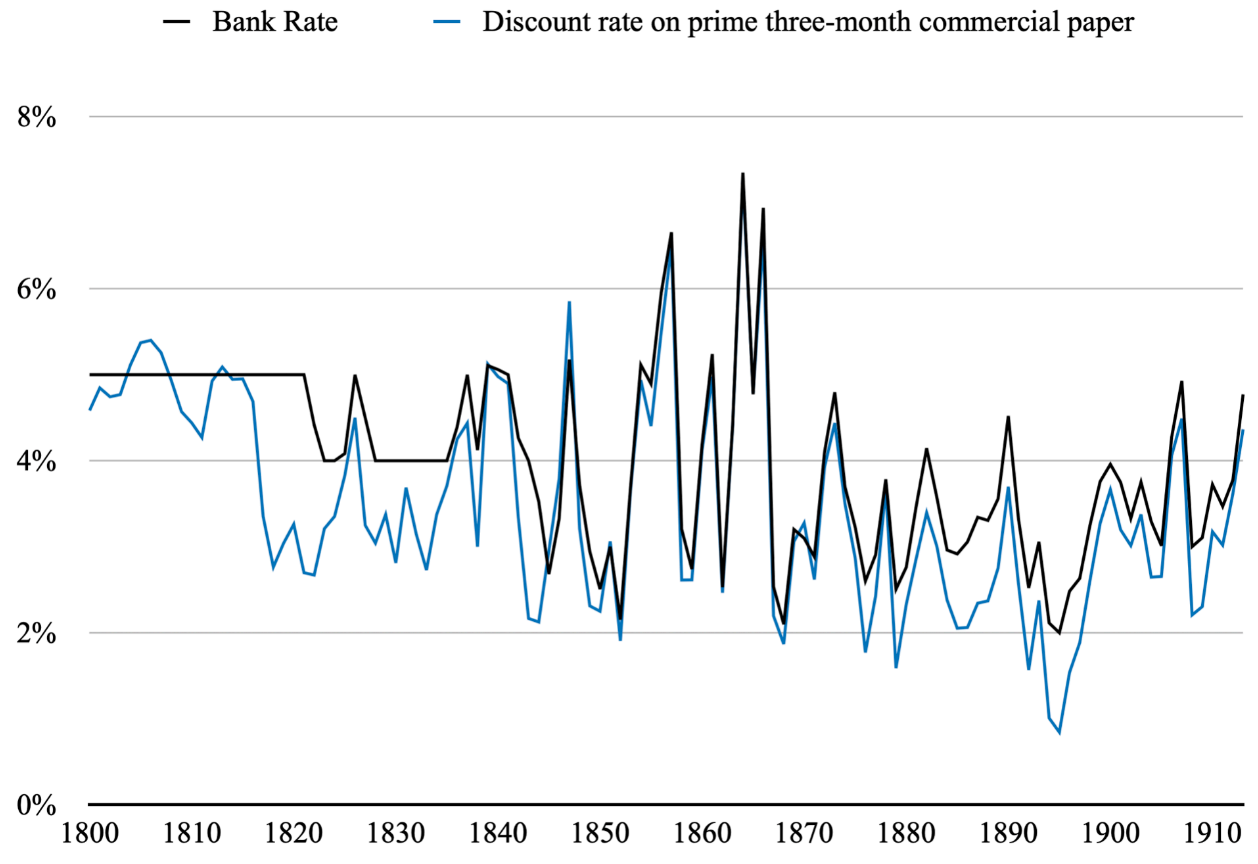
[74] It might be argued that the fulfilment of a lender of last resort function by the Bank of England undermines the idea that it contributed to a flattening or inversion of the yield curve by raising short-term interest rates (i.e. restricting credit) during crises. However, the view that the predictive power of yield curve inversions can be attributed to a rise in short-term interest rates prior to the onset of a recession, as such a rise would have the potential to both cause a flattening or inversion of the yield curve and contribute to the onset of a recession by restricting investment and aggregate demand, does not necessarily require short-term interest rates to be relatively high during the onset of a recession, only beforehand. Even if the central bank is committed to acting as lender of last resort during crises, it could still be expected to attempt to stem specie outflows or constrain inflation by contracting credit prior to the onset of a crisis. Furthermore, liberal discounts by the Bank of England were not always sufficient to lower short-term interest rates in the broader economy, as was the case during the Panic of 1857, due to the incentive for private banks to build up their cash reserves amidst the uncertainty of a banking panic (Turner 2014, 149).

modern central banks, there is likewise evidence that the Bank consciously aimed to raise short-term interest rates when necessary to constrain inflation and outflows of reserves, throughout the period from 1800 to 1913. In the aforementioned 1832 Bank Charter Renewal committee hearing, Governor Palmer argued that the Bank Rate should typically be held high relative to market interest rates in order to constrain the supply of money and credit from excessive expansion (Morgan 1943, 5), suggesting an intentional effort, even in the early nineteenth century, to raise short-term interest rates in response to inflation and specie outflows. It is true to note that certain limitations diminished the utility of the Bank Rate as a tool for influencing short-term interest rates upwards in the early nineteenth century, not least of which being the Usury Act of 1714 (13 Ann. c.15) which prohibited the Bank from setting the Bank Rate above 5 per cent prior to 1833.[75] However, the Bank actively sought to overcome these limitations on its ability to constrict the supply of money and credit using a number of means. Explicit rationing of credit was employed when the Bank was faced with an outflow of its reserves in December 1795, despite the Bank Rate already being at its legal maximum (Bordo and White 1991, 311), and the Bank likewise denied discounts to firms believed to be unsound during the specie drain which characterised the months prior to the Panic of 1825 (Fulmer 2022, 1046; Morgan 1943, 9; Jackson 2022, 241). The Bank also periodically bought and sold Exchequer Bills to influence the quantity of money and credit in circulation (Capie et al. 1994, 129), although such open market operations would not become a quotidian aspect of the Bank's toolkit until after 1873, and arguably did not become the the Bank's primary tool for influencing the supply of money and credit until after the First World War (Crouzet 1982, 329; Davutyan and Parks 1995, 1101).

Following the 1833 lifting of the Usury Act restrictions, however, raising the Bank Rate became the Bank's primary tool for stemming gold outflows. Although the official discount

[75] Strictly speaking this law was not repealed until 1854, but its applicability to the Bank Rate ceased when short-term bills of exchange were exempted after 1833 (Homer and Sylla 2005, 205-206).

Figure 23. The Bank Rate and the Short-Term Market Discount Rate, 1800-1913



Source: Thomas and Dimsdale (2017, Sheet A31, Columns C and G). Annual averages of monthly data.

rate was often above the market rate for short-term commercial paper, as is illustrated by Figure 23, efforts to "make the Bank rate effective" as a tool for influencing the levels of other interest rates were the focus of "a great deal of the energies of those governing the Bank" (Dutton 1984, 177). Such efforts to influence market interest rates up to the level of the Bank rate, and hence make alterations of the Bank rate a more effective tool for influencing market interest rates, were partly accomplished as a result of the fact that commercial banks held their reserves at the Bank of England, and were therefore required to discount paper at the Bank's chosen rate (Capie et al. 1994, 113). From the 1830s onwards, the Bank also aimed to influence market interest rates up to the level of the Bank rate by removing funds from the market, which it accomplished variously by selling securities, borrowing from other financial institutions against its securities holdings, and arranging repurchase agreements of consols (Capie et al. 1994, 114; Dutton 1984, 177). These efforts to influence market interest rates up to the level of the Bank rate suggest that ensuring the effectiveness of the Bank rate as a tool for influencing market interest rates *upwards* was a key concern of the Bank, as lowering them could theoretically have been accomplished more straightforwardly by simply lowering the Bank rate below the market rate, and hence imposing opportunity costs on anyone borrowing at the higher market rate.[76] This preoccupation with ensuring the effectiveness of the Bank rate as a tool for constricting the supply of money and credit conforms with the generally accepted view that the Bank's primary goal throughout the nineteenth century was protecting the country's gold reserves from outflows (Capie et al. 1994, 113).

The extent of the Bank of England's influence over the supply of money and credit was also bolstered by the increasing circulation of its notes throughout the country over the course of the nineteenth century, relative to the circulation of private banknotes, a development which the Bank seems to have actively promoted. The ratio of Bank of England notes to private banknotes in circulation was approximately 1:1 in 1826 (Turner 2014, 68; Coppieters 1955, 154), rising to 3:1 by 1850, 9:1 by 1880, and 27:1 by 1901 (Born 1983, 8). A number of legislative changes contributed to this trend, including the restriction of small note issues by the Country Bankers Act of 1826 (7 Geo. 4., c.6),[77] the granting of legal tender status to Bank of England notes by the Bank of England Act 1833 (3 & 4 Will. 4., c.98), and the restrictions placed by the Bank Charter Act of 1844 (7 & 8 Vict. c.32) on new note issuing activity by any new or existing private bank (Crouzet 1982, 326). While the Bank has been argued to have facilitated these developments through its influence over Parliament (Turner 2014, 36), it is certainly true that it aimed to reinforce them by pressuring other

[76] In the years immediately following the passage of the Bank Charter Act of 1844 the Bank did indeed briefly pursue such a policy, lowering its discount rate below market rates in an effort by its Banking Department, newly separated from the Issue Department, to more vigorously pursue profits. As might be expected, this influenced market interest rates downwards and stimulated a credit expansion and consequent specie outflows, culminating in the Panic of 1847 (Dimsdale and Thomas 2019, 135).

[77] Issues of small denomination banknotes had been viewed as a key cause of the credit expansion which culminated in the severe Panic of 1825. As this expansion of small denomination notes was generally attributed to the large number of small country banks, the 1826 legal restriction on the issue of small denomination bank notes could therefore be seen as a greater constrain on the circulation of private bank notes than of Bank of England notes (Dimsdale and Thomas 2019, 125-126).

banks to cease their note issues, including by refusing to discount bills for note-issuing joint-stock banks from the mid-1830s onwards, (Goodhart 1988, 40). Given the legal privilege which permitted private banks to pay out Bank of England notes instead of gold to customers requesting redemption of their private bank notes, private banks and country banks in the early part of the nineteenth century possessed considerable scope to expand the supply of money and credit by pyramiding their own note issues atop a fractional reserve of Bank of England notes (Selgin 1992, 179). Therefore, the decline in the circulation of private bank notes relative to Bank of England notes enabled the Bank of England to reinforce and make more direct its power to influence interest rates upwards via a rise in the Bank Rate or via open market operations.

One development between the years of 1800 and 1913 which could be argued to challenge this view of the Bank of England as having been primarily concerned with preventing outflows of specie was the development of the international gold standard and its concomitant 'rules of the game'. While Britain had resumed specie payments as early as 1821, by the late 1870s many of the other major industrial nations had likewise adopted gold as the basis of their currencies, including France, Germany, and the United States (Mitchener 2013). Subsequent authors have argued that maintaining this international gold standard required central banks in the participating countries to abide by a set of explicit and implicit 'rules of the game', including allowing free conversion between gold and domestic money at the fixed price, not restricting imports or exports of gold, and allowing price levels to fluctuate freely as a result of changes in the demand for and supply of gold (McKinnon 1993, 1-4).[78] Adherence to these rules was supposed to ensure the smooth operation of an international gold standard by constraining central banks from interfering with the price

[78] McKinnon (1993, 1) notes that Keynes is often credited with coining the phrase 'rules of the game' in 1925, more than a decade after the abandonment of the classical gold standard, and that Keynes did not systematically list what he felt these rules were, an omission which also characterised the work of many subsequent authors who have used the expression. This highlights the fact that these rules were a conceptual tool developed by economic historians to describe and explain the workings of the international classical gold standard, rather than a list of guidelines explicitly laid out and imposed on central banks by some organisation at the time.

adjustments and gold flows which, according to the processes outlined in the theory of the price-specie flow mechanism, were supposed to counteract the gold outflows which might afflict a country experiencing a balance of payments deficit. Indeed, some interpretations have emphasised that the only proper course of action for central banks wishing to operate by the rules of the game would have been to proactively reinforce and amplify the forces described by the price-specie flow mechanism so as to hasten its adjustments, for example by actively seeking to raise interest rates when confronted with an outflow of specie, so as to constrict the supply of money and credit, reduce price levels, and attract gold back into the country (Bordo and Kydland 1995, 442). In other words, if central banks had operated according to the rules of the game this would align with the view that yield curve inversions prior to recessions could be seen as a result of rising short-term interest rates, stemming from the rule-following efforts of central banks to raise short-term interest rates in order to offset the inflation and gold outflows which tend to characterise the peak of the business cycle. The issue, then, arises from the question of whether or not central banks actually did adhere to the rules of the game, a question which has been assessed by a number of prior studies (for example Dutton 1984; Giovannini 1986; McKinnon 1993; Ugolini 2013). While the methods and conclusions of these studies have varied, their seeming consensus that many central banks did not flawlessly adhere to the rules of the game during the period of the classical gold standard might be incorrectly taken to mean that the Bank of England could not be assumed to have aimed to combat inflation and outflows of reserves by seeking to raise short-term interest rates at the peak of the business cycle. However, while it seems to be true that not all central banks consistently followed the rules of the game during the period of the classical gold standard, a number of the studies in the prior literature have argued that the Bank of England was amongst the most rule-abiding participant in the system (Bloomfield 1959; Pippenger 1984; McKinnon 1993), possibly as a result of its central place in global economy and in the management of the classical gold standard

(Bordo and Kydland 1995, 443; Ugolini 2013).[79] Furthermore, the incentives for a central bank to violate the rules of the game were generally not of the kind which would lead it to refrain from raising interest rates when confronted with outflows of gold; needless to say, central banks could be expected to wish to limit such outflows of their own reserves regardless of their commitment to international cooperation. Instead, one of the key areas in which central banks were incentivised to violate the rules of the game was the sterilisation of gold inflows in order to increase their gold reserves (McKinnon 1993, 8),[80] which would not undermine the tendency for short-term interest rates to increase at the peak of a business cycle. All of this tends to suggest that neither the emergence of the international classical gold standard and its concomitant 'rules of the game', nor the failure of central banks to flawlessly adhere to those rules, could be regarded as having disrupted the incentives for the Bank of England to have aimed to raise short-term interest rates to combat the inflation and potential outflows of gold which characterise the peak of a business cycle, and therefore these factors do not undermine the view that such rises in short-term rates could be regarded as a particularly relevant cause of the flattening or inversion of the yield curve prior to recessions at the time.

It might also be objected that the Bank of England could not be viewed as having aimed to influence short-term interest rates upwards in response to the inflation and consequent threat of outflows of reserves which tend to accompany the peak of the business cycle, because the theoretical understanding of the transmission mechanism and the very idea of such a thing as a business cycle had not yet been developed at the start of the nineteenth century. Earlier in this chapter, it was noted that one could view pre-recession yield curve inversions as reflecting a rise in

[79] A contrasting perspective is offered by Giovannini (1986), who argues that the German Reichsbank adhered to the rules of the game to a greater extent than the Bank of England.

[80] While such sterilisation of gold inflows has typically been regarded as a violation of the rules of the game, McKinnon (1993, 9) argues that central banks seeking to accumulate 'excess' gold reserves in order to facilitate their last resort lending should not be regarded as having violated the rules of the game, as long as they maintained the convertibility of their currency at the official parity.

short-term above long-term interest rates based on an understanding of the incentives for central banks to raise their policy rates in response to the inflation and outflows of specie reserves which tend to accompany the peak of a business cycle, and based on an understanding of the more immediate influence of such rises in policy rates on short-term than long-term interest rates, which is a core assumption of most descriptions of the monetary transmission mechanism (Bank of England 1999, 162; Pétursson 2001, 63-64; Wu 2003). In other words, while certain theories of the business cycle, such as the Wicksell, Hawtrey, and circulation credit theories, could be argued to imply or offer insights into the tendency for yield curve inversions to occur as a result of rises in short-term interest rates at the peak of the business cycle, it is not necessary to subscribe to any of these theories in order to view such inversions as partly reflecting a rise in short-term above long-term rates, as such a perspective could also be seen as a straightforward implication of this generally accepted aspect of the monetary transmission mechanism. It is certainly true to note that the modern understanding of the monetary transmission mechanism[81] had not yet developed even by the end of the period under our consideration, in 1913, and was largely based on the insights of a number of investment, consumption, and international trade models developed in the mid-twentieth century (Boivin et al. 2010, 374-376). However, the aspect of this theory which informs the idea of pre-recession yield curve inversions as reflecting a rise in short-term interest rates is only its acknowledgement of the generally more direct and immediate influence of changes in the central bank policy rates on short-term than long-term interest rates. This is just one aspect of the monetary transmission mechanism, and could independently be arrived at as an implication of the fact that the Bank rate was a rate charged for discounting short-term bills, and therefore imposed an upper limit on short-term market interest rates more directly than on long-term interest rates, which might be influenced by expectations of future short-term interest rates, borrowers' long-run liquidity

[81] See, for example, the influential overview of the monetary transmission mechanism offered by Mishkin (1995).

preferences or time preferences, or other factors not under the Bank's direct control. Furthermore, the aforementioned efforts by the Bank from at least the 1830s onwards to make the Bank rate effective as a tool for influencing short-term market interest rates upwards in order to prevent undesired inflation and protect the Bank's reserves, suggests that decision makers at the Bank were aware of the potential for the Bank rate to influence short-term market interest rates, regardless of their lack of access to modern theoretical explanations of the impacts of monetary policy, such as the transmission mechanism. As for the absence of a clear understanding of the concept of business cycles in the early nineteenth century, while it is true to note that it wasn't until the 1860s that the first business cycle theory was advanced by the French statistician Clément Juglar (Legrand and Hagemann 2007; Dimsdale and Thomas 2019, 13), an understanding of the cyclical reoccurrence of economic crises is not a necessary precondition of the Bank's incentive to influence short-term interest rates upwards in order to offset the inflation and consequent outflows of reserves which tend to accompany the peak of a business cycle.

Given the scope of the topic of the development of the powers and goals of the Bank of England over the course of the period from 1800 to 1913, and the numerous dedicated studies which have analysed the subject in detail,[82] an exhaustive overview of of these developments would be beyond the scope of this subsection. However, these aforementioned factors do tend to suggest that, throughout the period from 1800 to 1913, a major goal of the Bank of England was the protection of its gold reserves from outflows, and that decision makers at the Bank can reasonably be assumed to have understood the theoretical utility of aiming to influence short-term interest rates upwards as a means to that end. Indeed, efforts to limit outflows of reserves by constricting the supply of money and credit do indeed seem to have been made at least as early as the Panics of 1795 and 1825, while the Bank appears to have become increasingly concerned from the 1830s

[82] The studies by Wood (2005), Flandreau and Ugolini (2013), and Capie (2018) represent just a few of the recent additions to this literature, not to mention the classic accounts of Clapham (1945), Fetter (1965), Sayers (1976), and others.

onwards with making the Bank rate effective as its primary tool for raising short-term interest rates. Furthermore, it is not clear that changes in the goals of the Bank over the course of the nineteenth century, such as its increasing commitment to act as lender of last resort or the requirement to adhere to the 'rules of the game' of the international classical gold standard, could be seen as having significantly altered the Bank's incentives to prevent outflows of gold reserves by aiming to raise short-term interest rates prior to the onset of a recession or economic crisis. All of this conforms with the view that the tendency for the yield curve to flatten or invert prior to recessions in Britain between the years of 1800 and 1913 was likely in part caused by rising short-term relative to long-term interest rates prior to the onset of recessions, as a countermeasure against the inflation and consequent outflows of reserves which tend to accompany the peak of a business cycle.

Illustrating the Rise in Short-Term Interest Rates Prior to Recessions

Having outlined, over the course of the previous subsections the various reasons why short-term interest rates might be expected to have risen relative to long-term interest rates prior to recessions in Britain between the years of 1800 and 1913, this subsection aims to demonstrate the extent to which such a tendency presents itself in the available data. The goal of this subsection is not to attempt to provide definitive answers to related questions, such as whether or not the influence of Bank of England actions on short-term interest rates can be empirically proved, or the extent to which other factors may have contributed to fluctuations of interest rates prior to recessions. While a fuller understanding of these topics would certainly provide additional insight into the question of whether or not pre-recession yield curve inversions could be seen as reflecting a rise in short-term relative to long-term interest rates, the assessment of such questions could more appropriately be accomplished by future studies able to more comprehensively engage with the complexities of the relevant prior studies and their methodologies. Instead, a descriptive statistics approach will be taken to illustrating the extent to which the expected rise in short-term interest rates can be seen to have occurred prior to recessions in Britain between 1800 and 1913.

Perhaps the most straightforward method by which a broad, preliminary picture can be gained of the extent to which rises in short-term relative to long-term interest rates appear to have preceded recessions in Britain between the years of 1800 and 1913 would be by presenting data concerning the average changes in their relative levels in the months prior to recessions, during the full 1800 to 1913 timeframe and each of the sub-periods. This data is presented in Table 14, and appears to somewhat conform to the idea that rising short-term interest rates characterised the period prior to recessions to a greater extent than declining long-term interest rates. In both the 1844 to 1870 and 1870 to 1913 sub-periods, short-term interest rates rose by more than one per cent on average in the eight quarters prior to a business cycle peak, both in absolute terms and relative to long-term interest rates. For the full period from 1800 to 1913, the level of short-term interest rates had risen by approximately 0.5 per cent on average by the peak of a business cycle relative to its levels both four and eight quarters previously, both in absolute terms and relative to long-term interest rates. For the full period 1800 to 1913, and for the two sub-periods 1844 to 1870 and 1870 to 1913, short-term interest rates four quarters prior to the peak of the business cycle appear to have been notably higher than those one or two quarters prior, suggesting that the greater part of the pre-recession rise in short-term relative to long-term interest rates occurred between 6 and 12 months prior to the business cycle peak on average, during those periods. However, the expected tendency for short-term interest rates to have risen prior to the peak of a business cycle is not as clearly evident in the data from the 1800 to 1821 and 1821 to 1844 sub-periods. This may reflect the increasingly active use of the Bank rate from the 1830s onwards, and particularly after the passage

Table 14. Average Pre-Recession Changes in Short-Term and Long-Term Interest Rates, 1800-1913

		Average change		
Period	Number of quarters prior to cycle peak	Δr	ΔR	Δr - ΔR
1800-1913	8	+0.52%	-0.04%	+0.55%
	6	+0.25%	+0.05%	+0.20%
	4	+0.55%	+0.11%	+0.44%
	2	+0.07%	+0.06%	0.00%
	1	-0.03%	+0.09%	-0.11%
1800-1821	8	-0.35%	-0.29%	-0.06%
	6	-0.22%	-0.01%	-0.20%
	4	-0.13%	+0.13%	-0.26%
	2	-0.05%	+0.06%	-0.10%
	1	-0.02%	+0.12%	-0.14%
1821-1844	8	-0.74%	-0.09%	-0.65%
	6	-0.07%	-0.05%	-0.02%
	4	+0.16%	+0.04%	+0.12%
	2	-0.03%	+0.05%	-0.08%
	1	-0.09%	+0.05%	-0.14%
1844-1870	8	+1.36%	+0.17%	+1.19%
	6	+0.67%	+0.17%	+0.51%
	4	+1.42%	+0.20%	+1.22%
	2	+0.29%	+0.13%	+0.16%
	1	-0.10%	+0.12%	-0.22%
1870-1913	8	+1.52%	+0.09%	+1.43%
	6	+0.59%	+0.07%	+0.52%
	4	+0.74%	+0.05%	+0.69%
	2	+0.04%	+0.02%	+0.01%
	1	+0.08%	+0.03%	+0.05%

Note: Figures represent average changes in the various interest rates from the given number of quarters prior to the cycle peak until the peak. Business cycle peak dates taken from the adjusted monthly chronology used throughout this thesis. Short-term interest rates (r) represented by the discount rate on prime short-term commercial paper (Thomas and Dimsdale 2017, Sheet M1, Column M). Long-term interest rates (R) represented by the yield on consols (Thomas and Dimsdale 2018, Sheet M1, Column U).

of the Bank Charter Act of 1844, as a tool for counteracting outflows of specie reserves (Capie et al. 1994, 113), which might be expected to have accentuated the increases in short-term interest rates prior the onset of recessions in the later nineteenth century. However, such discrepancies might also be a result of the limitations of the available data and potential inaccuracies in the adjusted chronology of business cycle peak and trough dates used, particularly given the small number of recessions in the 1821 to 1844 sub-period. Of course, the observed tendency for short-term interest rates to have risen more than long-term interest rates seem to have fallen prior to recessions, both in the full timeframe and in its latter two sub-periods, is not in itself conclusive evidence that a rise in short-term relative to long-term interest rates should or could be thought of as having been a primary or even noteworthy aspect of the tendency for a flattening or inversion of the yield curve to have taken place prior to recessions in nineteenth century Britain. Highlighting the significance of rising short-term interest rates before recessions, rather than simply describing their movement relative to one long-term interest rates, involves a judgement informed by the theoretical and historical factors outlined earlier in this section. However, the preliminary impression of the relative movements of long-term and short-term interest rates prior to recessions in nineteenth century Britain, offered by the results in Table 14, does conform in certain key respects to the pattern which might be expected if the Bank of England had tended to aim to raise short-term interest rates prior to recessions to combat the inflation and outflows of reserves which tend to accompany the peak of the business cycle.

This same data concerning the relative levels of short-term and long-term interest rates is also graphically represented by Figure 4 in the third chapter of this thesis, which illustrates the greater amplitude of the fluctuations of short-term than long-term interest rates, particularly from the 1830s onwards. Table 15 expresses this contrast in terms of the differing variances of the two interest rate series, in each of the sub-periods. The more steady, gradual changes in long-term than short-term interest rates conform with either the view that long-term interest rates are determined by the average of expected future short-term interest rates and therefore that their fluctuations are smoothed by that averaging process, or that short-term interest rates are more immediately responsive to short-term changes in monetary policy than long-term interest rates, which further underlines the necessity for judgements concerning the relative importance of these factors to be informed by historical and theoretical considerations in addition to presentation of empirical data. The greater variance of short-term than long-term interest rates, and the increase in the variance of short-term interest rates in the latter half of the timeframe, also conforms with what might be expected based on the view that short-term interest rates are influenced more strongly than long-term rates by changes in the Bank rate, and that the Bank rate became the primary tool of a more active management of the supply of credit by the Bank of England from the 1830s onwards.

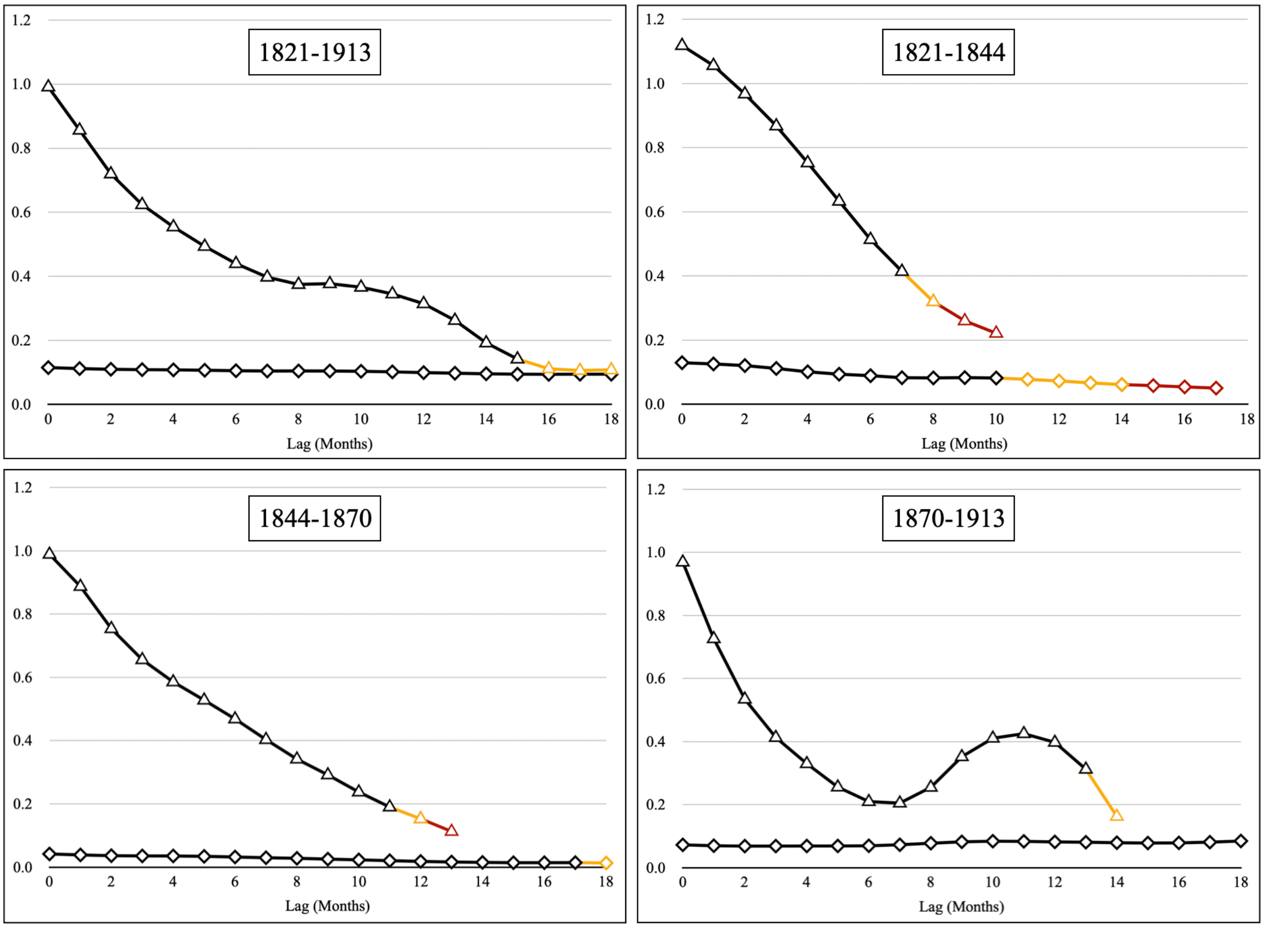
Table 15. Variance of Short-Term and Long-Term Interest Rates, 1800-1913

Period	Variance, σ^2	
	r	R
1800-1913	1.994	0.489
1800-1821	0.711	0.198
1821-1844	0.907	0.059
1844-1870	3.156	0.018
1870-1913	1.455	0.094

Note: Short-term interest rates (r) represented by the discount rate on prime short-term commercial paper (Thomas and Dimsdale 2018, Sheet M1, Column M). Long-term interest rates (R) represented by the yield on consols (Thomas and Dimsdale 2018, Sheet M1, Column U).

Figure 24 shows the varying extent to which short-term and long-term interest rates appear to have been influenced by changes in the Bank rate between the years of 1821 and 1913. The years from 1800 to 1821 are excluded, as the Bank rate remained unchanged at its legal maximum level of 5 per cent throughout that sub-period. These results suggest that there was a positive and more-or-less immediate association between changes in the Bank rate and changes in short-term interest

Figure 24. The Influence of the Bank Rate on Short-Term Interest Rates and Consol Yields up to 18 months hence, 1821-1913



Note: △ = Short-term interest rates. ◇ = Consol yields.

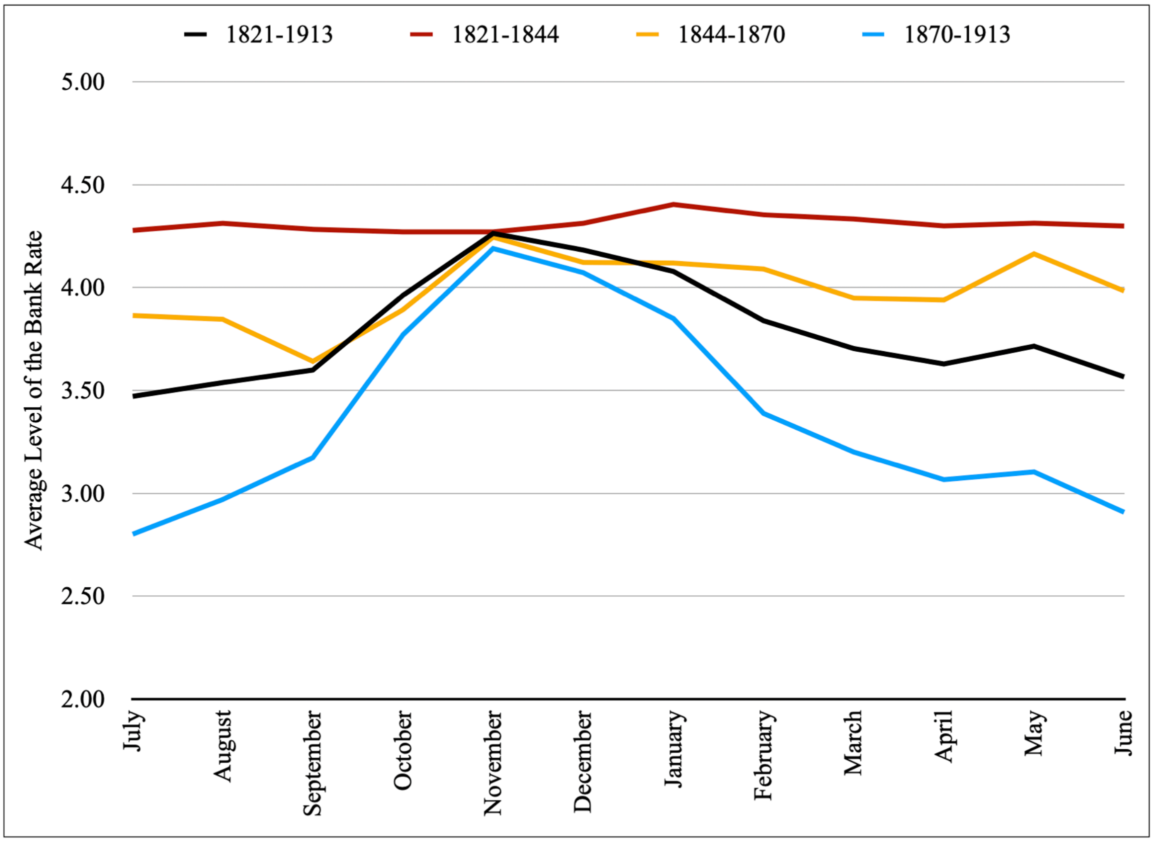
Regression coefficients on the Y axis. Black results denote $p < 0.001$. Orange results denote $p < 0.01$. Red results denote $p < 0.05$. Results for which $p > 0.05$ were excluded. Results for the sub-period 1800-1821 excluded because the Bank Rate remained unchanged at 5 per cent throughout that period.
Source: Thomas and Dimsdale 2017 (Sheet M9, Columns C and D; Sheet M1, Columns M and U).

rates, with a rise or fall in the Bank rate being associated with a statistically significant and approximately equal rise or fall in short-term interest rates in the same month, in each of the sub-periods. The tendency for short-term interest rates to be higher (lower) than they otherwise would have been in a given month following a rise (fall) in the Bank rate declines with each additional month after the change in the Bank rate at which the short-term interest rate is observed. This conforms with what might be expected given the role of other factors, including subsequent changes in the Bank rate, in influencing the level of short-term interest rates such that they did not remain stationary in the months following each change in the Bank rate. In contrast, consol yields exhibit a positive and statistically significant but far smaller relationship with the Bank rate, which conforms with the findings of Berument et al. (2017), whose results indicated a lower responsiveness of consol yields to changes in the Bank rate between 1844 and 1913, which they attribute to the anchor on inflationary expectations represented by the classical gold standard.

One aspect of this data worth highlighting is the rise in the regression coefficients for short-term interest rates between seven and thirteen months subsequent to changes in the Bank rate, during the 1870 to 1913 sub-period. This suggests that the level of short-term interest rates seems to have correlated more closely with the level of the Bank rate approximately a year prior than with the level of the Bank rate six months prior. This likely reflects the significant impact of seasonal forces on the Bank's reserves in the late nineteenth and early twentieth centuries (Pippenger 1984; Davutyan and Parke 1995), with factors such increased demand for credit in the autumn months as a results of the needs of the agricultural sector leading to outflows of reserves and consequent rises in the Bank rate. Figure 25 shows the average levels of the Bank rate in each month of the year during the different sub-periods after 1821, which illustrates the seemingly growing seasonality of fluctuations in the Bank rate, likely in part reflecting the increasingly active use of the Bank rate after the 1830s as a tool for altering the supply of credit and responding to seasonal and other drains on reserves.

The presentation of the data in Figure 24 assumes a causal influence of the Bank rate on short-term and long-term interest rates, based on the theoretical and historical case made that the Bank rate was amongst the primary tools used by the Bank of England to affect the supply of credit in nineteenth century Britain. However, when interpreting these results it should be noted that this assumption obscures the reverse influence by which market interest rates have been argued to have influenced the Bank rate at certain times during the nineteenth century, such as in the aftermath of the passage of the Bank Charter Act of 1844 (Le Maux 2018, 14-15).

Figure 25. Seasonal Trends in the Bank Rate, 1821-1913



Note: Results for the years between 1800 and 1821 are excluded because the Bank rate remained unchanged at its legal maximum of 5 per cent throughout that sub-period.
Source: Thomas and Dimsdale (2017, Sheet M9, Columns C and D).

As a result of the difficulty of illustrating the influence of the Bank rate on short-term interest rates in the 1800 to 1821 sub-period due to the lack of adjustments of the Bank rate during that time, it may be worth employing a different metric to analyse the factors which likely influenced short-term interest rates upwards prior to recessions in a way which incorporates data from throughout the period from 1800 to 1913. One possible approach could involve an assessment of the influence of fluctuations in the ratio of the Bank of England's specie reserves to its banknotes in circulation on the level of short-term interest rates. A decline in this ratio would indicate either an inflation of the supply of Bank notes relative to the specie backing them or an outflow of bullion from the Bank, both phenomena which could be seen as aspects of the inflation which tends to accompany the peak of the business cycle. To the extent that such declines in this ratio appear to have influenced short-term interest rates upwards, partly as a result of important but difficult to measure methods used by the Bank of England to constrict the supply of credit when the Bank rate was at its legal maximum before 1833, such as altering the maximum length to maturity of the bills it was willing to discount or rationing credit, such an association between the Bank's ratio of specie reserves to notes in circulation and the level of market interest rates could be seen as supporting the idea that pre-recession yield curve inversions ought to be viewed as partly stemming from rises in short-term interest rates relative to long-term interest rates at the peak of the business cycle.

Table 16. Influence of the Ratio of Bank of England Specie Reserves to Notes on Short-Term Interest Rates, 1800-1913

		Dependent variable, r		
	Period	Regression Coefficient	Correlation Coefficient	Number of observations
Annual	1800-1913	-1.697 *** (0.242)	-0.552	114
	1800-1821	-1.758 (1.446)	-0.262	22
	1821-1844	-3.673 *** (0.767)	-0.714	24
	1844-1870	-11.341 *** (1.591)	-0.819	27
	1870-1913	-0.471 (0.564)	-0.128	44
Monthly	Sept.1844 - Dec.1913	-3.348 *** (0.188)	-0.526	832
	Sept.1844 - Dec.1870	-11.850 *** (0.477)	-0.814	316
	Jan.1870 - Dec. 1913	-1.703 *** (0.241)	-0.294	528

Note: Standard errors in brackets under regression coefficients. Data from Thomas and Dimsdale (2017, Sheet A31, Column G; Sheet A23, Column G; Sheet A24, Column X; Sheet M1, Column M; Sheet W1, Column B; Sheet W1, Column L.) The monthly data on the ratio of Bank of England specie to notes in circulation was calculated as the monthly averages of weekly data.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 16 describes this relationship between short-term interest rates and the ratio of the Bank of England's specie reserves to its notes in circulation. These results generally support the view that short-term interest rates tended to rise in response to a decline in the ratio of the Bank of England's specie to its notes in circulation. In the case of the annual data, the expected negative relationship between these variables was returned for each of the sub-periods, and the results were statistically significant in the cases of the full 1800 to 1913 period, and the two sub-periods 1821 to 1844 and 1844 to 1870. However, in the case of the 1800 to 1821 and 1870 to 1913 sub-periods, the seeming influence of the ratio of Bank of England specie reserves to notes in circulation on the level of short-term interest rates is considerably weaker and statistically insignificant. This limits the extent to which these results can offer insights into whether pre-recession yield curve inversions in the 1800 to 1821 sub-period could be seen as reflecting a rise in short-term relative to long-term interest rates. The apparent absence of a clear relationship between short-term interest rates and the ratio of Bank of England specie reserves to notes in circulation during the 1800 to 1821 sub-period might be a result of the fact that redemption of Bank notes into specie was suspended in that period, limiting the threat of an outflow of specie reserves which might otherwise have incentivised the Bank to more aggressively aim to constrict the supply of money and credit. In the case of the sub-period from 1870 to 1913, the apparent absence of this in relationship in the annual data might be a result of the increased importance of short-term capital flows, rather than gold flows, as the key variable for balancing international payments and stabilising exchange rates under the international gold standard, which might limit the extent to which the ratio of Bank specie reserves to notes in circulation could be regarded as a useful measure in that sub-period of the inflation and consequent threat of outflows of reserves which tend to accompany the peak of the business cycle (McKinnon 1993, 8). However, the expected negative relationship between the ratio of Bank of England specie to notes in circulation and the level of short-term interest rates is evident to a statistically significant extent in the monthly data for each of the sub-periods for which such data is available. This seems to further support the view that short-term interest rates could be expected to rise in response to the increase in monetary inflation which tends to accompany the peak of the business cycle, as indicated by a decrease in the ratio of specie to notes in circulation. In other words, these results offer some support to the view that rising short-term interest rates prior to a recession ought to be considered a noteworthy cause of the flattening or inversion of the yield curve which tended to precede recessions in Britain between the years of 1800 and 1913, alongside the possible decline in long-term relative to short-term interest rates implied by the more often discussed expectations hypothesis.

However, these results offer only a preliminary glimpse into the nature, extent, and significance of the tendency for rising short-term interest rates at the peak of the business cycle to have contributed to the predictive qualities of the term structure of interest rates in Britain between the years of 1800 and 1913, with the limitations of the data suggesting a number of possible avenues for future research. In particular, the lack of data concerning the ratio of Bank of England specie reserves to notes in circulation at a finer than annual frequency prior to 1844 contributes to an uncertain impression of the extent to which Bank of England may have aimed to influence short-term interest rates upwards prior to recessions before that date, and the possible unearthing of such data in the future might hopefully allow for further insights to be gained in this regard. The construction of a timeline of all the decisions made by the Bank to alter the maximum length to maturity of the bills it was willing to discount, or to engage in credit rationing, or to aim to affect the supply of credit by other methods without resort to altering the Bank rate, and the estimation of the influence of these various actions on the level of short-term interest rates at the peak of the business cycle, represents another pathway for future research with the potential to further illuminate this topic.

Nevertheless, the results presented over the course of this chapter provide insights into the causes of the predictive relationship between the term structure of interest rates and future growth in Britain between the years of 1800 and 1913, and the varying extents to which the data seem to reflect the insights of two theories of the causes of that relationship. While the ongoing research and extensive scholarly debate surrounding the expectations hypothesis of the term structure of interest rates indicates the persistent interest in that theory as a result of its arguable merits as a theoretical framework, the results of this chapter have largely aligned with much of the prior literature on this subject in having struggled to find empirical evidence in support of the idea that the level of long-term interest rates in Britain between 1800 and 1913 were determined by the future course of short-term interest rates. The evidence in this regard was not entirely absent, with consol yields seeming to have tended toward the average level of future short-term interest rates to some extent during the overall 1800 to 1913 timeframe, and to a lesser extent during the 1800 to 1821 sub-period. However, significant contrary results are returned for the sub-periods between 1821 and 1870, and the nineteenth century British data was seen to violate the implications and assumptions of traditional expectations models in a number of key respects, all of which tends to undermine the persuasiveness of the policy anticipations hypothesis as an explanation of the predictive relationship between the yield curve and future growth in nineteenth century Britain. A historical and theoretical case was then made for viewing rises in short-term interest rates in response to the inflation and outflows of reserves which tend to occur at the peak of the business cycle as a noteworthy source of the predictive qualities of the yield curve in nineteenth century Britain. A historical overview of the developing powers and goals of the Bank of England between the years of 1800 and 1913 suggested its commitment throughout that period to counteract outflows of its reserves by aiming to constrict the supply of credit, and data concerning the movement of various interest rates prior to recessions and at other times generally tended to support that interpretation.

Chapter Five: Conclusions

In the time since the research for this thesis has been underway, a noticeable shift seems to have been occurring in the confidence with which an inversion of the yield curve is generally held to be a reliable harbinger of oncoming recessions in the present day. The preliminary stages of the research for this project were begun amidst the rising concern of an oncoming recession in 2019, which had partly been triggered by yield curve inversions that year.[83] These sparked a flurry of articles, both in the scholarly literature and for general audiences, which noted the consistency with which such yield curve inversions had preceded oncoming recessions in the United States since the mid-twentieth century, and therefore argued that the 2019 yield curve inversions suggested the possible arrival of a recession in 2020 (see for example Aramonte and Xia 2019; Tokic 2019; Jones 2019; Winck 2019). In the event, a brief but severe recession did occur in early-2020, dated as lasting from February until April in the United States, with unemployment rising to 14.7 per cent in that country by April 2020, its highest level since the Great Depression (National Bureau of Economic Research 2023; Mankiw 2021, 369-373). Needless to say, however, the 2020 recession is generally regarded as having largely been a result of the Covid-19 pandemic and the lockdown policies instituted by governments in the United States and elsewhere, which intentionally suspended activity across sectors of the economy deemed inessential (Allen 2021). Although the 2020 recession did happen to follow shortly after the 2019 yield curve inversions, the

[83] In March of 2019 the yield curve between three month and ten year U.S. Treasury Bills inverted, with the yield curve between two year and ten year Treasuries inverting that August, both for the first time since 2007, prior to the onset of the Great Recession (Federal Reserve Bank of St. Louis 2025a; 2025b; National Bureau of Economic Research 2023).

unforeseeable nature of the Covid-19 pandemic, the first cases of which were not recorded until December 2019, draws into question the possibility that this unprecedented external shock had been presaged by bond markets months in advance (Centers for Disease Control 2024; Gabriel 2022). While it has subsequently been argued that a more conventional recession was likely to have occurred even if the Covid-19 pandemic had not broken out (Bauer and Mertens 2022, 4), the ultimately unanswerable question of whether or not such a counterfactual recession would have occurred obscures the extent to which the 2019 inversions could be thought of as contributing to, or detracting from, the consistent record of yield curve inversions as harbingers of recessions in the United States since the mid-twentieth century.

Further doubt was cast on the ongoing reliability of the predictive qualities of yield curve inversions when an inversion lasting for more than two years occurred between 2022 and 2024, the longest in U.S. history, with no recession having yet materialised at the time of writing (Barbuscia 2024).[84] Depending on the window of time allowed after a yield curve inversion within which a recession would have to occur for a given study to regard it as having been accurately predicted, this would make the 2022 to 2024 inversion one of between two and four examples of a false positive signal from this recession indicator in the United States since 1955. The yield curve inversion of 1966 is arguably "the most prominent" example of a yield curve inversion which was not followed by a recession in the late-twentieth century United States, although it was followed by a slowdown in growth (Haubrich 2021, 342), and some studies have marked 1966 as a recession year (Friedman and Schwartz 1982). Dotsey (1998, 37) argues that the yield curve inversion in the first quarter of 1979 was a false positive based on the relatively strict standard that the subsequent recession occurred just over a year later, although that recession arguably actually began less than a year later in January 1980 (National Bureau of Economic Research 2023). Finally, a yield curve

[84] The yield curve between two year and ten year U.S. Treasuries remained inverted from early July 2022 to late August 2024, while the yield curve between three month and ten year Treasuries was inverted from late October 2022 until mid-December 2024 (Federal Reserve Bank of St. Louis 2025a; 2025b).

inversion occurred in mid-1998 with no recession materialising until March 2001, although this inversion was brief and shallow enough that some studies have classified it as a mere flattening of the yield curve (Wright 2006, 7). In contrast to these prior examples, the 2022 to 2024 yield curve inversion, which was not only the longest in U.S. history but also the deepest since 1981 (Federal Reserve Bank of St. Louis 2025b), was not merely unaccompanied by a recession but coincided with a period of fair growth by post-2009 U.S. standards, with annual real GDP growth figures falling between 2.5 and 2.9 per cent for each of the years 2022, 2023, and 2024 (International Monetary Fund 2025; Cox 2024). Given the recency of the 2022 to 2024 yield curve inversion, few scholarly studies have so far been published on the question of why it seems not to have signalled an oncoming recession in this case. In the non-scholarly press a range of possible explanations have been suggested, with some commentators arguing that unexpectedly vigorous economic growth allowed recession to be avoided despite rising short-term interest rates (Jackson 2025), or that a glut of deposits allowed banks to maintain low deposit rates and avoid having to contract credit despite a rising federal funds rate (Fisher Investments 2024), or that the Federal Reserve was unexpectedly light-handed in its approach to raising interest rates to combat inflation prior to mid-2022 (Cox 2024). What is clear is that there seems to have been a decline of confidence in the reliability of yield curve inversions as harbingers of oncoming recessions in the present day amongst many financial journalists, market analysts, and others (De Mott 2024).

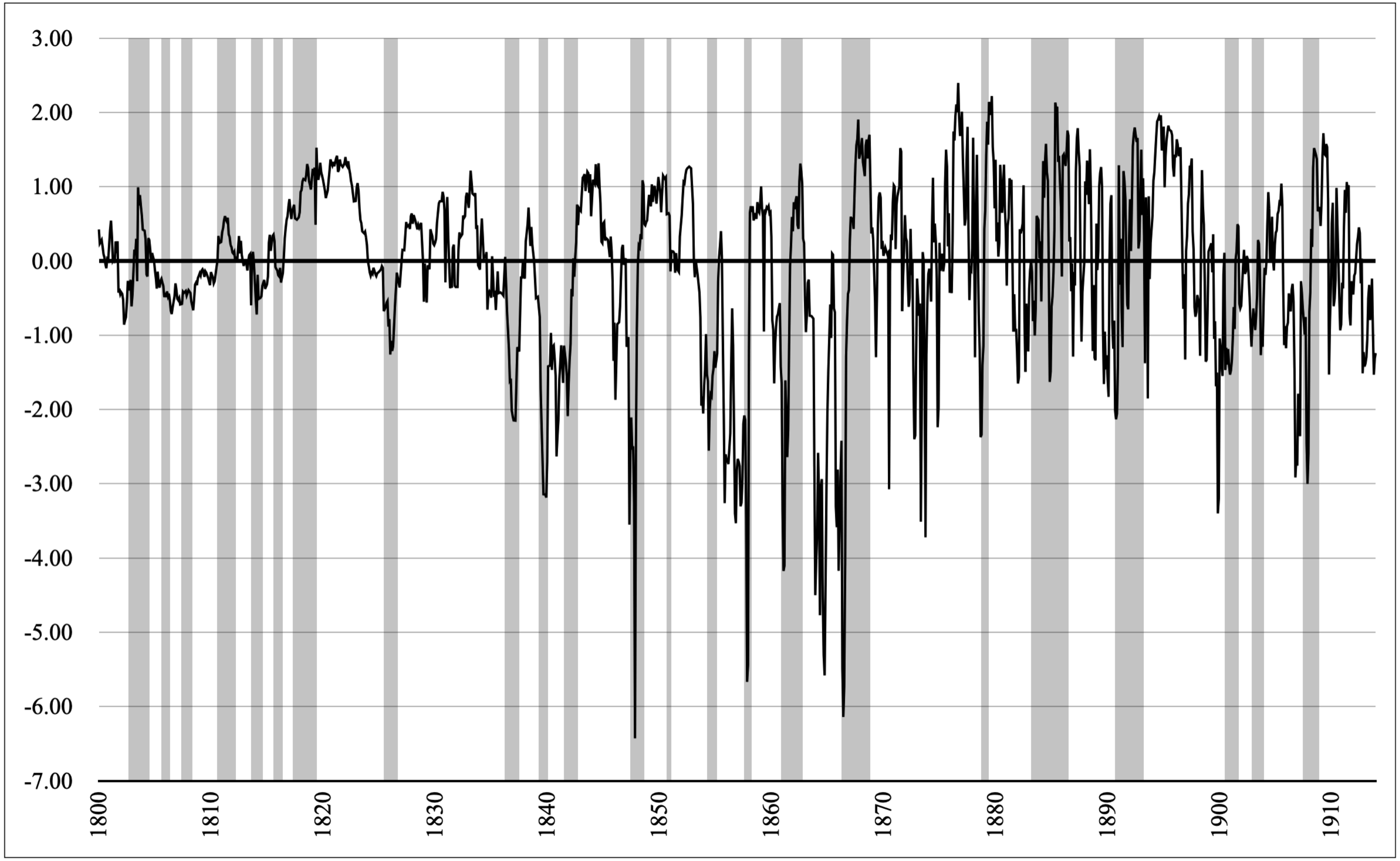
This decline in the confidence with which yield curve inversions are generally held to be reliable predictors of oncoming recessions in the present day was somewhat mirrored by the emerging view of the relationship between the yield curve and the business cycle in nineteenth century Britain, gained over the course of the research for this thesis. The optimism which tends to accompany the undertaking of a new research project naturally stoked some hope that straightforward and unambiguous results might be arrived at, perhaps revealing a predictive relationship between yield curve inversions and the onset of recessions equally as strong and reliable as is generally held to have been the case in the late-twentieth century United States. Instead, what began to come into focus was a more nuanced and varying picture, but one which nevertheless contributed to a clearer understanding of the nature, details, and implications of the relationship between the yield curve, the financial system, and the business cycle during a highly significant period in British economic history. In focussing on the British economy between the years of 1800 and 1913, the primary goal of this thesis was to expand the rich literature on the relationship between the yield curve and the business cycle to a time and place which had gone largely unremarked upon with regard to that particular subject, except for the study by Capie et al. (2019). In other respects, however, nineteenth century Britain has been amongst the most scrutinised periods in economic history. It was a time during which the ongoing Industrial Revolution, an emerging awareness of the business cycle as a subject of scholarly inquiry, key developments in the structure of the British banking system and of London as a global financial centre, and the adoption by the Bank of England of an increasing number of functions and goals characteristic of a modern central bank, all combined to suggest this period as one for which further study of the relationship between the yield curve and the business cycle could offer significant contributions to our understanding both of that relationship and of that period. Given this goal of contributing to the opening up of a lengthy new timeframe in which to assess the predictive qualities of the yield curve in a range of institutional contexts, and in the hope that such efforts might contribute to the establishment of a foundation from which more narrowly focussed future studies will be able to proceed, it seems doubtful that the results arrived at in this thesis are diminished by the fact that they do not simply and unremarkably reflect the pattern observed in the late-twentieth century United States. Instead, by aiming to present the relationship between the yield curve and the business cycle in all the complexity it exhibited in Britain between the years of 1800 and 1913, by using a range of different methods to illustrate this relationship, by comparing results between sub-periods of that timeframe to assess how the relationship changed, and by placing these results in historical context, a more detailed and varying picture of that relationship emerges, which may contribute to knowledge and suggest avenues for future research all the more than if the results had been simplified or reframed in such a way as to suggest greater similarity to the much studied late twentieth century U.S. experience.

Following the introductory chapter of this thesis, Chapter Two provided a review of the prior literature on the predictive relationship between the yield curve and the business cycle, with particular attention being paid to the subset of the literature which has assessed that relationship in places other than the United States, and in time periods prior to the mid-twentieth century. An overview of relevant historical context was then provided which aimed to illuminate the idiosyncratic structure of the British financial system and the composition of the bond market in 1800, and detail the key changes which occurred in both of those two areas between 1800 and 1913. This included a discussion of the various different kinds of banks which operated in Britain at the time and their different functions and capabilities with regard to influencing interest rates, including the many note-issuing country banks and their correspondent private London banks (Pressnell 1956). Lending between country banks in different parts of the country was intermediated by an increasing number of bill brokerages, which came to be known as 'discount houses' once their own lending activities expanded after the severe Panic of 1825. These played an important role in financing domestic trade and providing short-term commercial credit up until around the time of the Panic of 1866, after which they increasingly turned their attention toward international lending, adding to the significance of London as a global financial centre by the late nineteenth century (Fletcher 1976, Accominotti et al. 2021). Legislation in 1826 repealed the six partner limit which had previously been imposed on most private banks, permitted the Bank of England to establish provincial branches, and permitted joint-stock banks to be formed outside of London, and then within London after 1833 (Turner 2014, 38). Bank of England notes were also granted legal tender status in 1834, and the Bank Charter Act of 1844 forbade any new or existing bank from starting to issue bank notes of its own unless it had already been doing so (Born 1983, 7; Turner 2014, 39). All of this contributed to a decline in the number of note issuing private and country banks, and a rise in the number of joint-stock banks, which were allowed to form on the basis of limited liability after 1858, while the reach and influence of the Bank of England and its notes grew. The ongoing concentration of banking activity in London and in the hands of fewer and larger institutions culminated in the amalgamation movement of approximately 1870 to 1920, a series of mergers which saw 40 per cent of UK deposits held by the five largest banks by 1915 (Turner 2014, 41-46). The composition of the British national debt and the nature of the markets in which it was traded were also reviewed, with particular attention being drawn to the status of consols as the most widely traded form of long-term debt in Britain throughout the 1800 to 1913 period (Ellison and Scott 2020). All of these contextualising historical details were drawn upon in order to divide the long 1800 to 1913 timeframe into a number of distinct sub-periods between which the results of the following chapters could be compared. The first of these was the 1800 to 1821 sub-period, which included the Napoleonic Wars, and during which the convertibility of the currency into specie was suspended. The 1821 to 1844 sub-period was characterised by the aftermath of the resumption of the convertibility of the currency into specie, the Panic of 1825, and the legislative aftermath of both of these events. The 1844 to 1870 sub-period followed the significant Bank Charter Act of 1844, which separated the Bank of England's note issuing and bill discounting branches, resulting in more active use of variations in the Bank's discount rate as a tool for influencing the availability of credit throughout the banking system. This sub-period was also distinguished by the ongoing decline of the country banks and the concentration of banking activity amongst joint-stock banks and in London, and by the turn toward free trade represented by the abolition of the Corn Laws in 1846. Finally, the 1870 to 1913 sub-period was characterised by a long period of secular deflation from 1873 until around 1895, the emergence of the international classical gold standard, the cementing of London's status as the preeminent international financial centre, and the adoption by the Bank of England of a number of goals and policy tools characteristic of a modern central bank, such as a clearly understood commitment to act as a lender of last resort and an increasing use of open market operations to alter the supply of credit.

Chapter 3 turned to the question of the extent to which a flattening or inversion of the yield curve tended to precede recessions in Britain during the full period from 1800 to 1913, and during each of the four sub-periods outlined in the previous chapter. A discussion of the data and methodology to be employed explained the reasons for the selection of the particular interest rates to be used to construct yield curves throughout the 1800 to 1913 period, with the yields on consols being taken as representative of long-term interest rates, while the interest rate on three month prime or first-class commercial bills was selected as representative of short-term interest rates. The yield curve data constructed from these interest rates was compared with a monthly series of business cycle peak and trough date estimates, arrived at by aiming to augment the annual chronology of business cycle peak and trough dates suggested by Broadberry, Chadha, Lennard, and Thomas (2022) with the historical details and insights expressed by a range of contemporaneous and recent studies, as detailed in Appendix A of this thesis.

One of the most immediately apparent senses in which the data presented in Chapter 3 indicated that the predictive relationship between the yield curve and the business cycle in nineteenth century Britain differed from that in the late-twentieth century United States was in the failure of yield curve inversions to reliably occur prior to each recession and not at other times. A

Figure 26. Yield Curve and Adjusted Recession Dates, January 1800 - December 1913



Note: Grey bars indicate estimated recession dates, arrived at by considering the chronology of Broadberry, Chadha, Lennard, and Thomas (2022, 21) in combination with other sources, as outlined in Appendix A. Monthly yield curve data calculated from the consol and three month prime commercial paper rate series presented by Thomas and Dimsdale (2017, Sheet M1, Columns M and U), with a lower or negative number indicating a flatter or inverted yield curve.

total of 60 yield curve inversions occurred during the full 1800 to 1913 timeframe,[85] with 23 recessions occurring during the same period, and only 11 of those recessions were preceded by the start of a yield curve inversion within the prior 18 months. In other words, only slightly more than half of the recessions experienced in Britain between 1800 and 1913 were presaged by a yield curve inversion in the prior 18 months, if recessions which began during the same ongoing yield curve inversion as the prior recession are discounted, and only a third of the yield curve inversions between the years of 1800 and 1913 were followed by the start of a recession within 18 months. The tendency for a yield curve inversion to have begun within the 18 months prior to recessions increased modestly over the course of the 1800 to 1913 timeframe, and the average time between the start of a recession and the start of the most recent prior yield curve inversion also declined. Only around half of the recessions Britain experienced between 1800 and 1913 were preceded by the start of a yield curve inversion within the prior 18 months, but the yield curve was inverted within the 18 months prior to 21 of the 23 recessions.[86] It could be argued that all of this paints a picture of a shift in the predictive relationship between the yield curve and the business cycle in Britain between the years of 1800 and 1913, with that relationship becoming gradually somewhat more similar to that seen in the late twentieth century United States, inasmuch as that recessions later in the timeframe were more often preceded by a yield curve inversion, and the amount of time between the recession and its most recent prior yield curve inversion declined. However, the one overwhelming sense in which these results clearly do not reflect those of the late twentieth century United States is in the large number of 'false positive' yield curve inversions which were not followed by a recession within 18 months. Indeed, the false positive rate was between 55 and 71 per

[85] This number does not include yield curve inversions which had been preceded by another period of inversion within the prior three months, to avoid over-counting in situations which might better be thought of as ongoing periods of inversion during which the yield curve briefly returned to a normal, upward sloping shape, as explained in Chapter 3. See Table 3 for a complete presentation of the results being summarised in this paragraph.

[86] The two exceptions were the recessions of September 1818 to August 1820, and of August to December 1850.

cent in each of the four sub-periods, and during the full 1800 to 1913 timeframe. Furthermore, the seeming rise in the number of recessions which had been preceded by a yield curve inversion, and the decline in the number of months between a recession and its most recent prior yield curve inversion, partly simply reflects the large number of yield curve inversions in the final sub-period of 1870 to 1913, which appears to have been a result of the high demand for consols at the time and the consequent suppression of the level and variability of their yields compared to the more rapidly moving short-term interest rates. Precision-recall curves concerning the reliability of yield curve inversions as signals of oncoming recessions in nineteenth century Britain indicated that, regardless of whether one chose to regard recessions as having been accurately predicted if they occurred only within the same month as the inversion, within the following 215 months, or any number in between, no time window existed within which yield curve inversions would have been both accurate signals of oncoming recessions in more than 50 per cent of cases and more accurate in this regard than a randomly selected month in which a yield curve inversion did not occur. This poor performance of yield curve inversions as signals of oncoming recessions held both in the full 1800 to 1913 timeframe and in each of the sub-periods. The probability of a recession following within a given number of months of a yield curve inversion was consistently lower than the probability of a recession following within the same number of months of a randomly chosen non-inversion month, between the years of 1800 and 1913, suggesting that, if anything, yield curve inversions might have indicated a lower chance of an oncoming recession. All of this tends to undermine the view that yield curve inversions, as discrete events, were reliable predictors of oncoming recessions in Britain between the years of 1800 and 1913, in the same sense as they appear to have been in the late twentieth century United States.

Having found that yield curve inversions, as discrete events, do not seem to have been reliable harbingers of oncoming recessions in Britain between the years of 1800 and 1913, the remainder of Chapter 3 investigated the predictive qualities of the slope of the yield curve as a continuous variable. Despite the limited variety of macroeconomic data series available at a finer than annual frequency throughout the full 1800 to 1913 timeframe, it was possible to illustrate the relationship between the slope of the yield curve and the future levels of GDP, wholesale/producers' prices, and share prices, through regression analysis. Comparing the annual averages of the monthly yield curve data employed throughout this thesis with annual estimates of real GDP up to two years hence suggested that, for the overall timeframe of 1800 to 1913, an increase of one per cent in long-term relative to short-term interest rates (i.e. a steeper yield curve, as opposed to a flatter or more inverted one) was associated with more than a 0.5 per cent increase in the rate of growth of real GDP one year later.[87] In order to gain a picture of the relationship between the yield curve and GDP at a monthly frequency, and in order to increase the number of observations this approach was able to draw on, monthly yield curve data was also compared with monthly GDP estimates interpolated from the annual GDP data. This approach indicated that the same positive relationship existed between the slope of the yield curve and future GDP growth in each of the sub-periods, although the relationship appeared to be stronger in the earlier than in the later sub-periods, and particularly between the years of 1800 and 1821. Similarly, a positive association seems to have existed between the slope of the yield curve and the future rate of change of share prices, likewise appearing to have been strongest earlier in the timeframe. In the 1800 to 1821 sub-period, an increase of 1 per cent in the level of long-term relative to short-term interest rates was associated with an 0.5 per cent increase in the monthly growth rate of share prices two months hence, compared to a 0.33 per cent increase 5 months hence in the 1870 to 1913 sub-period. A weaker though still statistically significant positive association between the slope of the yield curve and the

[87] The regression coefficient was 0.549 in the case of real GDP at Factor Cost, and 0.524 in the case of real GDP at market prices, both to a significance level of less than 0.05. See Tabes 4 and 5.

rate of growth of wholesale/producers' prices also seems to have existed for the overall 1800 to 1913 timeframe and for the latter two sub-periods of 1844 to 1870 and 1870 to 1913.

Chapter 3 then concluded by reassessing the relationship between the yield curve and the adjusted chronology of business cycle turning point dates,[88] in terms of whether the yield curve was more likely to have been flatter or more inverted prior to recessions than at other times. A series of T-Tests comparing the extent to which a statistically significance difference existed between the average slope of the yield curve a given number of months before recessions and the average slope of the yield curve the same number of months before non-recession months, revealed that the yield curve did indeed tend to be flatter or more inverted prior to recessions than at other times, both during the full 1800 to 1913 timeframe and, to varying extents, in each of the sub-periods. In terms of the average slope of the yield curve a given number of months before the start of a recession, compared to its average slope at other times, the relationship appears to have been strongest in the 1870 to 1913 sub-period, with the level of long-term relative to short-term interest rates having been 1.9 per cent lower seven months prior to the start of recessions on average than at other times, or 0.7 per cent lower on average seven months prior to the start of recessions than at other times for the full 1800 to 1913 timeframe.[89] In order to increase the number of observations, a similar comparison was also made between the average slope of the yield curve a given number of months before any recession month, as opposed to just the start of the recession, and the average slope of the yield curve the same number of months before a non-recession month. This likewise indicated a tendency for the yield curve to have been flatter or more inverted prior to recessions than at other times, with this tendency having been particularly strong in the middle of the timeframe between 1821 and 1870. In the 1821 to 1844 sub-period, the level of long-term relative to short-term interest

[88] The results achieved using the unadjusted chronology of business cycle peak and trough months can also be found in Appendix B.

[89] A more extensive summary of the results being recapped in this paragraph can be found in Table 10, with the full results being graphically represented in Figures 17 to 21 and detailed in Appendix B.

rates was lower by 1.3 per cent in recession months than at other times, or 0.65 per cent lower ten months prior to recession months than ten months prior to non-recession months for the full 1800 to 1913 timeframe.

In summary, the results of Chapter 3 found that yield curve inversions as discrete events were unreliable signals of oncoming recessions in Britain between the years of 1800 to 1913, but the yield curve did tend to be significantly flatter or more inverted prior to recessions than at other times, particularly in the middle and later part of that timeframe. Likewise, a positive association does seem to have existed between the slope of the yield curve and future rates of growth of GDP, share prices, and wholesale/producers' prices, with these relationships seeming to have been strongest in the early part of the timeframe, particularly between the years of 1800 and 1821. The existence of this positive association conforms with the findings of much of the prior literature, which has generally described a similar positive relationship between the slope of the yield curve and future economic growth as having existed in the United States in the late twentieth century, and in various other countries and times.

The suggestion that yield curve inversions were not reliable signals of oncoming recessions in nineteenth century Britain seems to contrast with the findings of Capie, Goodhart, and Mills (2019), whose study has so far been the only other investigation into the relationship between the yield curve and the business cycle in Britain during that period. They found "reasonably strong support" for the hypothesis that inverted yield curves tended to precede recessions in the U.K. between 1822 and 1913, in contrast to the finding of this thesis that two thirds of yield curve inversions in Britain between the years of 1800 and 1913 were not followed by a recession within 18 months, and yield curves inversions had a lower likelihood of predicting an oncoming recession than randomly chosen non-inversion months in that timeframe. However, this divergence largely stems from the different methodological approaches employed, with their study having derived its business cycle chronology from monthly real GDP estimates. In this sense, the comparison of the slope of the yield curve with real GDP is arguably the closer aspect of the analysis of Chapter 3 to their methodology, with this approach having conformed with their finding of a positive relationship between the slope of the yield curve and future GDP growth. The T-Test results, suggesting a flatter or more inverted yield curve prior to recessions than at other times, likewise align with the picture of the relationship between the yield curve and recessions suggested by their study. This thesis intentionally aimed to arrive at its chronology of business cycle dates in a different manner than that employed by Capie et al., drawing on the insights and historical details discussed by a range of recent and contemporary sources, in order to contribute to the expansion of the literature on this subject by providing a a new set of results arrived at by a different methodological approach rather than aiming to replicate the results of a prior study. While the comparison of yield curve inversions and business cycle start dates as discrete events may have produced results which seemed to contrast with the spirit of the prior conclusions of Capie et al., the relationship between the business cycle and the slope of the yield curve as a continuous variable conforms with their conclusion that a flatter or more inverted yield curve tended to precede recessions and be associated with weaker growth.

The fact that the positive associations between the slope of the yield curve and future GDP growth, share prices, and wholesale prices appear to have been at their strongest in the 1800 to 1821 sub-period, during which the convertibility of the pound into specie was suspended, seemingly conforms with the findings of Baltzer and Kling (2007), who argued that the predictive power of the yield spread was greatest in Germany during periods when inflation expectations were higher, including during the period between the two World Wars and after the dissolution of the Bretton Woods international monetary system. Both their findings and the the results presented in Chapter 3 concerning the changing relationship between the yield curve and future GDP growth seem to support the view of Bordo and Haubrich (2004) who argued that, during periods when inflation is expected to persist, real economic shocks will tend to influence short-term interest rates disproportionately more than long-term interest rates, whereas inflationary shocks will tend to influence short-term and long-term interest rates more evenly, making the yield spread more sensitive to real shocks in such periods. Given the higher inflation expectations as a result of the suspension of convertibility of the currency in Britain between 1797 and 1821, and given the significant role of external shocks related to the Napoleonic Wars amongst the causes of many of the recessions in the 1800 to 1821 sub-period, the relatively strong relationship between the slope of the yield curve and future growth in that sub-period aligns with this view of the yield curve as having greater predictive power during periods of higher inflation expectations. The comparatively smaller association between the slope of the yield curve and GDP in the 1844 to 1913 period further bolsters this view, given the senses in which the Bank Charter Act of 1844 and adherence to the international classical gold standard acted as commitment mechanisms and signals of credibility which can be expected to have constrained inflation expectations (Bordo and Kydland 1995). The frequency of yield curve inversions during the 1800 to 1821 sub-period, which was second only to the 1870 to 1913 sub-period in this regard, also aligns with the findings of Wood (1983) who found that interest rates were higher and yield curve inversions more frequent in the United States between 1862 and 1878, which he attributed to higher inflation expectations due to the unconvertible nature of the currency in that period, resulting in a higher 'normal' level to which interest rates were expected to return.

There are a number of other respects in which the results presented in Chapter 3 conform with what might be expected based on the evolving historical and institutional context in Britain over the course of the 1800 to 1913 timeframe. The strengthening association between the slope of the yield curve and future share prices in the 1844 to 1870 and 1870 to 1913 sub-periods likely in part reflects the more active management of the supply of money and credit by the Bank of England after the Bank Charter Act of 1844, through alterations in the Bank rate and eventually through the increasing use of open market operations after 1873 (Kynaston 2017, 143-145; Capie et al. 1994, 129). This increasingly active management of the supply of credit likely both drove fluctuations in the yield curve via the channels described in Chapter 4 while also influencing the demand for shares on markets such as the London Stock Exchange, which was growing considerably during this period both in terms of the number of shares listed and as a result of the rising status of London as the preeminent global financial centre (Campbell, Quinn, Turner, and Ye 2018).[90] The decline in the strength of the association between the slope of the yield curve and real GDP in the later sub-periods may also reflect the exceptional demand for consols, due to their status as a highly liquid asset which was widely perceived to be very safe, causing them to be traded close to or even above their face value for much of the late nineteenth century (Checkland 1957; Brown et al. 2004). The high demand for consols by the last sub-period of this study, and their resultant high market value relative to their face value, suppressed their yields, constraining the amplitude of the fluctuations of the measure of long-term interest rates employed by this and other studies of nineteenth century Britain, limiting the extent to which long-term interest rates might otherwise have risen relative to short-term interest rates during or prior to periods of growth, or fallen relative to short-term interest rates prior to recessions. This suppression of consol yields rates closer to the lower level which short-term interest rates can be regarded as tending towards was also likely a cause of the large number of yield curve inversions in the 1870 to 1913 sub-period, creating a situation in which only a modest rise in short-term interest rates might see them rise above the already low consol yields,

[90] The railway mania of 1844 to 1846, and the subsequent Panic of 1847, provide a clear example of the senses in which the Bank of England's more active alteration of the Bank rate could be seen as having contributed to the increasing strength of the association between the slope of the yield curve and share prices after 1844. The Bank rate was set to a historic low shortly after the Bank Charter Act of 1844, with the resultant credit expansion stimulating a bubble in railway share prices, which burst when outflows of the Bank's bullion reserves forced a contraction of credit (Turner 2014, 72-75; Quinn and Turner 2020, 68-69).

with this likely contributing to the unreliability of yield curve inversions as recession signals in that period.

Chapter 4 turned to the question of the causes of fluctuations of the yield curve in Britain between the years of 1800 and 1913. Two significant contrasting views of the causes of the predictive relationship between the yield curve and the business cycle were considered: the policy anticipations hypothesis, which argues that pre-recession yield curve inversions reflect a decline in long-term relative to short-term interest rates caused by investors anticipating the oncoming recession and hence lowering their expectations of the future level of short-term interest rates, and the opposing view that short-term interest rates are often raised to limit the inflation and outflows of reserves which tend to occur at the peak of the business cycle, with this rise in short-term interest rates both causing the yield curve to flatten or invert and causing a contraction of credit which might be expected to contribute to a slowdown of growth or the onset of a recession. An overview of the competing theories of interest which undergird these opposing views was followed by a review of the literature related to each. In order to assess the applicability of the policy anticipations hypothesis as an explanation of the predictive qualities of the yield curve in nineteenth century Britain, an approach was adapted which had been used in the prior literature to test the extent to which the yields of perpetuities, such as the consols of nineteenth century Britain, appear to be determined according to the expectations hypothesis of the term structure of interest rates, on which the policy anticipations hypothesis is based (Shiller 1979). This approach revealed that actual consol yields in Britain between 1800 and 1913 tended to differ significantly from the yields which expectations hypothesis suggests should have prevailed based on the future course of short-term interest rates.[91] Furthermore, the nineteenth century British data failed to conform with the implication of traditional expectations models that long-term interest rates ought to rise on average

[91] See Figure 22 and Table 11.

when they are high relative to short-term interest rates, and fall on average when they are low relative to short-term interest rates.[92] The variance of the series of ex post rational long-term interest rates, which the expectations hypothesis suggests should have existed based on the future course of short-term interest rates, also appears to have been lower than the variance of actual consol yields, which violated the implications of the expectations model employed.[93] All of this combined to suggest that there is limited empirical support for the view that the expectations hypothesis provides an adequate explanation of the course of long-term interest rates in Britain between the years of 1800 and 1913, and therefore that the policy anticipations hypothesis explains the predictive relationship between the yield curve and the business cycle in that period. This verdict aligned with the findings of many prior studies of the expectations hypothesis, which have largely struggled to find empirical support for this explanation of the determinants of long-term interest rates (Crump et al. 2024, 1).

Following this assessment of the policy anticipations hypothesis the contrasting view was considered, that the predictive qualities of the yield curve in nineteenth century Britain stemmed from the efforts by the banking system, and particularly by the Bank of England, to limit the inflation and outflows of reserves which tend to occur at the peak of the business cycle by raising short-term interest rates, with this contraction of credit contributing both to a flattening or inversion of the yield curve and to a contraction of borrowing, demand, and economic activity. An overview of the development of the goals and policy tools of the Bank of England between the years of 1800 and 1913 made the case that preventing outflows of the country's gold reserves appears to have been amongst the primary goals of the Bank throughout that period (Capie et al. 1994, 113). Decision makers at the Bank can be assumed to have had a robust understanding of the utility of contracting the supply of money and credit as a means to that end even at the outset of the

[92] See Table 12.

[93] See Table 13.

nineteenth century, thanks to the prior development and popularisation of relevant economic theories such as the price specie flow mechanism and the quantity theory of money. Efforts to "make the Bank rate effective" as a tool for influencing short-term interest rates upward were a perennial concern of the Bank's governors from at least the 1830s onwards (Dutton 1984, 177), and other goals the Bank was pursuing by the late nineteenth century, such as acting as lender of last resort or adhering to the 'rules of the game' of the international classical gold standard, are unlikely to have interfered with its efforts to contract credit in response to outflows of reserves. Having outlined a range of historical and theoretical factors which suggest that the Bank of England can be expected to have intentionally aimed to raise short-term interest rates to counteract the inflationary pressure and outflows of reserves which tend to accompany the peak of the business cycle, a descriptive statistics approach was taken to illustrating the extent to which such a rise in short-term relative to long-term interest rates does appear to have occurred prior to recessions in Britain between the years of 1800 and 1913. The results presented in Table 14 indicated that short-term interest rates roes on average by 0.5 per cent in the eight quarters prior to recessions during the overall 1800 to 1913 timeframe, both in absolute terms and compared to long-term interest rates. This rise increased to more than 1 per cent for the sub-periods after 1844, with much of this rise in short-term interest rates tending to occur between six and 12 months prior to recessions on average. Greater variance was also seen in short-term interest rates than in the comparatively slow-moving consol yields, and a closer co-movement between short-term interest rates and the Bank rate than between consol yields and the Bank rate, suggesting that a rise in the Bank rate could be expected to influence short-term interest rates upwards more immediately and to a greater extent than long-term interest rates. A negative association was also seen between the ratio of the Bank of England's specie reserves to notes in circulation and the level of short-term interest rates, in the annual data for 1800 to 1913 and 1821 to 1870, and in the monthly data from 1844 to 1913.[94] All of this tends to

[94] See Table 16.

conform with the view that efforts by the Bank of England to counter the inflation and outflows of reserves which tend to accompany the peak of the business cycle influenced short-term interest rates upwards relative to long-term interest rates, with this likely constituting a less often discussed source of the positive association between the yield curve and future growth, and the tendency for a flatter or more inverted yield curve to have preceded recessions in Britain between the years of 1800 and 1913.

Much of the challenge of addressing the question of the extent to which a predictive relationship existed between the yield curve and the business cycle in nineteenth century Britain stems from the limitations of the available data, with data series spanning the entire 1800 to 1913 period at a finer than annual frequency being particularly scarce. A range of approaches were taken to addressing or working around these limitations in such a way that the results arrived at might be as accurate and illuminating as possible, despite the inherent opacity of a period before the collection of statistics and macroeconomic data had become as widespread and systematic as it would later in the twentieth century, and particularly after the Second World War (Vanoli 2005, 15-26; Tooze 2001). One of the key areas in which the limitations of the available data had to be accommodated was in the determination of the dates of business cycle peaks and troughs. Even in the present day the dates of business cycle turning points are not self-evident, with their determination being a subject of methodological debate (Harding and Pagan 2003), suggesting that a definitive and undeniable chronology of business cycle peak and trough dates is even less likely to be arrived at for a period during which the very concept of the business cycle was still developing (Dimsdale and Thomas 2019, 12-18). Rather than aiming to arrive at estimated business cycle turning point dates using monthly GDP estimates interpolated from annual GDP data which are themselves estimated for this period, the decision was made to employ the annual series of business cycle turning point dates suggested by Broadberry, Chadha, Lennard, and Thomas (2022), the merits of which were discussed in Chapter 3, and to narrow this down to an estimated monthly chronology by considering it alongside the insights of a range of recent and contemporary studies, as detailed in Appendix A. The hope was that reference to a wide range of sources, a number of which were qualitative in nature and emphasised particular events and other historical factors such as changes in foreign policy, harvests, and so forth, would enable the selection of particularly relevant months as turning points, and therefore might result in a more accurate chronology of business cycles than if estimated macroeconomic variables had been considered without these contextualising historical details. However, this approach is not without its own limitations, one of which is that the clearly perceptible events such qualitative sources draw on do not necessarily coincide with the true turning points from expansion to contraction of economic activity. While highly perceptible events such as banking panics or stock market crashes might be popularly identified as signalling the start of a recession, these often represent the culmination of a gradual decline in confidence which had quietly begun at an earlier date. For example, most sources drawn upon agreed that the 1819 to 1826 business cycle peaked some time between the end of 1824 and the autumn of 1825, before the severe Panic of 1825 began in December that year. While efforts were made to avoid overemphasising these clearly perceptible economic events by considering a range of sources with different methodologies, it is nevertheless possible that this issue might have limited the accuracy of the monthly business cycle chronology arrived at, and therefore affected the results concerning the relationship between the yield curve and the business cycle. Ironically, the general absence of any highly perceptible economic event to mark the turn back toward growth at the low point of a business cycle may also have contributed to the lack of consensus between different accounts of the dates of business cycle troughs. In certain situations when different accounts disagreed on the dates of business cycle turning points, the decision occasionally had to be made to arbitrarily choose between them if there was not sufficient evidence to regard one account as more likely to be accurate than another: for example discounting one suggested turning point date if it differed from the consensus of several other studies, or choosing a month equidistant between two contrasting proposed dates. Another potential limitation inherent in comparing the yield curve to a chronology of business cycle peak and trough dates is that such a binary chronology implicitly assumes that the contractionary phase of the cycle begins the instant after the peak is reached, and lacks the resolution to illustrate a possible gap in time between the peak of the cycle and the point at which the economic downturn accelerates or becomes more significant.

Although efforts were made to produce as accurate a monthly chronology of business cycle turning point dates as possible by drawing on a range of sources and historical details, the potential limitations of this approach nevertheless suggest a number of possible directions for future research on this topic. Naturally the yield curve could be compared with any new and improved business cycle chronology or GDP series which might become available in the future, but there are also a number of other variables which could be investigated as proxies for the general health of the economy. A potential positive association between the slope of the yield curve and the number of new companies chartered or registered in the following months, or a negative association between the slope of the yield curve and the number of bank failures a given number of months hence, might support the conclusion of this thesis that a flatter or more inverted yield curve tended to precede economic downturns in nineteenth century Britain. Such a study would have to account for the lower rate of bank failures in the late nineteenth and early twentieth centuries compared with the early nineteenth century (Kenny et al. 2017), with this decline being the result of a range of factors including the declining number of small unlimited liability country banks, legislative changes permitting joint-stock limited liability banks to be formed, the concentration of banking activity in a decreasing number of larger firms particularly during the agglomeration movement from the 1870s onwards, and the increasing adoption of lender of last resort functions by the Bank of England. In order to consider the relationship between the yield curve and the number of bank failures without inferring that the declining number of bank failures indicates a weakening relationship between the yield curve and the business cycle, the relationship between the two could be considered on a cycle-by-cycle basis.

Indeed, more narrowly focussed investigations into the relationship between the yield curve and other variables within individual business cycles is in general one of the more promising avenues for future research into this topic. While the dearth of prior studies on the relationship between the yield curve and the business cycle in Britain before the First World War led this thesis to pursue a broad view of the extent to which that relationship evolved during the long 1800 to 1913 timeframe, narrower investigations into single business cycles would have the opportunity to aim for a more detailed investigation into the workings of that relationship in particular cases. Such an approach would have the advantage of being able to draw on a wide range of primary and qualitative sources, the relevance of which might be too narrowly confined to the context of their individual business cycle to warrant inclusion in more broadly focussed studies. Drawing on such sources to produce a more granular timeline of the relevant events which occurred in a particular business cycle might enable an assessment of the extent to which contingent factors other than the actions of the Bank of England might have driven changes in interest rates, including the Bank rate, and hence fluctuations in the yield curve. While Chapter 4 of this thesis aimed to highlight the senses in which inflation and outflows of specie reserves influenced the decisions of monetary policymakers, a more detailed investigation into the possible influence of other relevant historical events on the Bank rate might contribute to a more complete and rounded picture of the causes of fluctuations of short-term interest rates, and of the yield curve. More narrowly focussed investigations of particular business cycles could also detail the potential influence of the yield curve on the interest rates and balance sheet components of significant individual banks. This might offer insights into the extent to which rises in the Bank rate in particular cycles diminished the net interest margins of significant private banks and contributed to a contraction of credit following the peak of the cycle.

Another possible avenue for future research related to this topic would be to assess the extent to which interest rates in nineteenth century Britain were influenced by expectations of changes in the Bank rate before they actually occurred. The question of the extent to which markets have been able to anticipate monetary policy decisions in the more recent past, and the implications of anticipatory adjustments for the effectiveness of monetary policy and of various predictive models, has been a topic closely related to the prior literature on the expectations hypothesis and the predictive qualities of the yield curve (see for example Mankiw and Miron 1986; Lange et al. 2003; D'Amico and King 2023). An investigation of this topic in nineteenth century Britain could incorporate a review of the historical development of the communication and transparency surrounding upcoming changes in the Bank rate by the Bank of England, as well as a discussion of the possible impact of the development of financial journalism, communications technology, and other information transmission networks during this period on the anticipatory capabilities of markets (Arrese 2024). To the extent that market interest rates did appear to adjust in anticipation of changes in the Bank rate, this might add an additional dimension to our understanding of the determinants of interest rates and the impacts of monetary policy in nineteenth century Britain. On the other hand, in cases in which markets appeared not to anticipate monetary policy changes, the extent to which the shock of an unanticipated rise in the Bank rate prior to a recession might have amplified the consequent rise in short-term interest rates, and hence reinforced the tendency of the yield curve to flatten or invert at such times, could be analysed.

Finally, a question which this thesis had originally aimed to investigate, but which might better be pursued as a more central focus of a future study, concerns the origins of the idea that a predictive relationship exists between the term structure of interest rates and the business cycle, and whether there seems to have been any awareness of this phenomenon amongst market participants or monetary policymakers in nineteenth century Britain. As outlined in Chapter 2 of this thesis, the idea of yield curve inversions as having been reliable signals of oncoming recessions in the United States since the mid-twentieth century was popularised as a result of of an upsurge of scholarly studies of this phenom in the late 1980s and early 1990s. However, detailed studies of the fluctuation of the yield curve over the course of the business cycle had been conducted at least as early as the mid-1960s (Kessel 1965; Cagan 1966), with the idea of an association between the slope of the yield curve and economic activity having been partly derived from earlier writings on the expectations hypothesis (Lutz 1940). Entrepreneurs had no doubt understood long before 1800 that rising interest rates could be expected to impact economic activity by disincentivising borrowing, but it is not clear when an awareness of the importance of the relative levels of short-term and long-term interest rates became common knowledge amongst financial professionals. Having constructed a monthly yield curve data series for Britain between the years of 1800 and 1913, the extent to which discussion of the relative levels of different interest rates was occurring in the financial press, in the minutes of the Court of Directors of the Bank of England, in political discussions, or elsewhere could be investigated, particularly during yield curve inversions of significant length or depth, or at other times when interest rates can be expected to have been a topic of widespread discussion, such as during conversions of the national debt. To the extent that an awareness or concern surrounding the term structure of interest rates was evident, gaining an impression of how this issue was viewed at the time might not only enhance our understanding of the development of the term structure of interest rates as a subject in the history of economic thought, but might also illuminate how expectations surrounding the yield curve might have impacted its predictive relationship with the business cycle in nineteenth century Britain.

Despite these questions which still remain to be explored, and despite certain limitations of the available data, the results presented over the course of this thesis have still aimed to illuminate a subject which had previously gone almost entirely unexplored in the prior literature. Having constructed yield curve data and a monthly business cycle chronology, evidence was presented which tended to suggest that yield curve inversions were not reliable signals of oncoming recessions in Britain between the years of 1800 and 1913, as they seem to have been in the late twentieth century United States. However, there does seem to have been a positive association between the slope of the yield curve and the subsequent rates of growth of key macroeconomic variables, both over the course of the full 1800 to 1913 timeframe and to varying extents in its different sub-periods. Furthermore, there is evidence of a tendency for the yield curve to have been flatter or more inverted on average prior to recessions than at other times. The much-discussed expectations hypothesis did not seem to clearly account for the course of long-term interest rates in nineteenth century Britain, suggesting that the closely related policy anticipations hypothesis does not necessarily explain the predictive relationship between the yield curve and the business cycle in that period. However, a historical and statistical case was made that efforts by the Bank of England to raise short-term interest rates in response to the inflation and outflows of specie reserves which tend to accompany the peak of a business cycle seem to partly account for the tendency for a flattening or inversion of the yield curve to have occurred before recessions, with this perspective conforming with the insights of a number of noteworthy business cycle theories.

Appendix A: Identifying British Business Cycle Peak and Trough Months, 1800-1913

This thesis took two different approaches to converting the recent annual chronology of British business cycle turning points suggested by Broadberry, Chadha, Lennard and Thomas (2022, 21) into a monthly series of peak and trough dates.. First, a simplistic method was used for drawing an 'unadjusted' monthly chronology of business cycle peak and trough dates directly from the annual chronology by assuming that recessions began in July of the peak years and ended in June of the trough years, with the results achieved using this unadjusted chronology being considered in a supplementary capacity. Following this, an 'adjusted' chronology was presented which aimed to narrow down the annual chronology of Broadberry et al. to a monthly frequency by considering it alongside the insights of a range of recent and contemporary sources. It was hoped that contextualising historical details drawn from these sources, and any degree of consensus which existed amongst them, might allow for a more accurate identification of the months of business cycle peaks and troughs in Britain between the years of 1800 and 1913. This appendix details the reasoning and sources behind the choices for which months to designate as the peaks and troughs in the second, adjusted business cycle chronology.

Cycle 1: 1797 to 1804 [95]

Gayer, Rostow and Schwartz (1975, 582) suggest that the upswing in this cycle was, to a great extent, a result of the brief period of peace Europe enjoyed after the Treaty of Amiens brought an end to the French Revolutionary Wars on the 25th of March 1802. This tends to suggest that Britain's resumption of war against Napoleonic France on the 18th of May 1803 could be regarded as the turning point back toward recession, with May therefore being marked as the peak month of this cycle, a view supported by Thorp (1926, 153) and also implied by Dimsdale and Thomas (2019, 120). Broadberry, Chadha, Lennard, and Thomas (2022, 67) also point to the May 1803 resumption of hostilities as marking the end of the previous expansion, and estimate that the subsequent downturn resulted in an overall 2.2% decline in GDP, suggesting that it was a relatively significant recession.

Given the limitations of the available data during this early part of the nineteenth century, and the fact that a cyclical return to growth often isn't heralded by any particular dramatic event, the date of the subsequent trough is more difficult to identify. Thorp (1926, 153) argues that the economy was in a state of revival by 1805, and Broadberry, Chadha, Lennard, and Thomas (2022, 68) also point to 1805 as the peak year of the next cycle. Therefore, for the purposes of this adjusted chronology it may suffice to assume that expansion had resumed by 12 months after the peak, marking April 1804 as the possible trough month.

Cycle 2: 1804 to 1806

Despite including this period as a discrete cycle in their own chronology, Broadberry, Chadha, Lennard, and Thomas (2022, 68) note that most other chronologies have not recognised it

[95] These sub-headings will use the trough-to-trough cycle dates suggested by Broadberry et al (2022, 21).

as such. They further argue that, if a recession did occur in 1806, it was likely a short and minor one, resulting in a mere 0.4% decline in GDP by their estimates, and leaving "little trace in the historical record [or] the statistical record". Silberling (1923, 237) argues that there was "nothing of cyclical importance" between the resumption of war in 1803 and the "violent smash of 1810-11", with the possible exception of a "minor disturbance" in 1807. However, Thorp (1926, 153/4) does identify 1807 as a recession year, and implies that the closing of Prussian ports to British shipping in March 1806 may have been amongst the causes of this recession. Gayer et al. (1975, 348) point to August 1806 as the peak month, although they seem to support Thorp's view that the aforementioned disruption to trade in March was arguably the primary cause of the downturn (Ibid, 587). Given the lack of other monthly turning point estimates for this early period, this chapter's adjusted chronology will follow Gayer et al. in assuming August 1806 was the peak month of this cycle.

Thorp (1926, 154) argues that 1807 was a recession year, and 1808 was a year of "mild depression", with the revival not beginning until 1809. This contrasts with the view of Dimsdale and Thomas (2019, 120), who argue that the opening up of trade with Spain after the start of the Peninsular War of 1807 to 1814 marked the British economy's turn toward recovery. Gayer et al. (1975, 348) seem to broadly concur with Thorp, however, arguing that the trough did not arrive until May 1808. Rostow (1948, 33) also suggests a relatively long recession, with an 1806 peak being followed by an 1808 trough. However, these estimates blur the distinction which Broadberry, Chadha, Lennard, and Thomas (2022, 21) draw between the 1804 to 1806 cycle and the separate 1806 to 1808 cycle. Given the lack of consensus concerning the date of the trough of this cycle, and given the goal of estimating a chronology of business cycle peak and trough months primarily based on the recent work of Broadberry et al., it will be assumed that the trough of this cycle came in January 1807, which conforms with their view that it was a relatively short recession..

Cycle 3:1806 to 1808

A period of monetary easing led to a speculative bubble in 1807 (Tooke 1838 Volume I, 277/8; Thorp 1926, 154; Gayer et al. 1975, 588), which then seems to have been punctured by shocks to British trade in the form of the American Embargo Act of December 1807, and the Milan Decree of the same month, by which Napoleon sought to blockade the United Kingdom from any trade with Europe (Thorp 1926, 154; Gayer et al. 1975, 587). This distress seems to have been exacerbated by a relatively poor harvest in 1807, and then an even worse harvest in 1808 (Tooke 1838 Volume I, 267/8). Broadberry, Chadha, Lennard, and Thomas (2022, 69) identify this as a short but quite severe recession, with an overall decline in GDP of 4.7%, and they further note that "all major chronologies identify a trough in 1808", although growth had returned by 1809.[96] For these reasons, this chapter's adjusted chronology will assume that the recession began in December of 1807, with the trough arriving in May of 1808, as per the estimate of Gayer et al. (1975, 348).

Cycle 4: 1808 to 1812

According to Tooke (1838 Volume I, 300-303), the 'continental system' established by the Milan Decree of December 1807, by which Napoleonic France sought to prevent other European states from trading with Britain, had caused prices in Britain to rise significantly above those of the continent by 1808. The arbitrage opportunities this created, combined with some inducement from the British government, caused a weakening of the blockade and an "enormous increase of importations" to Britain in 1809 and 1810, leading to significant price declines. This in turn slashed

[96] Dimsdale and Thomas (2019, 120) diverge from this seeming consensus, characterising the period from 1806 to 1810 as one of brisk growth in GDP and industrial production.

the profits which had been expected by the importers, many of whom had borrowed money to effectuate this trade. The outlook for importers was further impacted by American restriction of British trade through the Non-Intercourse Act of 1809 (Randall 2006, 275), and by a brief interruption to trade between Britain and Holland, as France attempted to reinforce its blockade (Narron et al. 2014). All of this led to "a general dismay … throughout nearly all branches of trade, during the last six months of 1810, and the first few months of the following year" (Tooke 1838 Volume I, 303). Tooke's identification of the mid-point of 1810 (specifically July) as the beginning of the crisis is supported by Thorp (1926, 154), and Narron et al. (2014), although Gayer et al. (1975, 348) place the peak slightly earlier, in March of 1810. Dimsdale and Thomas (2019, 122) also identify the disruptions to trade by France and the United States as having caused the end of an economic boom.

Broadberry, Chadha, Lennard, and Thomas (2022, 70) argue that this recession was severe and relatively lengthy, lasting until late 1811 and resulting in an overall GDP decline of 5.1%. Gayer et al. (1975, 348) concur with this view, specifying September of 1811 as the trough. Thorp (1926, 154/5) tends to support this view, arguing that "gradual improvement in industry" did not begin until 1812, with speculative activity not being fully revived until the autumn of 1812. Dimsdale and Thomas (2019, 122) argue that British export volumes only began to recover when the defeat of Napoleon's Russian campaign in the autumn of 1812 led to a weakening of the continental system of trade restrictions. Broadberry, Chadha, Lennard, and Thomas (2022, 71) note that all major chronologies of British business cycles identify 1810 as a peak year. Although the different chronologies exhibit some minor differences on their datings of this cycle, this chapter's adjusted chronology will attempt to follow what seems to be the broad consensus by classifying July 1810 as the peak of the cycle, with the recession lasting until September 1811.

Cycle 5: 1812 to 1814

Broadberry, Chadha, Lennard, and Thomas (2022, 71) identify 1814 as a recession year, with an overall decline in GDP of 2.2%, although they note that the contraction was mostly confined to the agricultural sector. They further note that the relative mildness of this recession has meant that most prior chronologies have not classified these years as constituting their own discrete business cycle, and have instead generally regarded the whole period from 1811 to 1815 as the boom phase of a single longer cycle. Gayer et al. (1975, 592) note the collapse of a speculative boom in 1814, although they do not count it as part of a discrete cycle (Ibid, 348). Tooke (1838 Volume II, 5-9) argues that this boom, which he regards as having peaked in the spring of 1814, was the result of expectations of an increase of demand for British exports to the continent, upon the seemingly imminent conclusion of the Napoleonic Wars. According to Tooke's account, considerable losses were being made on British exports to Europe in the spring and summer of 1814, with a large number of the speculative enterprises failing around the end of that same year. Thorp (1926, 155) also marks the spring of 1814 as the turning point, pointing to a rapid fall in commodity prices and resultant commercial distress after the first quarter of the year, and also noting the weakness of that year's crop, although he implies that the economy was booming again by the start of 1815. To reflect this, the 'adjusted' chronology of this thesis will classify the nine months from April to December of 1814 as a recession.

Cycle 6: 1814 to 1816

The final conclusion of the Napoleonic Wars in the summer of 1815 was followed by a period of deflation in anticipation of the resumption of the convertibility of the pound into gold, alongside a rapid decline in government spending and demobilisation of troops. All of this, in combination with an exceptionally bountiful crop that year, culminated in arguably the worst economic crash yet experienced in Britain, with an estimated 240 of the 700 country banks in England and Wales either ceasing payments or declaring bankruptcy between the years of 1814 and 1816 (Acworth 1925, 72). Tooke (1838 Volume II, 12/3) describes the years from 1814 to 1816 as a period "of most extensive suffering and distress", although he argues that standards of living were nevertheless notably higher in 1816 than they had been in the war years of 1811 and 1812. Tooke further argues that the increased abundance of all goods following the end of the war, and consequent declines in prices, led to "an accumulation of losses in nearly all the branches of industry, as entailed failures to an unprecedented extent [by 1816]" (Ibid, 56). Thorp (1926, 155/6) argues that the start of 1815 was characterised by booming economic activity, developing into a fully fledged speculative boom after the Battle of Waterloo in June, with widespread distress beginning in the autumn of 1815 and lasting until the spring of 1817. Gayer et al. (1975, 110/1) argued that "the depression of 1815-16" didn't reach its lowest point until "late in 1816", specifying March 1815 as the cycle's peak, with the subsequent trough coming in September 1816 (Ibid, 348). The economic distress was likely exacerbated by the April 1815 eruption of Mount Tambora in the Dutch East Indies, the largest volcanic eruption in recorded history, the ash from which caused a significant decrease in global temperatures and a wave of crop failures and food shortages in 1816, both in Britain and throughout the northern hemisphere (Luterbacher and Pfister 2015). Broadberry, Chadha, Lennard, and Thomas (2022, 72) argue that the recession began "not long after the Congress of Vienna" in June of 1815, and lasted until at least late 1816, with an overall GDP decline of 5.2%. Dimsdale and Thomas concur that the downturn was triggered by the conclusion of the Napoleonic Wars (2019, 122). This chapter's chronology will regard the recession as having lasted from shortly after the end of the Napoleonic wars, in July of 1815, until September of 1816.

Cycle 7: 1816 to 1819

Broadberry, Chadha, Lennard, and Thomas (2022, 73/4) argue that a relatively mild recession occurred in 1818-19, with an overall GDP decline of 1.8%, and note that all major chronologies of British business cycles agree that 1819 was a trough year, although the date given to the preceding peak or downward turning point varies between accounts. Tooke (1838 Volume II, 58-61) argued that declining imports over the course of 1816 and 1817 led to “a great advance of prices in 1817 and 1818” and consequent speculative boom, which was further stoked by expectations of a poor harvest in 1818. These developments were accompanied by increases in the money supply over the course of 1817 and consequent outflows of bullion from the Bank of England by 1818, followed by a contraction of the money supply over the course of 1818 (Ibid, 49). This monetary deflation combined with a surge of imports at the end of 1818 to produce significant declines in prices (Ibid, 59), bringing about a recession which “fully developed” in 1819 (Ibid, 61). Acworth generally supports this view, while emphasising the role of the Bank of England as the primary cause of the crisis:

> It was not then, the heavy imports of 1818 that were responsible for the depreciation of the pound; but it was the course of currency inflation countenanced by the Bank, that led to the wave of speculation and excessive importation; and when, in the latter part of 1818, the monetary crisis occurred in Paris, it merely emphasised the depreciation that had already taken place in the value of the pound (Acworth 1925, 83/4).

Thorp (1926, 156) argues that 1818 was a year of prosperity and “active speculation”, although he notes that the loose money which is implied to have fuelled this speculation was tightening by the autumn of 1818. He argues that this did not become serious enough to be regarded as a recession until the early spring of 1819, however, with a return to prosperity by the autumn of 1820. Silberling's price indices (1923, 232) likewise suggest a significant decline in prices, especially of imported goods, between the first and second quarters of 1819. A certain amount of the price deflation observed during and after the spring of 1819 was likely a result of Peel's Act of May 1819, which finalised the timeline for the resumption of the pound's convertibility into gold (Antipa 2016, 1068). Gayer et al. (1975, 110) categorise this recession as part of an international series of economic crises which were already ongoing by late 1818, including the American Panic of 1819 (Rothbard 1962), and argue that the high-point of the cycle was reached in September 1818, with the trough coming by September 1819. All studies seem to broadly agree that the turn towards recession had begun by the autumn of 1818, so this chapter's adjusted chronology will follow Gayer et al. (1975, 348) in choosing September 1818 as the peak month. Broadberry, Chadha, Lennard, and Thomas (2022, 73) characterise this as a two year recession, and Thorp seems to concur with this by arguing that prosperity was returning by the autumn of 1820, so this chapter's adjusted chronology will assume that the trough came after a 24 month recession, in August 1820.

Cycle 8: 1819 to 1826

According to Broadberry, Chadha, Lennard, and Thomas (2022, 74), all major chronologies agree that the Panic of 1825 was followed by a recession in 1826, with this downturn having been undoubtedly amongst the worst of the nineteenth century, with some measures suggesting that it was arguably the most severe economic crisis Britain experienced between the start of the Industrial Revolution and the Second World War. For this reason they regard their dating of this cycle as having "very high" reliability, with an estimated overall GDP decline of 5.4%. Tooke argues that the speculative mania preceding the crisis, which centred to a significant extent around investments in

Latin America (Dawson 1990; Quinn and Turner 2020, 39-57), began in the early part of 1824, with a decline of interest rates and expansion of the money supply beginning at around the same time. This expansion, Tooke argues, gradually turned to contraction from the end of 1824 onwards, with share and commodity prices beginning to fall from the summer of 1825, and a considerable number of bank failures in the Autumn of 1825 (Tooke 1838 Volume II, 191/2). Thorp (1926, 156-158) argues that a situation of easy money had prevailed throughout most of the period from mid-1820 to mid-1825, with commodity prices peaking in the second quarter of 1825 before a rapid decline, a tightening of credit and subsequent stock price "collapse" in May of 1825, and a general financial panic in November and December of 1825, with "stringency and panic" lasting into early 1826. Quinn and Turner (2020, 45) illustrate that declines had begun in the prices of various categories of stocks over the course of the first half of 1825. Gayer et al. (1975, 171) also point to May of 1825 as the peak of the expansionary phase of this cycle, with a severe financial panic arriving in December of 1825, and the depths of the trough not arriving until November of 1826 (Ibid, 348). Pickering (2018, 37-39) provides a chronology of this cycle which details a number of events from June to November of 1825 which indicate a decline of confidence in the banking system, with a banking panic beginning in earnest on 1st December 1825. Dimsdale and Thomas (2019, 126) point to tightening by the Bank of England from early 1825 onwards as a key cause of the downturn. Turner (2014, 70) argues that the banking crisis sounded its first rumblings with the failure of a number of minor country banks in the autumn of 1825, before the situation escalated significantly in December of that year, as major London banks began experiencing runs. Broadberry, Chadha, Lennard, and Thomas (2022, 74) characterise the 1826 recession as severe but short, with a relatively strong revival already being underway in 1827. Given the seemingly broad agreement with the monthly peak and trough dates suggested by Gayer et al. (1975, 348), this chapter's adjusted chronology will adopt these same dates, taking May 1825 as the peak month and November 1826 as the trough.

Cycle 9: 1826 to 1837

Matthews (1954, 209/10) argues that there does seem to have been a recession in 1837, but that its severity is a matter of debate: there were "substantial" falls in almost all prices and in the volume of exports, and a certain amount of unemployment and industrial distress was reported, but consumption levels and railway building continued to rise rapidly, with brick making only experiencing a small decline. Matthews suggests that this disturbance was largely an external shock stemming from the much more severe American Panic of 1837 (Lepler 2013), although he notes that a contraction of credit from July of 1836 onwards led to a gradual deflation of what had been a bubble of speculative investments in in joint-stock companies, with this not developing into a crisis until "well into 1837". Tooke (1838 Volume II, 343-345) argues that there was "pressure" in the money market during the last six months of 1836, but that this constituted only "an intermediate inconsiderable depression" which lasted until the summer of 1837. Tooke argues that there was no general decline in prices in the latter half of 1836, and that "the extreme fall in the markets for produce, between November, 1836, and July, 1837, was confined" to those commodities which had been heavily traded with America, and to a lesser extent China. Thorp (1926, 160), argues that a severe tightening of the money market precipitated panic in the autumn of 1836, resulting in a "gradual recession of activity" until the summer of 1837. Gayer et al. (1975, 348) deviate from this view somewhat, estimating that the cycle peaked earlier, in May 1836, although they agree with the view that the recession ended in the summer of 1837, specifying August as the trough month. Turner (2014, 71/2) notes that gold outflows from the Bank of England in the summer of 1836 resulted in the Bank Rate being raised twice, in July and September of 1836. Both Turner and Temin (1969, 137) argue that these rate hikes by the Bank caused pressure in the money market from late 1836 until early 1837, which contributed to the failure of two relatively large and new joint-stock banks, both in November of 1836. As in several of the previous cycles, Gayer et al. (1975, 348) broadly concur with most of the other accounts, while having the advantage of offering the only monthly chronology of peak and trough dates for this early part of the nineteenth century, so this chapter's adjusted chronology will again follow their example by taking May 1836 as the peak month, and August 1837 as the trough month.

Cycle 10: 1837 to 1839

As Kenny et al. (2021, Appendix D, 2/3) note, it is generally agreed amongst the different chronologies that there was some sort of economic crisis or crises between the years of 1836 and 1839, but little agreement exists on the magnitude of the event(s) or the specific dates. Thorp (1926, 160/1) classifies every year from 1837 to 1843 as a depression year, and only vaguely alludes to a handful of events which could possibly be regarded as turning points in the 1837-39 cycle identified by Broadberry, Chadha, Lennard, and Thomas (2022), including a vaguely defined "panic" in June 1837 and a gold crisis in April 1839. Wallis (2001, 9) attributes this gold crisis to the high rate of grain imports resulting from poor harvests in 1838 and 1839, which combined with the already high levels of British lending in the United States to cause a drain on the bullion reserves of the Bank of England, to which the Bank responded by raising its discount rate from 4% in April 1839 to 6% by August of that same year. Kenny et al. (2021 Appendix D, 3) argue that newspaper reports of the time do not give any indication of a panic or bank runs in either 1837, 1838, or 1839, aside from "some peripheral savings banks which operated outside of the commercial banking system". Gayer et al. (1975, 348) do not regard this period as a cycle in its own right, instead subsuming it into a longer cycle which they estimate lasted from August 1837 to November 1842. This view that the years from 1837 to 1842 constituted a single, longer cycle is also shared by Burns and Mitchell

(1946, 79). However, Bordo et al. (2003, 148) categorise both 1837 and 1839 as years of "severe distress", whereas 1838 was a year of only "moderate distress" in their estimation, suggesting a possible short cycle. Broadberry, Chadha, Lennard, and Thomas (2022, 76/7) assign the "lowest grade" of certainty to their classification of the years from 1837 to 1839 as a discrete cycle, estimating that GDP declined by a mere 0.6% in their proposed Recession of 1839. Given this lack of clarity regarding whether this period constitutes a cycle in its own right, or what the possible turning points might have been, this chapter's adjusted chronology will take the gold crisis of April 1839, identified by Thorp (1926, 160) as the start of the downturn, with the recession lasting an estimated 9 months until December of 1839, which conforms to the seeming shallowness of this downturn, as well as Thorp's identification of "signs of improvement" at the beginning of 1840.

Cycle 11: 1839 to 1842

Although this cycle, like the last, was arguably just part of a long, continuous economic slump, which Thorp (1926, 160/1) indicates was ongoing from the end of 1836 until as late as the spring of 1843, prior studies have nevertheless recognised a 'depression of 1841-42', distinct from the general ongoing malaise. Tooke (1848 Volume IV, 45-47) argues that a general sense of hopefulness had existed in the economy in the early months of 1841, but by the end of the summer it had become apparent that the economic situation was even worse than before, with signs of prosperity not returning until the late spring of 1842. Thorp (1926, 161) paints a bleak picture of "severe depression; many failures; widespread unemployment", but gives no indication of any particular turning point dates, other than to suggest that signs of recovery had begun to appear by the latter half of 1842. Matthews (1954, 215) suggests that the primary cause of the 1841-42 depression was a decline of domestic investment, suggesting a possible monetary tightening, but no rise in the Bank Rate occurred between August 1839 and October 1845. Gayer et al. (1975, 348) differ from the chronology of Broadberry, Chadha, Lennard, and Thomas (2022) in that they view 1839 as a peak year, rather than a trough year, although they do concur in their estimation of 1842 (specifically November) as a trough. Gayer et al. (Ibid, 299) further note a period of monetary stringency and bullion outflows from the Bank in the third quarter of 1841. Broadberry, Chadha, Lennard, and Thomas (2022, 77/8) categorise the recession of 1841-42 as a downturn of middling severity, with an overall GDP decline of 2.9%, although they note that this would make it the worst downturn Britain had experienced since the catastrophic Panic of 1825, by their estimates. For the purposes of this chapter's adjusted chronology, we will assume that the downturn began in August 1841, which fits with Tooke's account of a downturn in the late summer and the suggestion of a monetary tightening in the third quarter of that year, according to Gayer et al. We will also follow Gayer et al. in regarding November 1842 as the trough month.

Cycle 12: 1842 to 1847

Following the Bank Charter Act of 1844, the Bank of England lowered its discount rate below the market rate, where it remained consistently for the next three years, stoking "an orgy of speculative activity that surpassed the excesses of 1824-5, with a concentration on railway ventures" (Ward-Perkins 1950, 76). Tooke (1848, Volume IV, 329-332) argued that the crisis of 1847 had two distinct phases, a relatively more mild April downturn brought about by "a rapid contraction of banking accommodation", but not accompanied by widespread bank or business failures, and then a more severe panic in October, with Dimsdale and Thomas (2019, 139140) also highlighting these dates. Thorp (1926, 162) offers a slightly different timeline, agreeing that monetary tightening led to a financial panic in April 1847, but placing the second panic in August, with economic activity having "halted" by the autumn, and recovery not arriving until the second half of 1849. Both Burns and Mitchell (1946, 79) and Rostow (1948, 33) point to 1848 as the trough year. Gayer et al. (1975, 348) concur with Tooke and Thorp, placing the peak of the cycle in April 1847, with the subsequent trough arriving in September 1848. Turner also notes the monetary tightening of April 1847, which led to a series of mercantile failures throughout September, culminating in a "Week of Terror" from the 16th to the 23rd of October during which several banks were forced to suspend payments and the government resorted to relaxing the strictures imposed on the Bank of England by the 1844 Bank Charter Act (Turner 2014, 73/4; Quinn and Turner 2020, 74). Broadberry, Chadha, Lennard, and Thomas (2022, 78/9) also regard the downturn as having a first dip in April 1847, and argue that the second downturn later in the year was partly caused by a larger than expected harvest that year, leading to a sharp decline in the price of corn over the summer. Despite how relatively well-remembered 'The Commercial Crisis of 1847' is, compared to the many other obscure crises experienced by the British economy between the years of 1800 and 1913, Broadberry et al. estimate that it was a relatively minor and short-lived contraction, with an overall GDP decline of 1.2%, and a return to growth in 1848. This chapter's adjusted chronology will follow the seemingly widespread consensus in placing the start of the recession in April of 1847, and will accept the September 1848 trough date suggested by Gayer et al., which broadly conforms with the timing of the return to growth suggested by Burns and Mitchell, Rostow, and Broadberry, Chadha, Lennard, and Thomas.

Cycle 13: 1847 to 1850

Broadberry, Chadha, Lennard, and Thomas (2022, 80/1) acknowledge that few other chronologies have categorised 1850 as a recession year, and their own estimates suggest that it was a relatively mild and short downturn, with an overall GDP decline of 0.9%, confined mostly to the agricultural sector, and a "brisk recovery" in 1851. Tooke (1857 Volume V, 252/3) notes only "some uneasiness" in the summer as a result of the Don Pacifico Affair (Hicks 2004), and a rise in the Bank of England's discount rate in late December intended to stem bullion outflows, which had been achieved by early 1851. Thorp (1926, 162) argues that 1850 was a year of prosperity, although he notes some agricultural distress due to a poor harvest and very low prices. Neither Burns and Mitchell (1946, 79) nor Rostow (1948, 33) recognise 1850 as a year of cyclical downturn. Given the apparent shortness of this downturn and the seeming return to growth in 1851, and its apparent relation to the poor harvest of 1850, this chapter's adjusted chronology will assume that the recession lasted from August to December of 1850.

Cycle 14: 1850 to 1855

Tooke (1857 Volume V, 307/8) argues that a general sense of unease existed as early as the start of 1854, partly due to "the near approach" of the Crimean War, with difficulties deepening over the course of the summer and autumn due to the economic aftereffects of the outbreak of war in March 1854, and due to the economic distress in the United States and Australia at the time. Tooke (Ibid., 323) goes on to argue that the same "causes of depression" were still in effect throughout 1855, with the addition of heavy war taxes which were "severely felt by large classes of persons", but that "the difficulties did not prove by any means so severe" as they had been in 1854. Thorp (1926, 163), categorises 1854 as a recession year and 1855 as a year of mild depression, with a tightening of the money market in the spring of 1854, coinciding with the March declaration of war, and distress in the shipbuilding industry by the autumn, which Tooke had also observed. Thorp notes an easing of the money market early in 1855, followed by a severe tightening in the autumn; a rapid recovery is argued to have been underway by 1856. Burns and Mitchell (1946, 79) place the trough of this downturn in December 1854, while Klovland (1998, 63) puts the peak of the cycle in February 1854, with the trough arriving in February 1855. Broadberry, Chadha, Lennard, and Thomas (2022, 81/2) argue that there was a “not particularly severe” recession in 1855, with the ultimate cause being the Crimean War, and an estimated overall GDP decline of 2.3%. This chapter’s adjusted chronology will take the outbreak of the Crimean War in March 1854 as the start of the downturn, with the trough arriving in February of 1855, which conforms not only to Klovland’s estimate but also to the characterisation of 1855 as a less severely depressed year than 1854, according to Tooke and Thorp.

Cycle 15: 1855 to 1858

Thorp (1926, 164) suggests that the downturn began in the autumn of 1857, with declines in commodity prices and foreign trade taking place late in the year. He specifies November as a month of “panic, failures, and bank suspension”. The depression continued in 1838, in Thorp’s view, although failures were concentrated in the first half of the year, and there was an easing in the money market after February. This likely refers to the lowering of the Bank Rate from a high of 10% in November 1857, down to 3% by February 1858, and then down again to 2.5% by December of that same year. Revival was underway by 1859, according to Thorp. Burns and Mitchell (1946, 79) place the peak of the cycle in September 1857, with the trough arriving by March 1858, while

Klovland (1998, 63) agrees that March 1858 was the date of the trough, but places the peak further back in November 1856. Turner (2014, 75-77), however, argues that no signs of distress had yet manifested even as the autumn of 1857 approached, and that it was in September, when news arrived of the American Panic of 1857, that the British economy became unsettled, with a series of British bank failures taking place from late October to late November. Although Turner ranks the 1857 downturn as amongst the most severe of the nineteenth century, he notes that contemporary sources emphasised the quickness of the recovery, and argues that "the [banking] crisis was essentially over by the middle of December 1857 and the Bank Rate … [was back down to 3%] by 11 February 1858". Broadberry, Chadha, Lennard, and Thomas (2022, 82/3) note that their data does not show an overall decline in financial services output in either 1857 or 1858, which they interpret as supporting the view that the downturn was not long-lived. In line with Thorp, Burns and Mitchell, and Turner, this chapter's adjusted chronology will mark September of 1857 as the start of the downturn, with the trough arriving in March of 1858, as suggested by Burns and Mitchell and Klovland.

Cycle 16 1858 to 1862

Thorp (1926, 164/5) notes a tightening of monetary policy in the last quarter of 1860, reflected in the doubling of the Bank Rate from 4% in October 1860 to 8% by February 1861. However, Thorp generally regards 1860 as a year of prosperity, with depression only coming to the cotton industry with the outbreak of the American Civil War in April 1861. Thorp regards the "severe depression" in the British cotton industry as having "little hampered" the "continued activity" in the rest of the economy, and labels each year from 1860 to 1865 as one of either "prosperity" or "uneven prosperity". Burns and Mitchell (1946, 79) mark September 1860 as the peak of this cycle, perhaps reflecting the aforementioned tightening of monetary policy late that year, with the trough arriving in December 1862. Klovland (1998, 63) paints a broadly similar picture, with his approach suggesting the peak was in August 1860, and the trough in October 1862. Both Rostow (1948, 37) and Broadberry, Chadha, Lennard, and Thomas (2022, 83/4) argue that the depression was touched off by the external shock of the declaration of war in America, in April 1861. Broadberry et al. further argue that the distress was not limited to the British cotton industry, with estimated overall GDP declines of 0.2% in 1861 and 4% in 1862, although their figures suggest a very robust recovery in 1863. As a mid-point between the late summer 1860 peak date suggested by Burns and Mitchell and Klovland, and the April 1861 recession start date suggested by Thorp, Rostow, and Broadberry et al., this chapter's adjusted chronology will select December 1860 as the start of this recession, with the trough coming in November 1862, halfway between the trough months suggested by Burns and Mitchell, and Klovland.

Cycle 17: 1862 to 1868

For the sake of consistency, and due to the recent date of their study and the broad range of statistical data to which it had access, the adjusted monthly chronology of business cycle peak and trough dates estimated and used in this thesis has generally sought to avoid major deviations from the annual chronology suggested by Broadberry, Chadha, Lennard, and Thomas (2022, 21), even going so far as to follow their recognition of 1806, 1814, 1839, 1850, 1900, and 1903 as recession years, contrary to what most chronologies would suggest. However, Broadberry et al. regard the whole period from 1862 to 1879 as a single long cycle, with its peak in 1878. Although this no doubt reflects the range of data under their consideration, it obscures the Panic of 1866, which arguably ranks amongst the most significant economic downturns of the nineteenth century

(Flandreau and Ugolini 2014). The significance of this crisis stems not only from the fact that it featured the last bank runs seen in Britain until 2007, but also because the failure of Overend, Gurney & Co., as well as of several other major financial institutions, led to a significant diminution of the role of discount houses in the British financial system, and the Bank of England's response to the crisis prompted Walter Bagehot to publish his highly influential writings on the Bank's duty to act as lender of last resort (Grant 2019, 266-280). Therefore, this chapter's adjusted monthly chronology will deviate from Broadberry et al. in this one instance, in recognising a cycle from 1862 to 1868, in order to incorporate the historically significant Panic of 1866 into our adjusted chronology.

Thorp (1926, 165/6) argues that 1865 was a year of prosperity, full employment and rising wages. However, he categorises 1866, 1867 and 1868 as depression years, with the May 1866 failure of Overend, Gurney & Co.[97] and the suspension of the 1844 Bank Charter Act in the same month being specified as key events. Thorp argues that gradual improvement of the economic situation did not begin until l869, although he notes that unemployment remained high in that year. Burns and Mitchell (1946, 79) regard the years from 1862 to 1868 as a cycle in their own right, with the peak coming in March 1866, followed by a trough in March 1868. Klovland (1998, 63) also views this period as a discrete cycle, with the peak coming in February 1866, and the trough not arriving until September 1869. Dimsdale and Thomas (2019, 142) attribute the onset of the crisis to the failure of Overend, Gurney & Co. in May, but Turner (2014, 80/1) notes that a number of financial institutions were experiencing difficulties as early as January 1866, with the first bank failure occurring in mid-April, and the "crash" occurring in May. This chapter's adjusted chronology will assume that the downturn began in April 1866, as this coincides with the beginning of the banking panic and the "security speculation collapse" noted by Thorp (1926, 166), while also

[97] Thorp's abbreviated, note-like writing style seems to imply that Overend, Gurney and Co. failed in April 1866. In fact, it suspended payments on 10th May 1866 (Turner 2014, 81).

being more or less equidistant between the depths of the banking crisis on 'Black Friday' in May, and the February and March peak dates suggested by Klovland and Burns and Mitchell, respectively. The trough may be assumed to have been in November 1868, halfway between the trough dates suggested by Burns and Mitchell and Klovland, and a date which preserves Thorp's assessment of 1869 as a year of revival.

Cycle 18: 1868 to 1879

Thorp (1926, 167/8) argues that economic activity slackened in late 1873, with a decline in commodity prices and a tightening of the money market toward the end of that year, coinciding with the international Panic of 1873. Following this downturn, Thorp categorises every year from 1874 to 1878 as a depression year, with the revival not arriving until the final quarter of 1879. Within this long depression, Thorp notes 1878 as a particularly distressed year, with money tightening in the summer, followed by a rapid decline of commodity prices throughout the last half of the year, and a number of important bank failures in October. Burns and Mitchell (1946, 79) seem to concur with Thorp's broad timeline, estimating that this cycle peaked in September 1872, with the trough not arriving until June 1879. Rostow (1948, 33) also suggests a long depression, with a peak in 1873 followed by a trough in 1879. Klovland (1998, 63) also finds a long depression in this cycle, albeit with estimated turning point dates slightly earlier than those of Burns and Mitchell: Klovland puts the peak in December 1871, and the trough in December 1878. Turner (2014, 84-88) deviates from this view by emphasising the crisis of 1878-9 as its own significant event, aside from any ongoing distress. In Turner's view the economy was growing, albeit sluggishly, in 1877, with the downturn likely arriving in late 1878, as a number of bank failures occurred between October 1878 and July 1879. Kenny et al. (2021 Appendix D, 4/5) cite a number of different newspaper reports of bank runs between October 1878 and January 1879, but argue that this banking panic was not amongst the most severe of the century. Broadberry, Chadha, Lennard, and Thomas (2022, 84/5) argue that 1878 was the peak year of this cycle, with a downturn in 1879 characterised by an overall GDP decline of 2.2%, mostly concentrated in the agricultural sector, with strong growth returning in 1880, suggesting a short recession. This chapter's adjusted chronology will adhere to the short recession view of Broadberry et al., placing the downturn month in October 1878, given the emphasis placed on this month by several prior chronologies as the start of the banking panic. Given the broad agreement between Thorp, Burns and Mitchell, and Turner that recovery had begun by the latter half of 1879, this chapter's adjusted chronology will select July 1879, the month of the last bank failure, as the point of the trough.

Cycle 19: 1879 to 1885

Thorp (1926, 168-170) argues that, after several years of "mild prosperity", a recession slowly set in over the course of 1883, which would persist until late 1886. Thorp notes a number of business failures in May 1883, and a deficient wheat crop. Burns and Mitchell (1946, 79) suggest December 1882 as the peak of this cycle, with the trough not arriving until June 1886. Rostow (1948, 33) likewise suggests a long recession, with the 1883 peak sliding into an 1886 trough. Klovland's (1998, 63) estimates are similar, indicating that the peak came in August 1883, with the trough following in March 1886. Broadberry, Chadha, Lennard, and Thomas (2022, 85/6) argue that a moderate recession occurred in 1884-85, with an overall GDP decline of 1.7%, and point to the secular deflation which characterised most of the last quarter of the nineteenth century as the primary cause of this downturn. This adjusted monthly chronology will take April 1883 to be the start date of this downturn, which is a month before the business failures noted by Thorp, and midway between the peak dates suggested by Klovland and Burns and Mitchell. June 1886 will be taken to be the trough month, as this is in line with Burns and Mitchells chronology, and lies between the March 1886 trough date suggested by Klovland and the more vaguely defined late 1886 recovery date suggested by Thorp.

Cycle 20: 1885 to 1893

Thorp (1926, 171) points to the November 1890 stock market collapse, as well as the near-collapse of Barings Bank that same month, as the turning point toward a recession which lasted until the summer of 1895, although Thorp notes 1893 as a year of particularly severe depression. Burns and Mitchell (1946, 79) paint a similar picture, suggesting September 1890 as the peak month, with the trough not arriving until February 1895. Rostow (1948, 33) also finds a peak in 1890, with the subsequent trough coming in 1894. Klovland (1998, 63) suggests a somewhat shorter recession, with a June 1890 peak preceding a February 1893 trough. Broadberry, Chadha, Lennard, and Thomas (2022, 86) argue that there was a relatively severe recession in 1892, and to a lesser extent 1893, with an overall GDP decline of 2.9%, although their figures indicate a robust recovery in 1894. This chapter's adjusted chronology will take September 1890 as the peak month, which conforms to Burns and Mitchell's estimate and falls halfway between the views of Thorp and Klovland. Klovland's date of February 1893 may be taken as the trough, as this conforms with the view of Broadberry et al. that the worst part of the downturn was concentrated in 1892.

Cycle 21: 1893 to 1900

In Thorp's (1926, 171-173) view, the revival which had begun in the summer of 1895 continued unabated through 1896, with prosperous conditions continuing until mid-1900. He mentions a gradual tightening of the money market in late 1899, coinciding with the declaration of the Second Boer War that October, but he argues that "activity and progress" continued throughout the first half of 1900, only gradually sliding into recession that summer, coinciding with a relatively small crop. He categorises 1901 as a year of mild depression, with an easing in the money market toward the end of that year, and further modest improvements in 1902, although he argues that a return to true prosperity did not take place until the last quarter of 1904. Burns and Mitchell (1948, 79) offer a similar timeline, with a peak in June 1900 followed by a trough in September 1901. Klovland (1998, 63) estimates that the turning points were slightly earlier, with the peak arriving in May 1899 and the trough in October 1900. Broadberry, Chadha, Lennard, and Thomas (2022, 87) argue that there was a recession in 1900, but that it was concentrated almost exclusively in the agricultural sector, with a fairly mild overall GDP decline of just 0.6%. Given the recognition of an agricultural element to this downturn by Broadberry et al., and implicitly by Thorp, and the specification of a summer 1900 peak by Thorp and Burns and Mitchell, approximately coinciding with that year's harvest, this adjusted chronology will follow Burns and Mitchell in selecting June 1900 as the peak month. Burns and Mitchell's trough date of September 1901 also coincides with the gradual easing noted by Thorp toward the end of 1901, so this may be taken as our trough month.

Cycle 22: 1900 to 1903

Thorp (1926, 174) classifies 1903 as a year of deepening depression, noting high prices in the cotton industry, a very poor crop, and increasing unemployment, especially in the last half of the year. He suggests there was some improvement prior to February 1904, but doesn't regard the revival as having truly set in until the last quarter of 1904. Burns and Mitchell (1946, 79) largely concur with Thorp, selecting June 1903 as the peak month, with November 1904 as the trough. Klovland (1998, 63) sets the turning points a little earlier, with November 1902 as the peak and October 1903 as the trough. Dimsdale and Thomas (2019, 147) argue that the conclusion of the Second Boer War in May 1902, and the consequent reduction in military spending, was the cause of this mild depression. Broadberry, Chadha, Lennard, and Thomas (2022, 88) implicitly concur with this view, noting a particular decline in the agricultural sector, and estimate that this recession had its peak in 1902 and its trough in 1903, with an overall GDP decline of 0.9%, and a strong return to growth in 1904. Given its closeness to the narrative and timeline suggested by Broadberry et al., this adjusted chronology will follow Klovland's view of a November 1902 peak followed by an October 1903 trough.

Cycle 23: 1903 to 1908

Thorp (1926, 175) suggests a strong economy from 1905 to the beginning of 1907, but a stock market slump and string of business failures in June 1907, combined with a general "collapse" of commodity prices that summer, contributed to a rapid rise in unemployment that August, and a "gradual restriction of industry" throughout the autumn. Depression continued throughout 1908, with small signs of a revival that summer, before a "steady and continuous recovery" throughout the course of 1909. Burns and Mitchell (1946, 79) suggest a very similar timeline, with the peak coming in June 1907, followed by a trough in November 1908. Rostow (1948, 33) also suggests a 1907 peak followed by a 1908 trough. This general view is also suggested by Klovland's (1998, 63) estimates, albeit with a slightly longer recession; he suggests a March 1907 peak followed by a November 1908 trough. Dimsdale and Thomas (2019, 147) instead argue that this downturn was caused by the external shock of the American Panic of 1907, which began in October 1907, and point to the Bank of England's raising of its discount rate from 4% in July 1907 up to 7% by November 1907, as a consequence of the gold outflows inflicted by this external crisis, and a contributor to deepening distress in Britain. Broadberry, Chadha, Lennard, and Thomas (2022, 89-90) seem to concur with this view, suggesting a 1907 peak followed by a 1908 trough, with growth returning in 1909, and an overall GDP decline of 3.8%, indicating a relatively severe recession. However, given the apparent existence of considerable economic distress in Britain as early as June 1907, this chapter's adjusted chronology will dissent from Broadberry et al. in this instance, and follow Thorp and Burns and Mitchell in assuming a June 1907 peak, followed by a November 1908 trough, which seems to be the consensus amongst many of the prior chronologies.

Following this downturn, Broadberry et al. indicate that there was no other cyclical downturn until after the First World War, which takes us beyond the conclusion of the 1800 to 1913 timeframe of this thesis. In conclusion, Table 2 summarises the adjusted monthly chronology of business cycle peak and trough dates arrived at based on the sources cited in this thesis, which is the primary business cycle chronology used throughout this thesis.

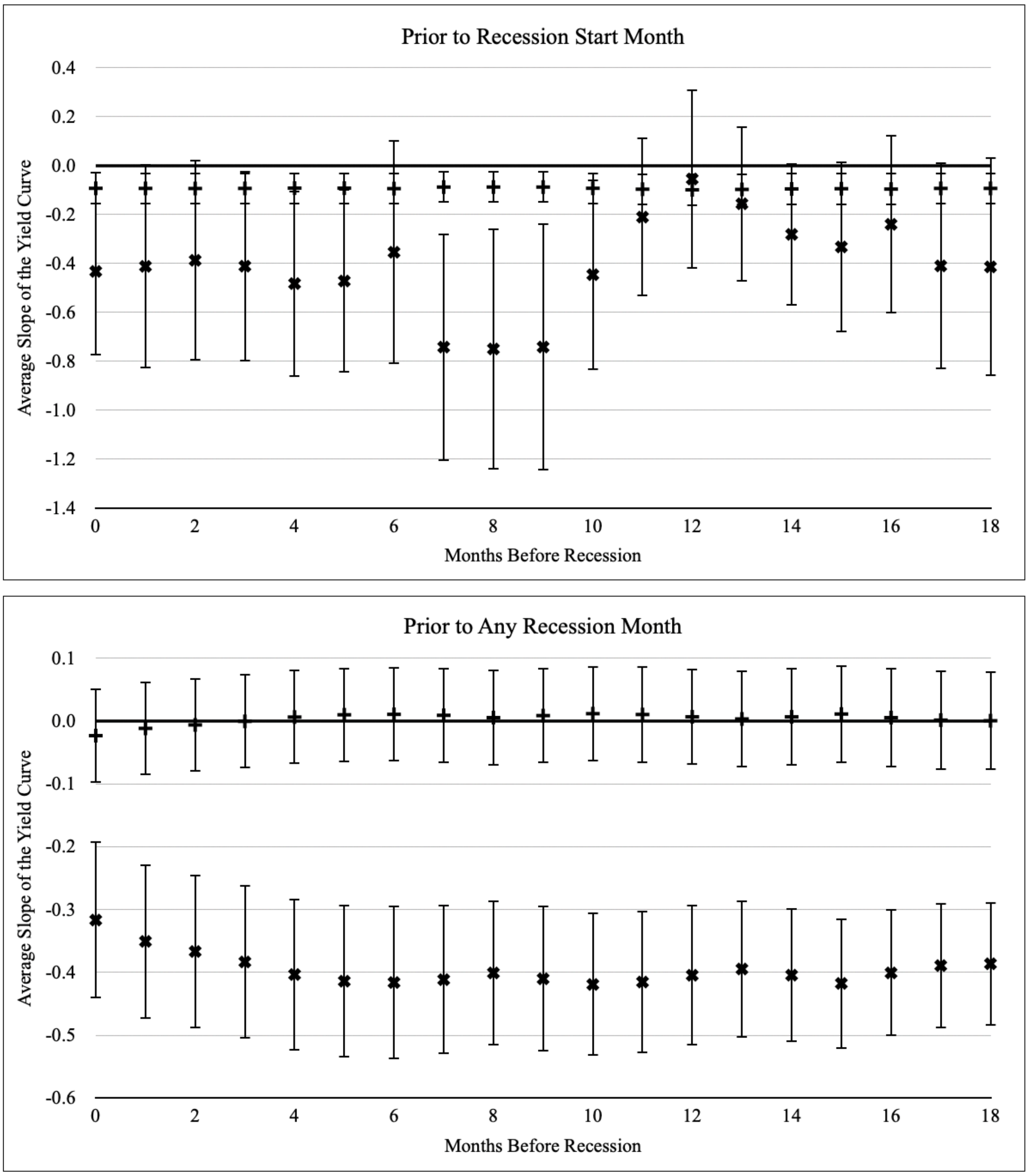
Table 2. Monthly Turning Points in the U.K. business cycle, 1800-1913.

Peak	Trough	Peak	Trough
May 1803	April 1804	August 1851	December 1851
August 1806	January 1807	March 1854	February 1855
December 1807	May 1808	September 1857	March 1858
July 1810	September 1811	December 1860	November 1862
April 1814	December 1814	April 1866	November 1868
July 1815	September 1816	October 1878	July 1879
September 1818	August 1820	April 1883	June 1886
May 1825	November 1826	September 1890	February 1893
May 1836	August 1837	June 1900	September 1901
April 1839	December 1839	November 1902	October 1903
August 1841	November 1842	June 1907	November 1908
April 1847	September 1848		

Source: Adjusted from the annual chronology of Broadberry, Chadha, Lennard, and Thomas (2022, 21), in combination with the information presented in Appendix A.

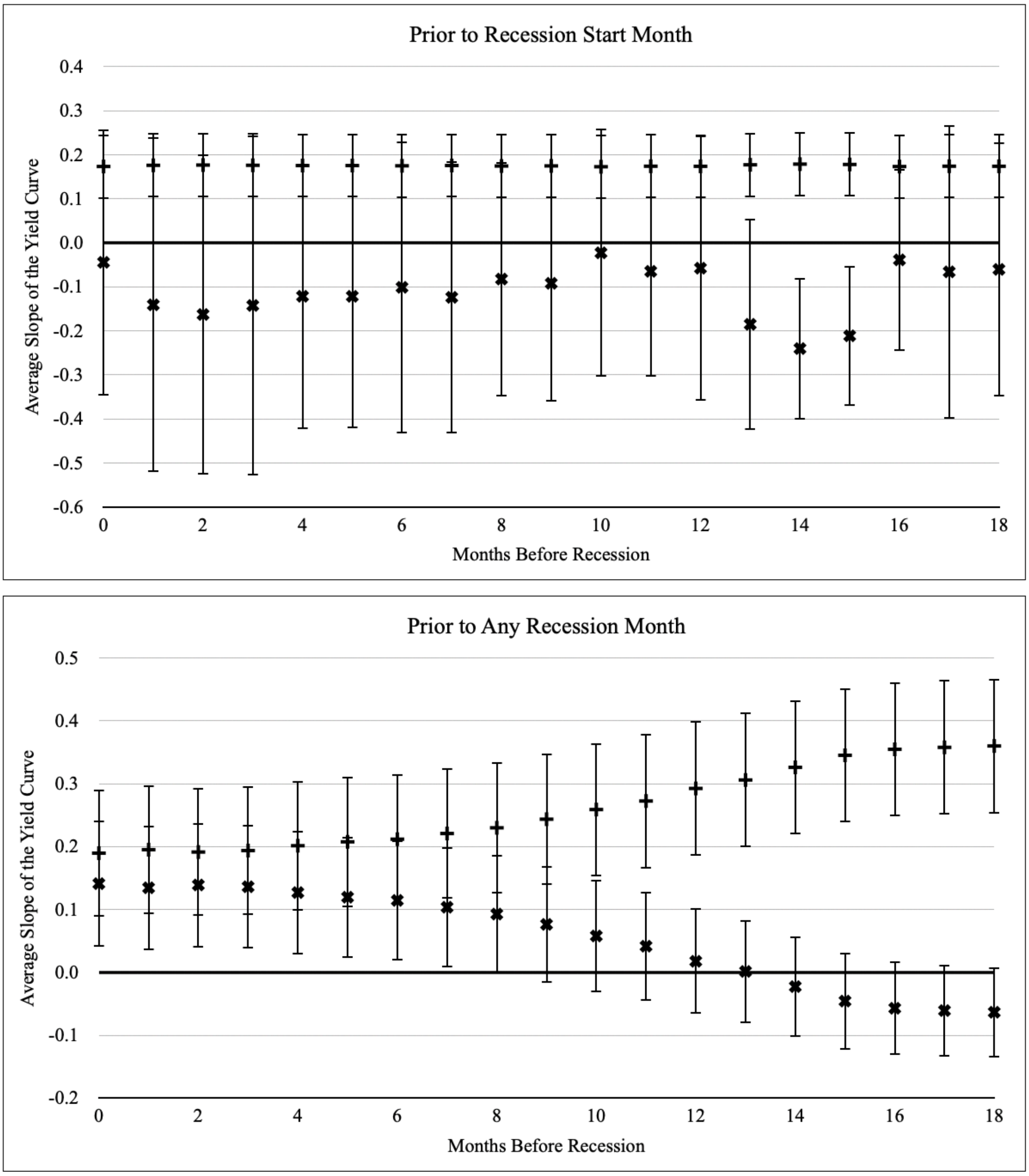
Appendix B - Full T-Test Results

Figure 27. Average Slope of the Yield Curve Prior to Recessions and at Other Times, 1800 - 1913 (Unadjusted Chronology)



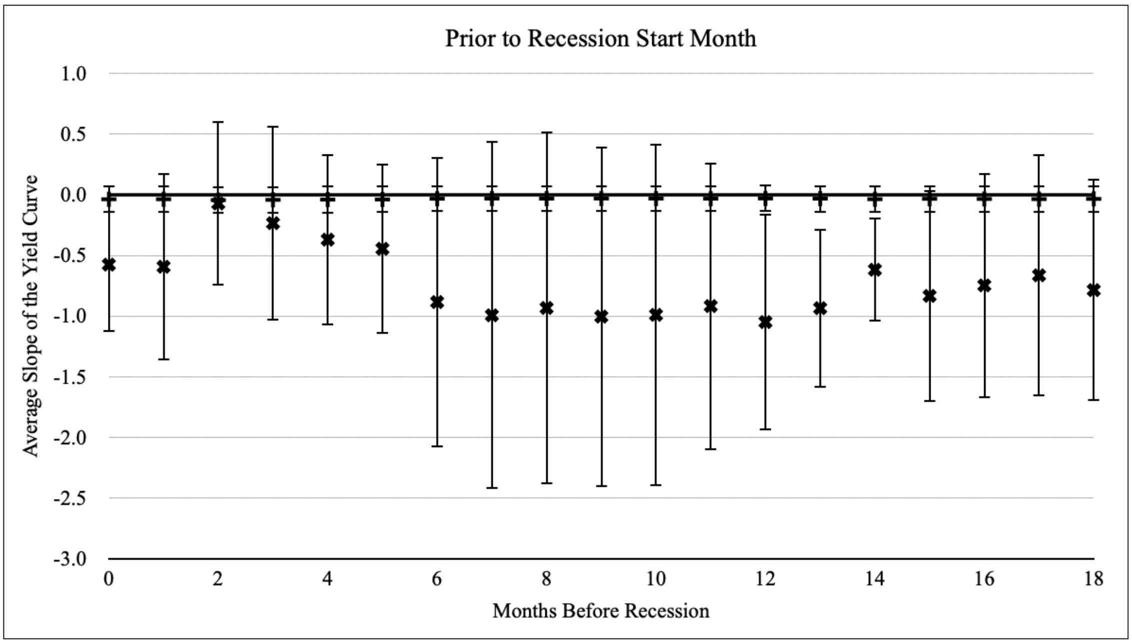
Note: ✖ = Mean slope of the yield curve a given number of months before a recession.
✚ = Mean slope of the yield curve when not a given number of months before a recession.
'Candlesticks' represent 95% confidence intervals.

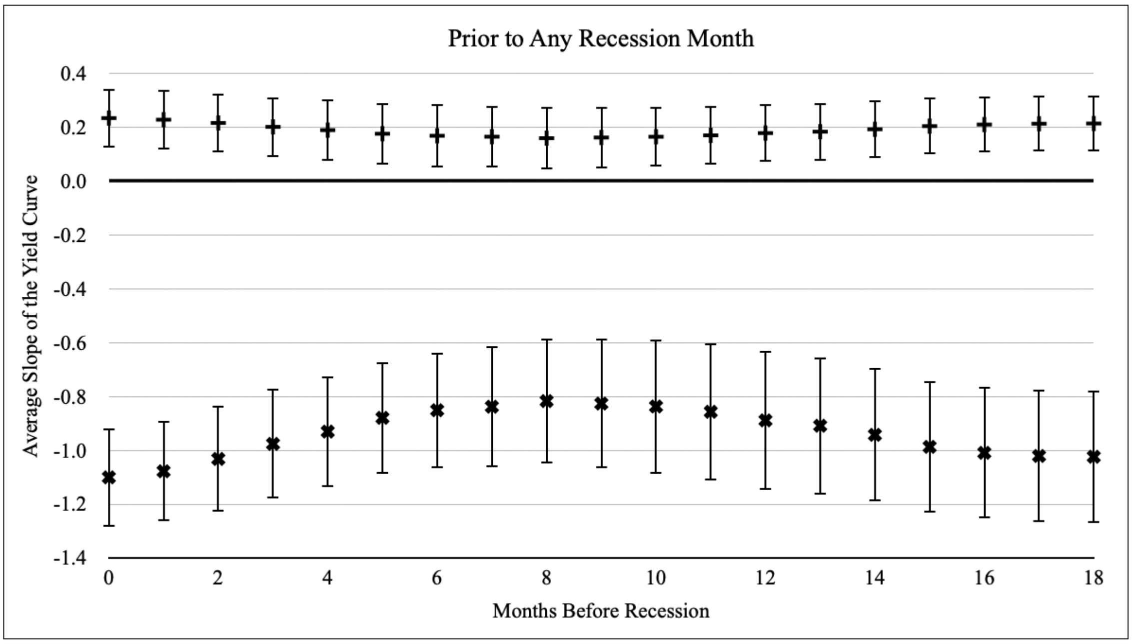
Figure 28. Average Slope of the Yield Curve Prior to Recessions and at Other Times, 1800 - 1821 (Unadjusted Chronology)



Note: ✖ = Mean slope of the yield curve a given number of months before a recession.
✚ = Mean slope of the yield curve when not a given number of months before a recession.
'Candlesticks' represent 95% confidence intervals.

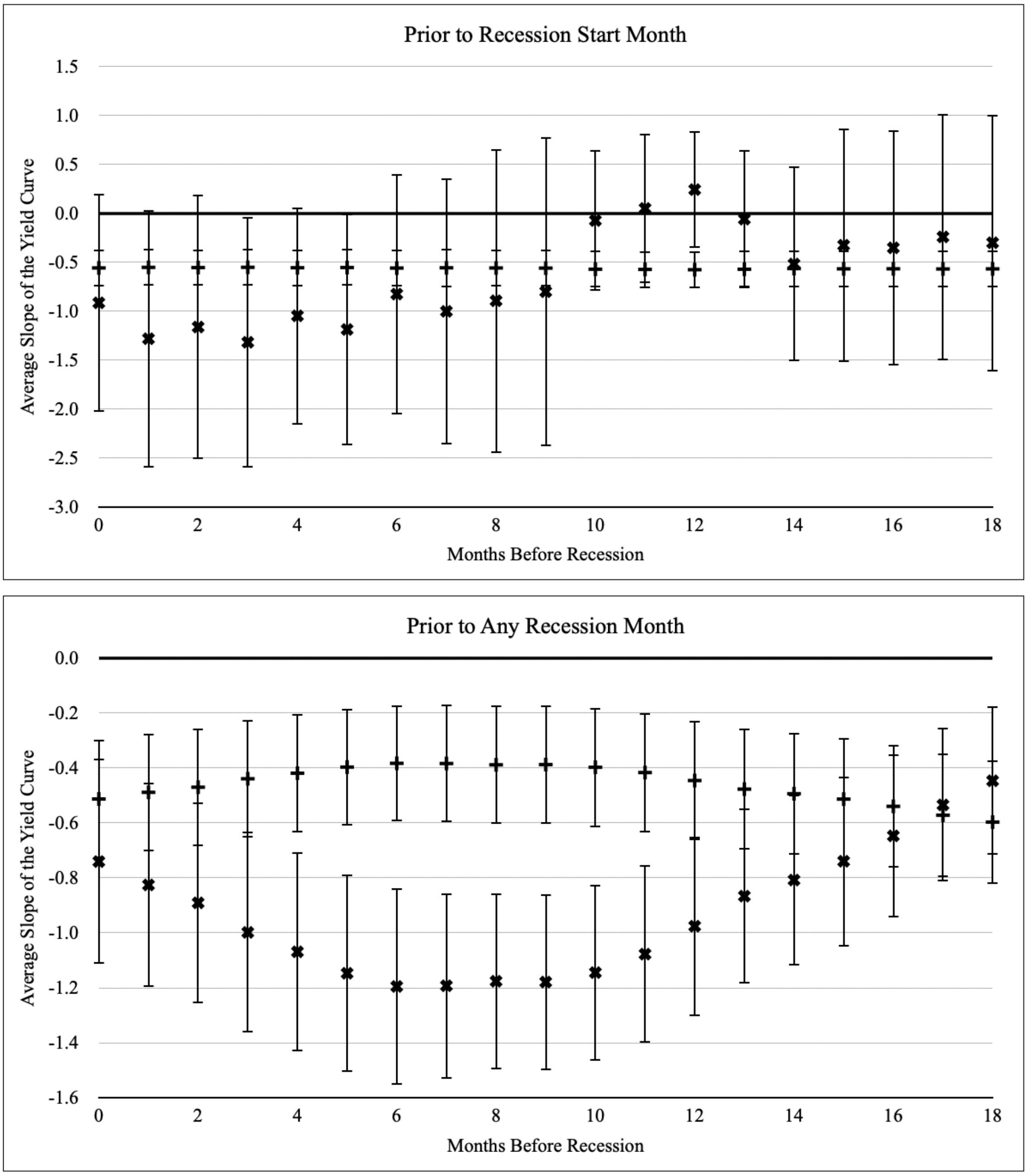
Figure 29. Average Slope of the Yield Curve Prior to Recessions and at Other Times, 1821 - 1844 (Unadjusted Chronology)





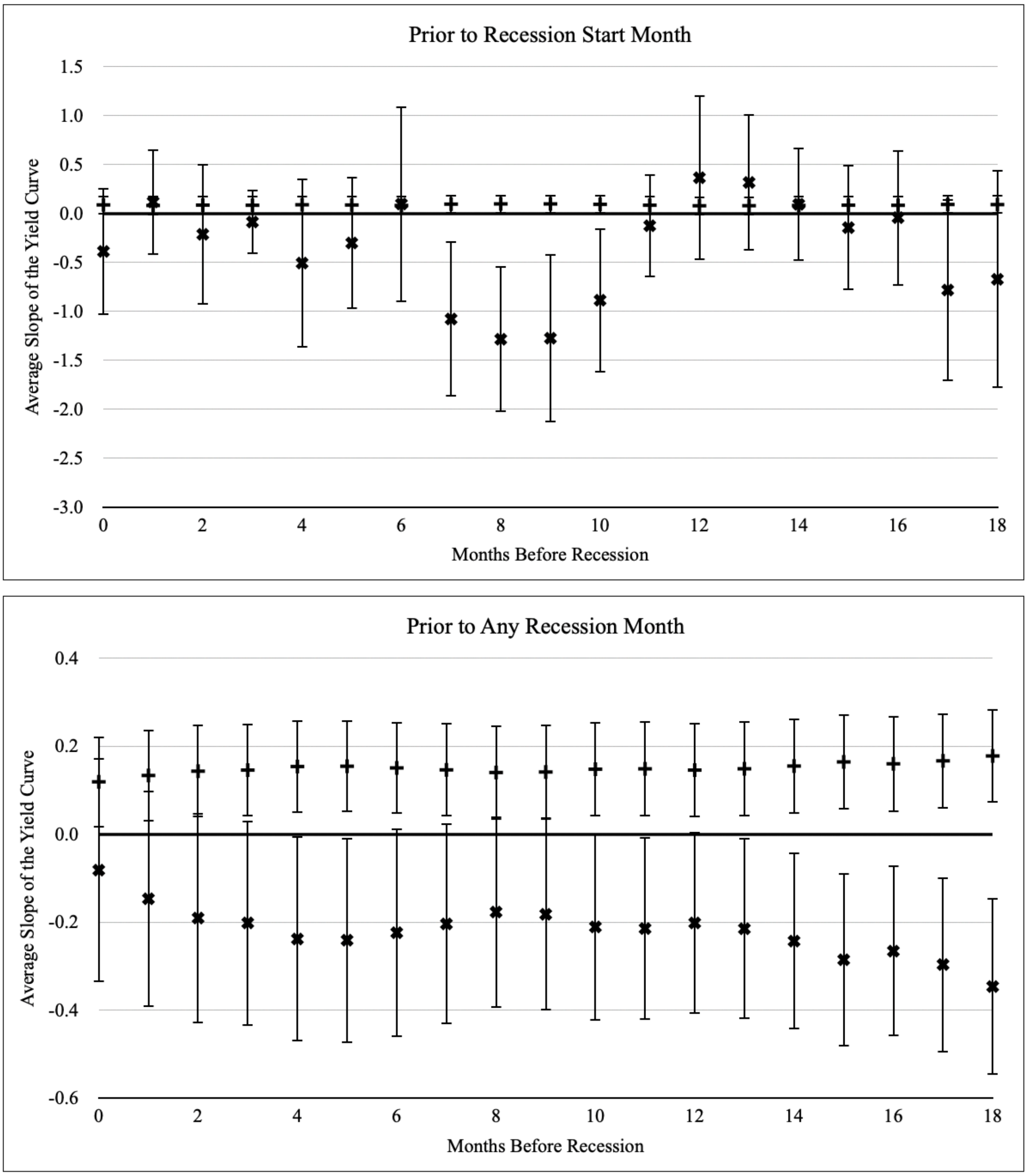
Note: ✖ = Mean slope of the yield curve a given number of months before a recession.
✚ = Mean slope of the yield curve when not a given number of months before a recession.
'Candlesticks' represent 95% confidence intervals.

Figure 30. Average Slope of the Yield Curve Prior to Recessions and at Other Times, 1844 - 1870 (Unadjusted Chronology)



Note: ✖ = Mean slope of the yield curve a given number of months before a recession.
✚ = Mean slope of the yield curve when not a given number of months before a recession.
'Candlesticks' represent 95% confidence intervals.

Figure 31. Average Slope of the Yield Curve Prior to Recessions and at Other Times, 1870 - 1913 (Unadjusted Chronology)



Note: ✖ = Mean slope of the yield curve a given number of months before a recession.
✚ = Mean slope of the yield curve when not a given number of months before a recession.
'Candlesticks' represent 95% confidence intervals.

Table 17. Comparing the Average Slope of the Yield Curve Before the Start of a Recession and Before Non-Recession Start Months, 1800-1913 (Unadjusted Recession Dates)

	Not Recession Start Month		Recession Start Month			
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t	p
0 Months	-0.093	1.226	-0.433	0.819	1.913 *	0.069
1 Month	-0.093	1.224	-0.412	0.998	1.481	0.153
2 Months	-0.093	1.224	-0.387	0.984	1.383	0.181
3 Months	-0.093	1.225	-0.411	0.936	1.572	0.130
4 Months	-0.092	1.225	-0.482	0.910	1.985 *	0.060
5 Months	-0.092	1.225	-0.472	0.898	1.954 *	0.063
6 Months	-0.094	1.223	-0.354	1.097	1.102	0.283
7 Months	-0.088	1.220	-0.742	1.112	2.733 **	0.012
8 Months	-0.088	1.219	-0.750	1.183	2.603 **	0.016
9 Months	-0.088	1.219	-0.742	1.207	2.520 **	0.020
10 Months	-0.092	1.225	-0.446	0.934	1.751 *	0.094
11 Months	-0.096	1.227	-0.210	0.778	0.674	0.507
12 Months	-0.099	1.226	-0.055	0.882	-0.232	0.818
13 Months	-0.097	1.227	-0.156	0.762	0.354	0.726
14 Months	-0.095	1.228	-0.281	0.698	1.219	0.235
15 Months	-0.094	1.226	-0.333	0.833	1.318	0.201
16 Months	-0.096	1.226	-0.240	0.874	0.762	0.454
17 Months	-0.093	1.224	-0.410	1.009	1.456	0.160
18 Months	-0.093	1.223	-0.414	1.071	1.391	0.178
Sample size	1346		22			

Recession dates from Broadberry, Chadha, Lennard, and Thomas (2022, 21), with recessions assumed to last from July of the peak year to June of the trough year.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 18. Comparing the Average Slope of the Yield Curve Before the Start of a Recession and Before Non-Recession Start Months, 1800-1821 (Unadjusted Recession Dates)

	Not Recession Start Month		Recession Start Month			
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t	p
0 Months	0.173	0.597	-0.045	0.407	1.375	0.213
1 Month	0.176	0.594	-0.141	0.513	1.606	0.156
2 Months	0.176	0.594	-0.163	0.491	1.795	0.119
3 Months	0.176	0.594	-0.143	0.522	1.585	0.161
4 Months	0.175	0.597	-0.122	0.406	1.881	0.104
5 Months	0.175	0.597	-0.122	0.403	1.893	0.102
6 Months	0.175	0.596	-0.101	0.446	1.598	0.157
7 Months	0.175	0.596	-0.124	0.417	1.851	0.109
8 Months	0.174	0.598	-0.083	0.359	1.823	0.111
9 Months	0.174	0.598	-0.092	0.363	1.875	0.103
10 Months	0.173	0.598	-0.023	0.381	1.316	0.231
11 Months	0.174	0.598	-0.065	0.324	1.864	0.104
12 Months	0.174	0.597	-0.058	0.408	1.460	0.189
13 Months	0.177	0.597	-0.185	0.322	2.847 **	0.024
14 Months	0.179	0.597	-0.240	0.217	4.652 ***	0.001
15 Months	0.178	0.597	-0.211	0.215	4.358 ***	0.002
16 Months	0.173	0.599	-0.039	0.278	1.900 *	0.096
17 Months	0.174	0.597	-0.066	0.450	1.379	0.213
18 Months	0.174	0.598	-0.061	0.389	1.543	0.168
Sample size	257		7			

Recession dates from Broadberry, Chadha, Lennard, and Thomas (2022, 21), with recessions assumed to last from July of the peak year to June of the trough year.
$* p < 0.1$, $** p < 0.05$, $*** p < 0.01$

Table 19. Comparing the Average Slope of the Yield Curve Before the Start of a Recession and Before Non-Recession Start Months, 1821-1844 (Unadjusted Recession Dates)

	Not Recession Start Month		Recession Start Month			
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t	p
0 Months	-0.036	0.976	-0.576	0.566	1.868	0.151
1 Month	-0.036	0.974	-0.593	0.791	1.393	0.254
2 Months	-0.044	0.977	-0.072	0.694	0.080	0.941
3 Months	-0.041	0.976	-0.234	0.820	0.464	0.673
4 Months	-0.039	0.976	-0.370	0.720	0.906	0.429
5 Months	-0.038	0.976	-0.445	0.713	1.126	0.339
6 Months	-0.032	0.966	-0.884	1.223	1.388	0.258
7 Months	-0.031	0.961	-0.994	1.465	1.311	0.280
8 Months	-0.031	0.962	-0.933	1.485	1.211	0.312
9 Months	-0.030	0.962	-1.005	1.433	1.355	0.267
10 Months	-0.031	0.962	-0.990	1.439	1.330	0.275
11 Months	-0.032	0.966	-0.918	1.210	1.458	0.239
12 Months	-0.030	0.968	-1.050	0.911	2.222	0.110
13 Months	-0.031	0.971	-0.935	0.669	2.662 *	0.072
14 Months	-0.036	0.976	-0.618	0.437	2.578 *	0.071
15 Months	-0.033	0.971	-0.834	0.892	1.782	0.170
16 Months	-0.034	0.971	-0.747	0.946	1.496	0.229
17 Months	-0.035	0.971	-0.664	1.017	1.228	0.305
18 Months	-0.034	0.971	-0.786	0.936	1.595	0.206
Sample size	284		4			

Recession dates from Broadberry, Chadha, Lennard, and Thomas (2022, 21), with recessions assumed to last from July of the peak year to June of the trough year.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 20. Comparing the Average Slope of the Yield Curve Before the Start of a Recession and Before Non-Recession Start Months, 1844-1870 (Unadjusted Recession Dates)

	Not Recession Start Month		Recession Start Month			
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t	p
0 Months	-0.558	1.713	-0.915	1.274	0.617	0.569
1 Month	-0.553	1.709	-1.282	1.504	1.074	0.341
2 Months	-0.555	1.709	-1.163	1.541	0.874	0.430
3 Months	-0.552	1.709	-1.318	1.460	1.161	0.308
4 Months	-0.556	1.713	-1.048	1.267	0.856	0.438
5 Months	-0.554	1.711	-1.188	1.351	1.036	0.356
6 Months	-0.560	1.712	-0.826	1.402	0.419	0.696
7 Months	-0.557	1.710	-1.002	1.554	0.635	0.559
8 Months	-0.559	1.708	-0.894	1.771	0.420	0.695
9 Months	-0.560	1.708	-0.801	1.798	0.298	0.780
10 Months	-0.572	1.716	-0.074	0.823	-1.309	0.253
11 Months	-0.574	1.715	0.050	0.869	-1.557	0.187
12 Months	-0.577	1.715	0.242	0.680	-2.566 *	0.052
13 Months	-0.572	1.716	-0.060	0.803	-1.378	0.231
14 Months	-0.565	1.715	-0.518	1.136	-0.090	0.933
15 Months	-0.568	1.713	-0.326	1.360	-0.392	0.714
16 Months	-0.567	1.713	-0.353	1.371	-0.345	0.746
17 Months	-0.569	1.712	-0.241	1.436	-0.505	0.639
18 Months	-0.568	1.711	-0.301	1.497	-0.395	0.712
Sample size	319		5			

Recession dates from Broadberry, Chadha, Lennard, and Thomas (2022, 21), with recessions assumed to last from July of the peak year to June of the trough year.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 21. Comparing the Average Slope of the Yield Curve Before the Start of a Recession and Before Non-Recession Start Months, 1870-1913 (Unadjusted Recession Dates)

	Not Recession Start Month		Recession Start Month			
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t	p
0 Months	0.088	1.135	-0.388	0.815	1.414	0.214
1 Month	0.082	1.137	0.118	0.676	-0.129	0.902
2 Months	0.086	1.135	-0.213	0.896	0.809	0.454
3 Months	0.084	1.138	-0.087	0.413	0.975	0.368
4 Months	0.089	1.132	-0.507	1.081	1.342	0.236
5 Months	0.087	1.135	-0.302	0.842	1.119	0.312
6 Months	0.082	1.132	0.097	1.250	-0.029	0.978
7 Months	0.096	1.127	-1.079	0.990	2.883 **	0.033
8 Months	0.098	1.125	-1.286	0.935	3.595 **	0.015
9 Months	0.098	1.124	-1.275	1.075	3.108 **	0.026
10 Months	0.093	1.130	-0.887	0.919	2.590 **	0.047
11 Months	0.085	1.136	-0.125	0.656	0.771	0.473
12 Months	0.079	1.133	0.366	1.052	-0.663	0.536
13 Months	0.080	1.135	0.317	0.875	-0.659	0.538
14 Months	0.082	1.136	0.094	0.723	-0.039	0.970
15 Months	0.085	1.136	-0.145	0.800	0.696	0.516
16 Months	0.084	1.135	-0.042	0.866	0.353	0.738
17 Months	0.092	1.129	-0.783	1.164	1.832	0.125
18 Months	0.091	1.127	-0.673	1.393	1.338	0.238
Sample size	522		6			

Recession dates from Broadberry, Chadha, Lennard, and Thomas (2022, 21), with recessions assumed to last from July of the peak year to June of the trough year.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 22. Comparing the Average Slope of the Yield Curve Before the Start of a Recession and Before Non-Recession Start Months, 1800-1913 (Adjusted Recession Dates)

	Not Recession Start Month		Recession Start Month			
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t	p
0 Months	-0.089	1.223	-0.642	1.011	2.644 **	0.016
1 Month	-0.089	1.223	-0.621	0.996	2.582 **	0.019
2 Months	-0.088	1.221	-0.718	1.111	2.751 **	0.013
3 Months	-0.087	1.219	-0.763	1.199	2.739 **	0.013
4 Months	-0.090	1.222	-0.571	1.100	2.118 **	0.049
5 Months	-0.090	1.220	-0.584	1.229	1.955 *	0.068
6 Months	-0.089	1.219	-0.660	1.240	2.236 **	0.039
7 Months	-0.086	1.219	-0.788	1.144	2.977 ***	0.008
8 Months	-0.089	1.222	-0.654	1.051	2.605 **	0.018
9 Months	-0.093	1.223	-0.392	1.065	1.359	0.196
10 Months	-0.093	1.225	-0.427	0.902	1.788 *	0.093
11 Months	-0.093	1.226	-0.412	0.888	1.732	0.103
12 Months	-0.095	1.229	-0.261	0.640	1.230	0.239
13 Months	-0.094	1.229	-0.326	0.618	1.772 *	0.095
14 Months	-0.096	1.227	-0.203	0.815	0.629	0.544
15 Months	-0.098	1.225	-0.093	0.959	-0.028	0.978
16 Months	-0.095	1.223	-0.269	1.091	0.772	0.458
17 Months	-0.094	1.221	-0.350	1.236	1.005	0.335
18 Months	-0.091	1.217	-0.499	1.401	1.416	0.179
Sample size	1345		23			

Recession dates adjusted from Broadberry, Chadha, Lennard, and Thomas (2022, 21) via the method described in Appendix A and outlined in Table 2.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 23. Comparing the Average Slope of the Yield Curve Before the Start of a Recession and Before Non-Recession Start Months, 1800-1821 (Adjusted Recession Dates)

	Not Recession Start Month		Recession Start Month			
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t	p
0 Months	0.171	0.593	0.029	0.663	0.563	0.593
1 Month	0.172	0.593	-0.015	0.654	0.750	0.480
2 Months	0.174	0.592	-0.089	0.648	1.064	0.327
3 Months	0.175	0.592	-0.116	0.614	1.238	0.260
4 Months	0.173	0.595	-0.033	0.565	0.949	0.377
5 Months	0.175	0.593	-0.114	0.573	1.315	0.234
6 Months	0.174	0.594	-0.074	0.550	1.173	0.283
7 Months	0.176	0.594	-0.157	0.527	1.645	0.148
8 Months	0.179	0.592	-0.248	0.531	2.091 *	0.079
9 Months	0.176	0.596	-0.141	0.403	2.023 *	0.084
10 Months	0.177	0.596	-0.179	0.401	2.277 *	0.058
11 Months	0.178	0.595	-0.212	0.420	2.390 **	0.050
12 Months	0.178	0.595	-0.231	0.417	2.524 **	0.041
13 Months	0.178	0.594	-0.229	0.440	2.388 *	0.050
14 Months	0.177	0.595	-0.201	0.398	2.446 **	0.046
15 Months	0.177	0.595	-0.183	0.467	1.995 *	0.089
16 Months	0.175	0.596	-0.127	0.407	1.914 *	0.099
17 Months	0.179	0.593	-0.242	0.493	2.213 *	0.066
18 Months	0.177	0.595	-0.187	0.412	2.278 *	0.058
Sample size	257		7			

Recession dates adjusted from Broadberry, Chadha, Lennard, and Thomas (2022, 21) via the method described in Appendix A and outlined in Table 2.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 24. Comparing the Average Slope of the Yield Curve Before the Start of a Recession and Before Non-Recession Start Months, 1821-1844 (Adjusted Recession Dates)

	Not Recession Start Month		Recession Start Month			
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t	p
0 Months	-0.039	0.977	-0.416	0.531	1.387	0.252
1 Month	-0.039	0.977	-0.410	0.538	1.347	0.263
2 Months	-0.036	0.975	-0.614	0.705	1.620	0.199
3 Months	-0.037	0.977	-0.561	0.406	2.484 *	0.077
4 Months	-0.038	0.977	-0.494	0.445	1.984	0.130
5 Months	-0.037	0.975	-0.548	0.714	1.412	0.248
6 Months	-0.038	0.975	-0.491	0.781	1.150	0.330
7 Months	-0.036	0.971	-0.637	1.038	1.152	0.331
8 Months	-0.036	0.969	-0.625	1.209	0.971	0.402
9 Months	-0.035	0.967	-0.676	1.314	0.972	0.402
10 Months	-0.038	0.974	-0.460	0.854	0.979	0.398
11 Months	-0.040	0.975	-0.358	0.856	0.737	0.513
12 Months	-0.040	0.977	-0.301	0.672	0.764	0.497
13 Months	-0.039	0.977	-0.398	0.587	1.200	0.310
14 Months	-0.039	0.976	-0.391	0.746	0.933	0.417
15 Months	-0.040	0.978	-0.303	0.460	1.109	0.340
16 Months	-0.037	0.976	-0.526	0.623	1.542	0.215
17 Months	-0.039	0.976	-0.407	0.722	1.007	0.385
18 Months	-0.038	0.976	-0.437	0.725	1.086	0.354
Sample size	284		4			

Recession dates adjusted from Broadberry, Chadha, Lennard, and Thomas (2022, 21) via the method described in Appendix A and outlined in Table 2.
$* p < 0.1$, $** p < 0.05$, $*** p < 0.01$

Table 25. Comparing the Average Slope of the Yield Curve Before the Start of a Recession and Before Non-Recession Start Months, 1844-1870 (Adjusted Recession Dates)

	Not Recession Start Month		Recession Start Month			
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t	p
0 Months	-0.552	1.713	-1.183	1.271	1.196	0.282
1 Month	-0.550	1.711	-1.312	1.343	1.369	0.226
2 Months	-0.547	1.704	-1.440	1.760	1.231	0.271
3 Months	-0.548	1.700	-1.436	1.981	1.091	0.324
4 Months	-0.550	1.707	-1.294	1.620	1.112	0.315
5 Months	-0.546	1.704	-1.497	1.738	1.327	0.240
6 Months	-0.554	1.708	-1.096	1.649	0.797	0.460
7 Months	-0.563	1.715	-0.607	1.289	0.082	0.938
8 Months	-0.560	1.715	-0.771	1.292	0.393	0.710
9 Months	-0.564	1.715	-0.589	1.264	0.049	0.962
10 Months	-0.561	1.712	-0.710	1.507	0.239	0.821
11 Months	-0.562	1.712	-0.657	1.542	0.149	0.887
12 Months	-0.571	1.718	-0.189	0.855	-1.056	0.333
13 Months	-0.569	1.718	-0.312	0.995	-0.614	0.563
14 Months	-0.569	1.715	-0.277	1.212	-0.580	0.585
15 Months	-0.571	1.713	-0.213	1.383	-0.624	0.559
16 Months	-0.562	1.707	-0.665	1.808	0.138	0.896
17 Months	-0.560	1.699	-0.776	2.269	0.232	0.826
18 Months	-0.558	1.688	-0.889	2.711	0.298	0.777
Sample size	318		6			

Recession dates adjusted from Broadberry, Chadha, Lennard, and Thomas (2022, 21) via the method described in Appendix A and outlined in Table 2.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 26. Comparing the Average Slope of the Yield Curve Before the Start of a Recession and Before Non-Recession Start Months, 1870-1913 (Adjusted Recession Dates)

	Not Recession Start Month		Recession Start Month			
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t	p
0 Months	0.095	1.128	-1.033	0.992	2.982 **	0.038
1 Month	0.092	1.132	-0.779	0.852	2.676 *	0.054
2 Months	0.092	1.133	-0.800	0.581	3.966 **	0.012
3 Months	0.094	1.130	-0.981	0.792	3.543 **	0.020
4 Months	0.089	1.132	-0.526	1.074	1.505	0.220
5 Months	0.086	1.132	-0.246	1.216	0.718	0.535
6 Months	0.095	1.122	-1.020	1.560	1.883	0.141
7 Months	0.104	1.115	-1.807	1.120	4.485 ***	0.008
8 Months	0.095	1.126	-1.031	1.247	2.376 *	0.078
9 Months	0.087	1.129	-0.298	1.399	0.724	0.532
10 Months	0.088	1.135	-0.412	0.701	1.855	0.142
11 Months	0.088	1.136	-0.436	0.552	2.445 *	0.067
12 Months	0.087	1.135	-0.343	0.758	1.479	0.226
13 Months	0.088	1.136	-0.403	0.476	2.630 *	0.052
14 Months	0.083	1.135	-0.006	0.921	0.254	0.823
15 Months	0.080	1.132	0.274	1.232	-0.413	0.717
16 Months	0.082	1.134	0.132	1.038	-0.128	0.910
17 Months	0.083	1.136	-0.011	0.771	0.319	0.779
18 Months	0.089	1.135	-0.513	0.665	2.349 *	0.078
Sample size	522		6			

Recession dates adjusted from Broadberry, Chadha, Lennard, and Thomas (2022, 21) via the method described in Appendix A and outlined in Table 2.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 27. Comparing the Average Slope of the Yield Curve Before Recession Months and Before Non-Recession Months, 1800-1913 (Unadjusted Recession Dates)

	Non-Recession Month		Recession Month			
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t	p
0 Months	-0.024	1.225	-0.317	1.186	3.951 ***	0.001 <
1 Month	-0.012	1.226	-0.351	1.171	4.604 ***	0.001 <
2 Months	-0.006	1.229	-0.367	1.158	4.934 ***	0.001 <
3 Months	-0.001	1.228	-0.384	1.157	5.245 ***	0.001 <
4 Months	0.006	1.226	-0.404	1.154	5.623 ***	0.001 <
5 Months	0.010	1.225	-0.414	1.155	5.818 ***	0.001 <
6 Months	0.010	1.222	-0.416	1.164	5.828 ***	0.001 <
7 Months	0.009	1.232	-0.412	1.134	5.842 ***	0.001 <
8 Months	0.005	1.244	-0.401	1.097	5.758 ***	0.001 <
9 Months	0.008	1.242	-0.410	1.101	5.922 ***	0.001 <
10 Months	0.011	1.245	-0.419	1.089	6.138 ***	0.001 <
11 Months	0.010	1.249	-0.415	1.077	6.104 ***	0.001 <
12 Months	0.006	1.254	-0.405	1.065	5.934 ***	0.001 <
13 Months	0.003	1.262	-0.395	1.038	5.827 ***	0.001 <
14 Months	0.006	1.269	-0.405	1.010	6.118 ***	0.001 <
15 Months	0.011	1.272	-0.418	0.993	6.447 ***	0.001 <
16 Months	0.005	1.281	-0.401	0.965	6.202 ***	0.001 <
17 Months	0.001	1.287	-0.389	0.948	6.022 ***	0.001 <
18 Months	0.000	1.290	-0.386	0.937	5.998 ***	0.001 <
Sample size	1020		348			

Recession dates from Broadberry, Chadha, Lennard, and Thomas (2022, 21), with recessions assumed to last from July of the peak year to June of the trough year.
* p < 0.1, ** p < 0.05, *** p < 0.01

Table 28. Comparing the Average Slope of the Yield Curve Before Recession Months and Before Non-Recession Months, 1800-1821 (Unadjusted Recession Dates)

	Non-Recession Month		Recession Month			
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t	p
0 Months	0.189	0.618	0.141	0.564	0.666	0.506
1 Month	0.195	0.627	0.134	0.551	0.835	0.404
2 Months	0.191	0.626	0.139	0.553	0.721	0.471
3 Months	0.194	0.629	0.136	0.549	0.794	0.428
4 Months	0.201	0.631	0.127	0.545	1.029	0.304
5 Months	0.207	0.638	0.119	0.535	1.220	0.223
6 Months	0.212	0.639	0.114	0.532	1.351	0.178
7 Months	0.221	0.638	0.103	0.531	1.629	0.104
8 Months	0.230	0.641	0.093	0.524	1.913 *	0.057
9 Months	0.243	0.643	0.076	0.517	2.343 **	0.020
10 Months	0.259	0.647	0.058	0.504	2.837 ***	0.005
11 Months	0.272	0.655	0.041	0.484	3.288 ***	0.001
12 Months	0.292	0.657	0.017	0.468	3.958 ***	0.001 <
13 Months	0.306	0.657	0.001	0.458	4.420 ***	0.001 <
14 Months	0.326	0.654	-0.023	0.445	5.130 ***	0.001 <
15 Months	0.345	0.652	-0.046	0.428	5.837 ***	0.001 <
16 Months	0.355	0.655	-0.057	0.412	6.211 ***	0.001 <
17 Months	0.358	0.656	-0.061	0.407	6.333 ***	0.001 <
18 Months	0.360	0.658	-0.064	0.400	6.427 ***	0.001 <
Sample size	144		120			

Recession dates from Broadberry, Chadha, Lennard, and Thomas (2022, 21), with recessions assumed to last from July of the peak year to June of the trough year.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 29. Comparing the Average Slope of the Yield Curve Before Recession Months and Before Non-Recession Months, 1821-1844 (Unadjusted Recession Dates)

	Non-Recession Month		Recession Month				
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t		p
0 Months	0.234	0.831	-1.100	0.718	12.369	***	0.001 <
1 Month	0.228	0.836	-1.077	0.735	11.878	***	0.001 <
2 Months	0.216	0.844	-1.031	0.780	10.829	***	0.001 <
3 Months	0.201	0.859	-0.976	0.807	9.917	***	0.001 <
4 Months	0.189	0.873	-0.930	0.816	9.316	***	0.001 <
5 Months	0.176	0.888	-0.879	0.822	8.694	***	0.001 <
6 Months	0.168	0.891	-0.851	0.846	8.210	***	0.001 <
7 Months	0.165	0.885	-0.838	0.885	7.808	***	0.001 <
8 Months	0.159	0.883	-0.817	0.913	7.416	***	0.001 <
9 Months	0.162	0.871	-0.826	0.950	7.290	***	0.001 <
10 Months	0.165	0.857	-0.837	0.987	7.180	***	0.001 <
11 Months	0.170	0.844	-0.856	1.008	7.249	***	0.001 <
12 Months	0.178	0.830	-0.888	1.019	7.483	***	0.001 <
13 Months	0.183	0.826	-0.908	1.009	7.725	***	0.001 <
14 Months	0.192	0.823	-0.942	0.980	8.236	***	0.001 <
15 Months	0.204	0.811	-0.987	0.966	8.766	***	0.001 <
16 Months	0.210	0.803	-1.009	0.963	9.011	***	0.001 <
17 Months	0.213	0.797	-1.020	0.968	9.089	***	0.001 <
18 Months	0.214	0.796	-1.023	0.967	9.126	***	0.001 <
Sample size	228		60				

Recession dates from Broadberry, Chadha, Lennard, and Thomas (2022, 21), with recessions assumed to last from July of the peak year to June of the trough year.
* p < 0.1, ** p < 0.05, *** p < 0.01

Table 30. Comparing the Average Slope of the Yield Curve Before Recession Months and Before Non-Recession Months, 1844-1870 (Unadjusted Recession Dates)

	Non-Recession Month		Recession Month				
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t		p
0 Months	-0.513	1.731	-0.741	1.615	1.037		0.302
1 Month	-0.489	1.728	-0.826	1.612	1.538		0.127
2 Months	-0.471	1.732	-0.891	1.583	1.945	*	0.054
3 Months	-0.440	1.724	-0.998	1.581	2.590	**	0.011
4 Months	-0.420	1.720	-1.069	1.567	3.032	***	0.003
5 Months	-0.397	1.715	-1.147	1.552	3.528	***	0.001
6 Months	-0.384	1.711	-1.195	1.542	3.838	***	0.001 <
7 Months	-0.384	1.731	-1.192	1.461	3.964	***	0.001 <
8 Months	-0.389	1.752	-1.176	1.381	4.001	***	0.001 <
9 Months	-0.388	1.751	-1.179	1.385	4.014	***	0.001 <
10 Months	-0.398	1.756	-1.145	1.382	3.791	***	0.001 <
11 Months	-0.417	1.759	-1.077	1.400	3.320	***	0.001
12 Months	-0.446	1.767	-0.976	1.410	2.648	***	0.009
13 Months	-0.478	1.782	-0.867	1.378	1.971	*	0.051
14 Months	-0.494	1.792	-0.808	1.347	1.611		0.109
15 Months	-0.514	1.797	-0.740	1.339	1.163		0.246
16 Months	-0.540	1.811	-0.647	1.283	0.567		0.572
17 Months	-0.572	1.826	-0.535	1.209	-0.205		0.838
18 Months	-0.597	1.832	-0.447	1.168	-0.836		0.404
Sample size	252		72				

Recession dates from Broadberry, Chadha, Lennard, and Thomas (2022, 21), with recessions assumed to last from July of the peak year to June of the trough year.
* p < 0.1, ** p < 0.05, *** p < 0.01

Table 31. Comparing the Average Slope of the Yield Curve Before Recession Months and Before Non-Recession Months, 1870-1913 (Unadjusted Recession Dates)

	Non-Recession Month		Recession Month				
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t		p
0 Months	0.119	1.096	-0.082	1.274	1.429		0.155
1 Month	0.133	1.105	-0.147	1.228	2.058	**	0.042
2 Months	0.143	1.110	-0.191	1.194	2.508	**	0.013
3 Months	0.145	1.116	-0.202	1.166	2.659	***	0.009
4 Months	0.154	1.114	-0.238	1.164	3.008	***	0.003
5 Months	0.154	1.113	-0.241	1.167	3.026	***	0.003
6 Months	0.150	1.110	-0.224	1.184	2.833	***	0.005
7 Months	0.146	1.121	-0.204	1.142	2.724	***	0.007
8 Months	0.140	1.135	-0.177	1.089	2.560	**	0.012
9 Months	0.141	1.133	-0.182	1.093	2.604	**	0.010
10 Months	0.147	1.137	-0.211	1.067	2.941	***	0.004
11 Months	0.148	1.142	-0.215	1.042	3.032	***	0.003
12 Months	0.145	1.144	-0.202	1.037	2.910	***	0.004
13 Months	0.148	1.144	-0.215	1.028	3.066	***	0.003
14 Months	0.155	1.147	-0.243	1.005	3.414	***	0.001
15 Months	0.164	1.147	-0.285	0.987	3.914	***	0.001 <
16 Months	0.160	1.152	-0.266	0.969	3.754	***	0.001 <
17 Months	0.166	1.145	-0.296	0.993	4.011	***	0.001 <
18 Months	0.178	1.137	-0.346	1.006	4.502	***	0.001 <
Sample size	432		96				

Recession dates from Broadberry, Chadha, Lennard, and Thomas (2022, 21), with recessions assumed to last from July of the peak year to June of the trough year.
* p < 0.1, ** p < 0.05, *** p < 0.01

Table 32. Comparing the Average Slope of the Yield Curve Before Recession Months and Before Non-Recession Months, 1800-1913 (Adjusted Recession Dates)

	Non-Recession Month		Recession Month				
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t		p
0 Months	-0.043	1.117	-0.248	1.457	2.530	**	0.014
1 Month	-0.025	1.116	-0.295	1.451	3.342	***	0.001
2 Months	-0.003	1.114	-0.354	1.443	4.356	***	0.001 <
3 Months	0.019	1.106	-0.413	1.443	5.379	***	0.001 <
4 Months	0.030	1.116	-0.444	1.412	5.991	***	0.001 <
5 Months	0.039	1.125	-0.468	1.385	6.505	***	0.001 <
6 Months	0.052	1.122	-0.502	1.377	7.132	***	0.001 <
7 Months	0.066	1.116	-0.540	1.377	7.815	***	0.001 <
8 Months	0.075	1.112	-0.566	1.371	8.301	***	0.001 <
9 Months	0.078	1.115	-0.572	1.363	8.458	***	0.001 <
10 Months	0.078	1.124	-0.574	1.341	8.580	***	0.001 <
11 Months	0.072	1.151	-0.558	1.287	8.499	***	0.001 <
12 Months	0.066	1.168	-0.541	1.252	8.326	***	0.001 <
13 Months	0.062	1.183	-0.531	1.219	8.269	***	0.001 <
14 Months	0.060	1.193	-0.525	1.196	8.246	***	0.001 <
15 Months	0.055	1.197	-0.512	1.190	8.025	***	0.001 <
16 Months	0.052	1.197	-0.504	1.195	7.840	***	0.001 <
17 Months	0.046	1.200	-0.487	1.193	7.515	***	0.001 <
18 Months	0.047	1.193	-0.490	1.212	7.505	***	0.001 <
Sample size	998		370				

Recession dates adjusted from Broadberry, Chadha, Lennard, and Thomas (2022, 21) via the method described in Appendix A and outlined in Table 2.
* p < 0.1, ** p < 0.05, *** p < 0.01

Table 33. Comparing the Average Slope of the Yield Curve Before Recession Months and Before Non-Recession Months, 1800-1821 (Adjusted Recession Dates)

	Non-Recession Month		Recession Month				
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t		p
0 Months	0.094	0.570	0.317	0.615	-3.028	***	0.005
1 Month	0.096	0.570	0.312	0.617	-2.925	***	0.007
2 Months	0.104	0.566	0.296	0.630	-2.587	**	0.017
3 Months	0.114	0.561	0.276	0.644	-2.148	**	0.048
4 Months	0.118	0.560	0.267	0.649	-1.978	*	0.069
5 Months	0.124	0.558	0.256	0.655	-1.752		0.107
6 Months	0.128	0.561	0.247	0.652	-1.567		0.148
7 Months	0.140	0.564	0.228	0.650	-1.165		0.282
8 Months	0.151	0.565	0.201	0.650	-0.660		0.541
9 Months	0.160	0.571	0.182	0.640	-0.287		0.790
10 Months	0.174	0.576	0.153	0.632	0.286		0.790
11 Months	0.180	0.581	0.141	0.621	0.526		0.623
12 Months	0.190	0.582	0.121	0.617	0.928		0.386
13 Months	0.203	0.580	0.095	0.618	1.454		0.175
14 Months	0.214	0.580	0.072	0.614	1.929	*	0.072
15 Months	0.224	0.584	0.052	0.600	2.352	**	0.028
16 Months	0.224	0.583	0.052	0.602	2.344	**	0.029
17 Months	0.229	0.585	0.043	0.594	2.546	**	0.018
18 Months	0.238	0.584	0.023	0.590	2.966	***	0.006
Sample size	177		87				

Recession dates adjusted from Broadberry, Chadha, Lennard, and Thomas (2022, 21) via the method described in Appendix A and outlined in Table 2.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 34. Comparing the Average Slope of the Yield Curve Before Recession Months and Before Non-Recession Months, 1821-1844 (Adjusted Recession Dates)

	Non-Recession Month		Recession Month				
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t		p
0 Months	0.230	0.776	-1.085	0.946	10.663	***	0.001 <
1 Month	0.222	0.805	-1.054	0.894	10.740	***	0.001 <
2 Months	0.214	0.831	-1.025	0.844	10.832	***	0.001 <
3 Months	0.207	0.859	-0.999	0.770	11.180	***	0.001 <
4 Months	0.198	0.886	-0.962	0.709	11.262	***	0.001 <
5 Months	0.184	0.912	-0.908	0.666	10.917	***	0.001 <
6 Months	0.169	0.932	-0.854	0.646	10.331	***	0.001 <
7 Months	0.159	0.944	-0.814	0.646	9.761	***	0.001 <
8 Months	0.150	0.947	-0.780	0.677	9.060	***	0.001 <
9 Months	0.143	0.946	-0.755	0.715	8.477	***	0.001 <
10 Months	0.131	0.956	-0.708	0.721	7.837	***	0.001 <
11 Months	0.116	0.966	-0.654	0.732	7.099	***	0.001 <
12 Months	0.102	0.978	-0.598	0.730	6.441	***	0.001 <
13 Months	0.090	0.990	-0.551	0.710	5.970	***	0.001 <
14 Months	0.084	0.992	-0.531	0.715	5.697	***	0.001 <
15 Months	0.079	0.997	-0.511	0.709	5.483	***	0.001 <
16 Months	0.082	0.995	-0.522	0.708	5.615	***	0.001 <
17 Months	0.083	0.994	-0.527	0.707	5.689	***	0.001 <
18 Months	0.081	0.997	-0.518	0.703	5.590	***	0.001 <
Sample size	228		60				

Recession dates adjusted from Broadberry, Chadha, Lennard, and Thomas (2022, 21) via the method described in Appendix A and outlined in Table 2.
* p < 0.1, ** p < 0.05, *** p < 0.01

Table 35. Comparing the Average Slope of the Yield Curve Before Recession Months and Before Non-Recession Months, 1844-1870 (Adjusted Recession Dates)

	Non-Recession Month		Recession Month				
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t		p
0 Months	-0.511	1.529	-0.687	2.062	0.749		0.448
1 Month	-0.468	1.521	-0.785	2.064	1.348		0.173
2 Months	-0.414	1.507	-0.910	2.062	2.115	**	0.033
3 Months	-0.366	1.485	-1.020	2.069	2.785	***	0.005
4 Months	-0.346	1.509	-1.066	2.013	3.124	***	0.002
5 Months	-0.320	1.531	-1.127	1.950	3.584	***	0.001 <
6 Months	-0.300	1.532	-1.173	1.927	3.918	***	0.001 <
7 Months	-0.288	1.535	-1.201	1.909	4.121	***	0.001 <
8 Months	-0.271	1.538	-1.239	1.885	4.412	***	0.001 <
9 Months	-0.267	1.546	-1.248	1.863	4.510	***	0.001 <
10 Months	-0.266	1.556	-1.251	1.843	4.558	***	0.001 <
11 Months	-0.284	1.614	-1.210	1.747	4.424	***	0.001 <
12 Months	-0.299	1.641	-1.175	1.706	4.238	***	0.001 <
13 Months	-0.307	1.659	-1.157	1.675	4.156	***	0.001 <
14 Months	-0.317	1.674	-1.134	1.650	4.029	***	0.001 <
15 Months	-0.331	1.684	-1.101	1.643	3.802	***	0.001 <
16 Months	-0.339	1.687	-1.083	1.644	3.670	***	0.001 <
17 Months	-0.358	1.693	-1.039	1.650	3.346	***	0.001
18 Months	-0.361	1.666	-1.033	1.714	3.228	***	0.001
Sample size	226		98				

Recession dates adjusted from Broadberry, Chadha, Lennard, and Thomas (2022, 21) via the method described in Appendix A and outlined in Table 2.
* p < 0.1, ** p < 0.05, *** p < 0.01

Table 36. Comparing the Average Slope of the Yield Curve Before Recession Months and Before Non-Recession Months, 1870-1913 (Adjusted Recession Dates)

	Non-Recession Month		Recession Month				
Time lag	Mean	Standard Deviation	Mean	Standard Deviation	t		p
0 Months	0.075	1.109	0.106	1.209	-0.253		0.801
1 Month	0.098	1.109	0.031	1.206	0.556		0.579
2 Months	0.123	1.113	-0.048	1.186	1.422		0.157
3 Months	0.150	1.108	-0.136	1.186	2.386	**	0.018
4 Months	0.171	1.105	-0.202	1.176	3.140	***	0.002
5 Months	0.184	1.102	-0.245	1.170	3.629	***	0.001 <
6 Months	0.209	1.086	-0.327	1.185	4.511	***	0.001 <
7 Months	0.240	1.056	-0.425	1.221	5.479	***	0.001 <
8 Months	0.253	1.045	-0.469	1.226	5.945	***	0.001 <
9 Months	0.257	1.043	-0.480	1.225	6.073	***	0.001 <
10 Months	0.258	1.055	-0.485	1.190	6.264	***	0.001 <
11 Months	0.259	1.067	-0.487	1.154	6.421	***	0.001 <
12 Months	0.256	1.081	-0.477	1.114	6.472	***	0.001 <
13 Months	0.252	1.099	-0.466	1.066	6.536	***	0.001 <
14 Months	0.250	1.109	-0.459	1.036	6.578	***	0.001 <
15 Months	0.246	1.107	-0.444	1.054	6.316	***	0.001 <
16 Months	0.241	1.103	-0.428	1.074	6.043	***	0.001 <
17 Months	0.233	1.105	-0.404	1.085	5.709	***	0.001 <
18 Months	0.235	1.104	-0.409	1.084	5.773	***	0.001 <
Sample size	403		125				

Recession dates adjusted from Broadberry, Chadha, Lennard, and Thomas (2022, 21) via the method described in Appendix A and outlined in Table 2.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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