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Lennard, Jason

2018

Document Version:
Publisher's PDF, also known as Version of record

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JASON LENNARD

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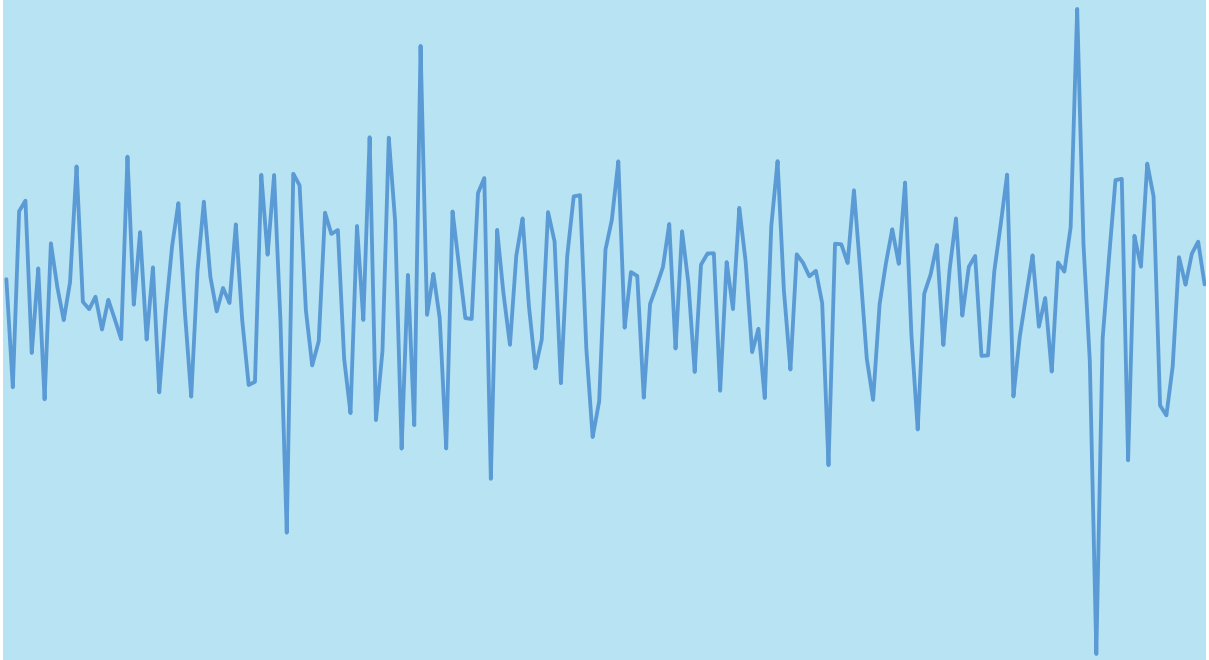

Economic Fluctuations in the United Kingdom, 1750-1938

Jason Lennard

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DOCTORAL DISSERTATION
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To be defended at EC2:101 on Friday 1 June at 14:15.

Faculty opponent
Rui Esteves

Organization:	Document name:
Department of Economic History, Lund University	Doctoral dissertation
	Date of issue: 2018-05-11
Author(s): Jason Lennard	Sponsoring organization:

Title and subtitle: Economic Fluctuations in the United Kingdom, 1750-1938

Abstract:

This dissertation investigates the causes of economic fluctuations in the United Kingdom between the Industrial Revolution and the Second World War. The first part of the dissertation studies the micro origins of fluctuations by focusing on regional variation and its aggregate implications. Chapter 1 constructs estimates of the money supply in Ireland between 1840 and 1921. Chapter 2 develops annual estimates of real gross domestic product in Ireland between 1842 and 1913 using an original econometric methodology. The second part of the dissertation studies the macro origins of fluctuations using the narrative record to identify the causal effect of macroeconomic shocks. Chapter 3 examines how monetary policy affected the economy during the classical gold standard. Chapter 4 analyses the impact of economic policy uncertainty in the interwar period. Chapter 5 measures the macroeconomic effects of banking crises between 1750 and 1938.

Key words: Banking crises, business cycles, GDP, monetary policy, money supply, narrative approach, uncertainty

Classification system and/or index terms (if any):

Supplementary bibliographical information:		Language: English
ISSN and key title: 1400-4860		ISBN: 978-91-87793-46-2
Recipient's notes:	Number of pages: 222	Price:
	Security classification	

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Cover photo by Sam Lennard

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ISBN 978-91-87793-46-2
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Printed in Sweden by Media-Tryck, Lund University
Lund 2018

Contents

Acknowledgements

In some ways, completing a PhD has been like a season supporting my childhood football club, Arsenal. It began in August with lots of optimism, it was followed by a series of crushing defeats due to a woeful lack of experience and it ended with a dash to the finish in the hope of achieving a respectable, if not glorious, result. A PhD, like football, is also a team effort and I am thankful to many people.

In Lund, I am grateful to my supervisors, Anders Ögren, Fredrik NG Andersson and Kerstin Enflo, who have given endless encouragement and feedback. I am also thankful to Anneli Nilsson Ahlm, Birgit Olsson, Kristin Fransson, Mats Olsson and Tina Wueggertz for their fantastic administration of the Department of Economic History and to Astrid Kander, Martin Dribe and Patrick Svensson for great advice as the directors of the PhD programme. I am grateful too to my colleagues there, who I have learnt a lot from, particularly my office mate, Seán Kenny. Thank you all for making my time in Sweden so great.

Outside of Lund, I am grateful to Eric Golson, John Turner, Nicholas Dimsdale and Ryland Thomas, who have helped me over and above their contribution to our joint work and to my colleagues at the National Institute of Economic and Social Research for making it a supportive place to finish off the dissertation. Above all, I am thankful to Susie, my family and friends for supporting me from the first whistle to the last.

List of papers

I Seán Kenny and Jason Lennard (forthcoming). Monetary Aggregates for Ireland, 1840-1921. *Economic History Review.*

II Fredrik NG Andersson and Jason Lennard (forthcoming). Irish GDP between the Famine and the First World War: Estimates Based on a Dynamic Factor Model. *European Review of Economic History.*

III Jason Lennard (2018). Did Monetary Policy Matter? Narrative Evidence from the Classical Gold Standard. *Explorations in Economic History.*

IV Jason Lennard (2018). Uncertainty and the Great Slump. *Under review.*

V Seán Kenny, Jason Lennard and John D. Turner (2018). The Macroeconomic Effects of Banking Crises: Evidence from the United Kingdom, 1750-1938. *Under review.*

Introduction

Overview

This dissertation investigates the causes of economic fluctuations in the United Kingdom between the Industrial Revolution and the Second World War. The first part of the dissertation studies the micro origins of fluctuations by focusing on regional variation and its aggregate implications. Chapter 1 constructs estimates of the money supply in Ireland between 1840 and 1921. Chapter 2 develops annual estimates of real gross domestic product in Ireland between 1842 and 1913 using an original econometric methodology. The second part of the dissertation studies the macro origins of fluctuations using the narrative record to identify the causal effect of macroeconomic shocks. Chapter 3 examines how monetary policy affected the economy during the classical gold standard. Chapter 4 analyses the impact of economic policy uncertainty in the interwar period. Chapter 5 measures the macroeconomic effects of banking crises between 1750 and 1938.

There are two main motivations for this dissertation. First, since the last major review of British business cycles (Aldcroft and Fearon, 1972), a wealth of new macroeconomic data has been constructed, such as national accounts back to the eighteenth century and beyond (Broadberry et al., 2015). Second, following the "credibility revolution" in empirical economics (Angrist and Pischke, 2010), the methods that are now used to identify the causes of fluctuations have also changed greatly. This dissertation combines this new data with leading econometric methods to revisit the causes of economic fluctuations in the United Kingdom.

The rest of this introductory chapter is organized as follows. The first section examines the welfare cost of business cycles. The second introduces the relevant previous literature. The third section presents the geographical and historical context. The fourth and fifth sections run through the data and methodology used in the dissertation. The sixth section presents the results. The final section discusses the aggregate implications of the new regional macroeconomic statistics and the significance of the new evidence on the effects of macroeconomic shocks.

The Cost of Business Cycles

Lucas (1987) famously argued that business cycles did not matter. He conducted a thought experiment in which he asked what would be the effect on welfare if

fluctuations in consumption could be eliminated, quantifying the effect using the following formula:

$$\lambda = \frac{1}{2}\gamma\sigma^2 \tag{1}$$

where λ is the welfare cost of business cycles, γ is a risk aversion parameter and σ is the volatility of consumption. The equation suggests that the welfare cost rises with the degree of risk aversion and the volatility of consumption. Setting $\gamma = 1$ and $\sigma = 0.032$, measured as the standard deviation of the log of real per capita consumption around a linear trend in the United States between 1947 and 2001, Lucas calculated that $\lambda = 0.0005$, which implies that consumers would only be willing to give up about one-twentieth of one per cent of average consumption to live in a world free of business cycles.

As a result of these seemingly small welfare gains from eliminating business cycles, Lucas urged economists to shift their priorities away from business cycles. It is useful to understand whether the same is true for historical business cycles. As a result, I replicate Lucas's experiment, estimating σ in the same way, but using annual British data (Thomas and Dimsdale, 2017) between 1830 and 1938. The results show that the welfare cost of historical business cycles in the United Kingdom was $1/2(0.08)^2$ or 0.3 per cent of a year's average consumption, which is more than six times larger than in the United States in the post-war period.

Even though this exercise has shown that the cost of historical business cycles was non-trivial, subsequent research has shown that equation 1 is likely to *underestimate* the true cost of business cycles for a variety of reasons. First, as Lucas recognized, 1 is a lower bound for the coefficient of risk aversion. In the case of $\lambda = 5$, as in Galí et al. (2007) and Romer (2006), the welfare cost of historical business cycles is as large as 1.6 per cent of average consumption. Second, De Santis (2007), Barillas et al. (2009) and Ellison and Sargent (2015) show that the welfare cost of consumption fluctuations increases with the level of uninsured idiosyncratic consumption risk and with agents' concern for robustness to model misspecification. Third, Galí et al. (2007) note that the overall welfare cost is relatively small because recessions are infrequent, but the costs are big when they do occur. The major US recession of the early 1980s, for example, was associated with welfare losses equivalent to 8 per cent of a year's consumption.

Lastly, and perhaps most importantly, Lucas assumed that fluctuations did not affect the growth of consumption. Barlevy (2004), however, finds that eliminating fluctuations could increase the growth rate by up to 0.4 percentage points. Ramey and Ramey (1995) similarly find that high volatility is associated with low growth in a sample of 92 countries for the period 1960 to 1985. Indeed, figure 1 shows an association in the United Kingdom between the 1750s and 1930s between periods of high volatility, as measured by the decadal standard deviation of output growth, and low growth, calculated as the decadal average growth rate.

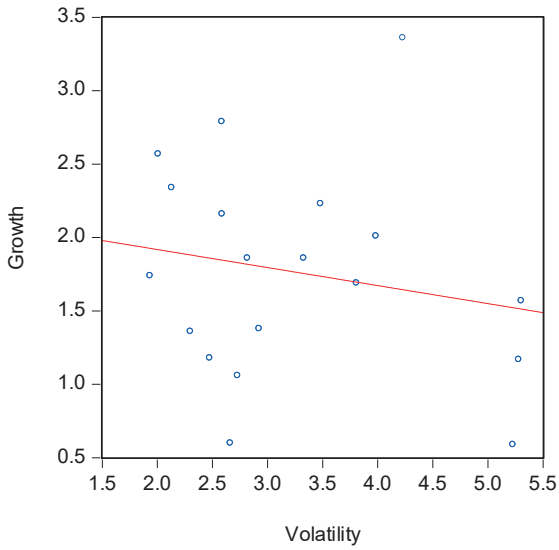

FIGURE 1. VOLATILITY AND GROWTH IN THE UNITED KINGDOM, 1750S-1930S
Source: Thomas and Dimsdale (2017).

Previous Research

Theoretical

The theory of business cycles has a long and interesting history. In 1927 Slutzky observed that the sum of randomly generated time series exhibits "waves" like those seen in economic variables, implying that economic fluctuations are the outcome of random shocks.[1] A great deal of subsequent research has attempted to understand these random shocks.

The major battle grounds have been those to monetary and fiscal policy. The case for fiscal shocks was most famously made by Keynes, who, along with Henderson, advocated fiscal stimulus to curb the unemployment problem in the run-up to the 1929 general election (Keynes and Henderson, 1929). The case for monetary shocks was most prominently made by Friedman and Schwartz (1963), who argued that monetary factors were important during the US Great Depression. The popularity of these shocks among economists has since ebbed and flowed like the waves described by Slutzky.

In the 1980s Kydland and Prescott (1982) and Prescott (1986) pioneered Real Business Cycle (RBC) theory. This theory is built from a dynamic stochastic general

[1] See Slutzky (1937) for the English translation.

equilibrium (DSGE) model based on the optimal intertemporal behaviour of consumers and firms.[2] The model shows that economic fluctuations are largely due to exogenous real shocks – mainly those to technology. As a consequence, stabilization policy, such as monetary and fiscal policy, is not only unnecessary but potentially inefficient. However, as with all models, the predictions are linked to the assumptions, such as perfect competition and flexible wages and prices.

The New Keynesian model is the leading macroeconomic model today.[3] While it is also a type of DSGE model, it differs from the RBC model in a few important ways. The assumption of perfect competition is replaced with monopolistic competition, while nominal rigidities are introduced so that wages and prices are not flexible but "sticky". As a result, the New Keynesian model predicts that monetary policy is not neutral and that a government spending multiplier in excess of one is possible if monetary policy is at the zero lower bound (Woodford, 2011).

Empirical

In this section, I will discuss the leading empirical research on the causes of economic fluctuations.

Monetary Policy

The impact of monetary policy is of special interest in macroeconomics. The leading identification strategy is the so called "narrative approach", which was pioneered by Romer and Romer in classic papers in 1989 and 2004 and involves using historical records to determine whether policy changes were exogenous or endogenous. A one percentage point increase in their exogenous series of monetary policy is associated with a decline of up to 4.3 per cent in industrial production and up to 6 per cent in the price level in the modern US economy. Cloyne and Hürtgen (2016) follow this approach for the United Kingdom between 1975 and 2007 with similar, albeit more modest, results.

Fiscal Policy

The efficacy of fiscal policy has been a staple of macroeconomic research since the 1930s. The leading identification method has focused on news of future defence spending based on the logic that wars are the result of geopolitical events and are therefore relatively exogenous with respect to the current state of the macroeconomy. Based on data from the US between 1939 and 2008, Ramey (2011) estimates that the multiplier ranged between 0.6 and 1.2. In other words, an additional dollar of government spending is associated with an increase in GDP of $0.60 to $1.20.

The most recent research has focused on the state-dependency of the government spending multiplier. Auerbach and Gorodnichenko (2012) find that the multiplier is as high as 2.5 in recessions, while it is close to zero during expansions. In contrast, Ramey

[2] See Galí (2008) for an introduction.
[3] Also see Galí (2008) for a primer.

and Zubairy (2018) estimate that the multiplier is below unity irrespective of the amount of slack in the economy.

While most public debate on fiscal stimulus focuses on government spending, recent research shows that the tax multiplier is larger. Romer and Romer (2010) sort legislated tax changes in the US into endogenous and exogenous bins and find a multiplier of nearly -3. That is, an additional dollar of government revenue raised through taxation is associated with a decrease in GDP of up to $3. Cloyne (2013) constructs a series of exogenous tax changes in the United Kingdom between 1945 and 2009, which yielded a tax multiplier of -2.5. Similarly, Hayo and Uhl (2014) replicate the approach for Germany and find a multiplier of -2.4.

Technology

There is little consensus on the contribution of technology shocks to business cycle fluctuations. The problem lies in the measure of technology. Patents, for example, suffer from a long, sometimes infinite, lag between the granting of the patent and the appearance of the product on the market, and also reflect changes in patent laws and the resources of the patent office. Alexopoulos (2011) constructs a new indicator based on the number of new book titles on the subject of technology published in each year. This measure of technology shocks is positively associated with GDP, total factor productivity (TFP), investment and hours, accounting for almost half of all output volatility in the US between 1955 and 1997.

Energy

The importance of energy shocks to the macroeconomy became apparent in the 1970s. There has been a lot of research since on the role of oil prices, in particular. Hamilton (1983), for example, found that most post-war recessions in the US were preceded by increases in the price of crude oil. Similarly, Shapiro and Watson (1988) estimated that oil shocks accounted for 11 per cent of output volatility at the 20 quarter horizon in the US between 1951 and 1987.

Credit

Credit shocks can be thought of as those that affect the cost of credit intermediation (CCI). Bernanke (1983) defines the CCI "as being the cost of channelling funds from the ultimate savers/lenders into the hands of good borrowers. The CCI includes screening, monitoring, and accounting costs, as well as the expected losses inflicted by bad borrowers." As the CCI is a nebulous concept that is not directly observable it is often proxied. One approach is to look at the excess bond premium. In this spirit, Gilchrist and Zakrajsek (2012) find that a one standard deviation increase in this variable is followed by a 0.5 per cent decrease in real GDP after five quarters in the US. These credit shocks explain more than 10 per cent of the variance in output. Another proxy is to look at banking crises on the basis that bank failures are events that abruptly impact the CCI, as has been discussed in relation to the Great Depression (Carlson and Rose, 2015).

Uncertainty

The literature on the macroeconomic effects of uncertainty has boomed in recent years.[4] As with shocks to the CCI, uncertainty is not directly observable but approximated by other measures. An interesting approach has been to construct indices based on the frequency of words associated with uncertainty in newspapers. Baker et al. (2016) construct a monthly index of economic policy uncertainty for the US economy between 1900 and the present based on articles in 10 newspapers. The authors find that output fell in the US (based on a sample that spans 1985-2014) by up to 1.1 per cent following an uncertainty shock that was orthogonal to the current state of the economy and equal in size to the increase in uncertainty around the recent financial crisis.

Labour Supply

A labour supply shock affects the macroeconomy through employment and real wages. Shapiro and Watson (1988) estimate that these shocks accounted for as much as 62 per cent of output volatility in the US between 1951 and 1987. The shocks were identified using a structural vector autoregression with long-run restrictions.

Microeconomic Origins

The microeconomic origins of macroeconomic fluctuations is an exciting new topic. Just as Slutzky observed cyclical variations in the sum of random time series, the idea is that aggregate fluctuations are built up from variation at the microeconomic level, such as at the level of the industry, sector or region. At the industry level, Garin et al. (2018) find that aggregate shocks account for only 30 per cent of the variance of American output since 1983, which implies that industry-specific shocks are the major driver of fluctuations. At the sectoral level, idiosyncratic shocks may not wash out but lead to aggregate fluctuations if sectors are interconnected by input-output linkages (Acemoglu et al., 2012) or if sectors are sufficiently dominant (Acemoglu et al., 2017). At the regional level, Beraja et al. (2016) find that regional fluctuations during the Great Recession in the United States did not square with aggregate fluctuations.

Historical

The major reviews of British economic fluctuations between the Industrial Revolution and the Second World War identify a number of causes. The first major cause of fluctuations in the British economy was the agricultural sector. Agriculture was particularly important in the eighteenth century when approximately 30 per cent of value added was directly derived from the sector (Broadberry et al., 2015). Ashton (1955, p. 62) notes that "among the causes of instability of economic life in this century variations in the yield of the soil must be given first place." Despite agriculture's declining importance in the nineteenth century, Solomou (1994, pp. 263-4) finds that

[4] See Bloom (2014) for a recent literature review.

there was a significant correlation between fluctuations in agricultural output and aggregate economic activity as late as 1890, although the association faded soon after.

The second major cause of economic fluctuations was war. Ashton (1959, p. 136), for example, argues that war and domestic conflict explain many of the major panics of the eighteenth century. Aldcroft and Fearon (1972, p. 57) also note:

> The most influential type of shock has undoubtedly been that of war, the only one of sufficient strength to upset cyclical patterns substantially. The French and Napoleonic Wars certainly distorted the cyclical pattern in Britain up to 1815, though precisely in what way is more difficult to say because we have only a hazy notion of what went before. The impact of the First World War was even greater since it was global in its effects and had repercussions for many years afterwards.

Interestingly, these writers both note the exogenous nature of war in this period, describing them as "bolts from the blue" (Ashton, 1959, p. 136) and as "random shocks" (Aldcroft and Fearon, 1972, p. 56), which is consistent with later writers such as Ramey and Shapiro (1998) for American wars in the second half of the twentieth century.

The third major cause of fluctuations was banking crises. Banking crises were commonplace in the eighteenth (Hoppit, 1986) and nineteenth (Turner, 2014) centuries. Ashton (1959, p. 114), Hicks (1982, p. 335) and Hoppit (1986) all associated these events with spikes in the number of bankruptcies. The latter, for example, found that "from 1772 crises were always marked by a substantial and quick surge in the numbers of bankrupts."

The fourth (and highly contentious) cause of fluctuations was monetary policy (Sayers, 1976; Aldcroft and Fearon, 1972; Goodhart, 1972; Andréadès, 1966; Ford, 1962; Pesmazoglu, 1951; Tinbergen, 1950). Although monetary policy was not used to actively stabilize the economy until the interwar period, inadvertent changes in the stance of policy may still have had economic consequences.

According to previous research, the other causes of fluctuations were exports and investment. Gayer et al. (1975, p. 532), in particular, stress "two factors, above all others, could usefully be said to have had a causal significance in British business cycles during this period: the volume of exports and the volume of domestic investment." However, I find this explanation unconvincing because exports and investment are not primitive shocks (Ramey, 2016). They are endogenous variables that respond to more fundamental factors.

Context

Geography

The unit of analysis in this dissertation is the United Kingdom. Over the three centuries studied, however, there have been a couple of significant border changes so that the

United Kingdom has meant different things at different times. At the beginning of the sample period in 1750, the British Isles were divided into the Kingdom of Great Britain, which consisted of England, Scotland and Wales, and the Kingdom of Ireland, which was made up of modern-day Northern Ireland and the Republic of Ireland. In 1800 political integration in the British Isles reached a high water mark with the Act of Union to form the United Kingdom of Great Britain and Ireland. From the formation of the Irish Free State in 1921 until the end of the sample period in 1938, the union has been reduced to the United Kingdom of Great Britain and Northern Ireland. In each of the component chapters, the analysis applies to the United Kingdom within the borders that applied during the respective sample period. Appropriate data is therefore used to control for the changing composition of the unit of analysis, such as using break-adjusted GDP data.

Economic Growth

The period under investigation begins around the onset of the Industrial Revolution. This was a turning point marking the end of the relatively slow growth of the preceding centuries and the start of modern economic growth. Older vintages of British national accounts pointed to a rapid take-off in economic growth in this period (Deane and Cole, 1962), but today the consensus view, beginning with the work of Harley (1982) and Crafts (1983) and confirmed by the most recent estimates of Broadberry et al. (2015), is that this was a time of modest, yet sustained, economic growth. Table 1 shows that by the middle of the eighteenth century the UK had become the richest country in the world.[5] Economic growth subsequently advanced by 1.6 per cent per year on average between 1760 and 1855, most of which came from additions to capital and labour, while only 0.2 percentage points came from TFP growth (table 2).

Even as the embers of the Industrial Revolution cooled, the growth of the British economy accelerated to 2.0 per cent per year on average between 1856 and 1913.[6] This growth was also mainly extensive, but TFP growth made a non-trivial contribution of 0.8 percentage points. This period was significant for the relative peace – the so-called *Pax Britannica* – and high levels of monetary and economic integration across borders.

Between the onset of the first and second world wars, economic growth was not only highly volatile but also lower on average than the earlier periods. However, the growth was completely intensive, with TFP growth accounting for the entirety of economic growth in this period. Thus, technological progress advanced quickly in this volatile environment.

Overall, living standards improved significantly between 1750 and 1938, as figure 2 shows. Real GDP per capita increased by 0.7 per cent per year on average, which over almost two centuries amounted to a four-fold increase.

[5] There is a discrepancy between when Bolt et al. (2018) and Broadberry et al. (2015) date the take-over, as the latter notes that Britain took the lead over the Netherlands in 1800.
[6] For a more detailed analysis of growth between 1856 and 1973, see Matthews et al. (1982).

TABLE 1. REAL GDP PER CAPITA, 1750-1938
(1990 GEARY-KHAMIS INTERNATIONAL DOLLARS)

	1750	1855	1913	1938
United Kingdom	1,782	3,132	6,393	8,456
Canada			7,026	7,754
China			881	965
France	1,337	2,055	5,169	5,620
Germany	1,020	1,379	5,587	6,968
India	1,103		1,340	1,466
Italy	1,494	1,312	2,728	3,010
Japan	799		1,852	3,259
Netherlands		2,469	5,482	5,634
Spain	1,665	2,723	4,416	3,539
Sweden	1,310	1,507	4,825	6,236
Switzerland		2,194	5,622	6,467
United States		3,237	8,101	9,797

Source: Bolt et al. (2018).

TABLE 2. GROWTH ACCOUNTING, 1760-1938 (PER CENT PER YEAR)

	$\Delta Y/Y$	Due to Capital	Due to Labour	TFP Growth
1760-1855	1.6	0.7	0.7	0.2
1856-1913	2.0	0.8	0.4	0.8
1914-38	1.0	0.2	-0.2	1.0

Notes: Weights used are $K = 0.4$,$L = 0.6$ as in Crafts (1995). Reasonable alternatives, such as $K = 0.5$,$L = 0.5$ as in Crafts and Harley (1992), do not materially affect the results. The periodization is partly informed by data availability.
Source: Thomas and Dimsdale (2017).

Economic Fluctuations

This section chronicles the major turning points of the business cycle between the Industrial Revolution and the Second World War. Figure 3 shows the UK business cycle between 1750 and 1938. The cycle represents log deviations from trend real GDP, as determined by a Maximum Overlap Discrete Wavelet Transform with a Daubechies 4 wavelet filter.[7] This approach enables the estimation of cycles in the presence of structural breaks, outliers and other non-recurring events.

The earliest major decline in the sample is 1794. There is some disagreement in the literature as to when the trough was reached. Broadberry et al. (2012) are in agreement that it came in 1794, while Gayer et al. (1975) and Rostow (1972) date it as falling in

[7] See Andersson (2016) and Percival and Walden (2006) for a primer.

1793. The downturn coincided with the banking panic of the same year when 26 country banks failed (Gayer et al., 1975).

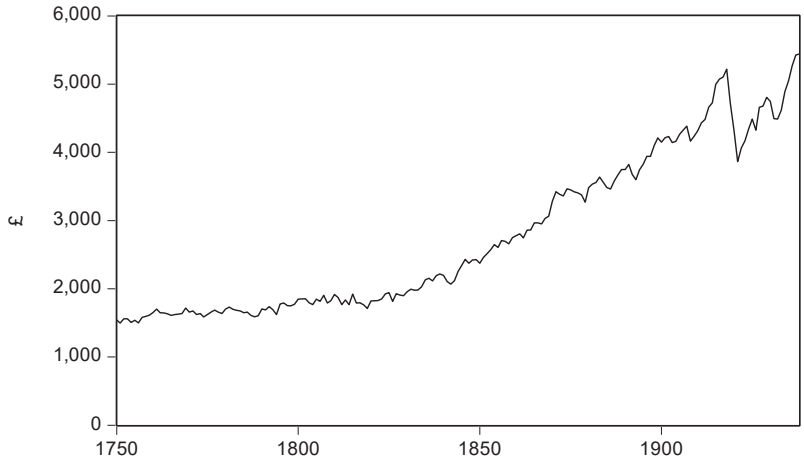

FIGURE 2. REAL GDP PER CAPITA, 1750-1938
Note: Chained composite measure at factor cost. The reference year is 2013.
Source: Thomas and Dimsdale (2017).

Financial instability was a recurring source of economic volatility. In 1819, for example, moderate financial stress (Bordo et al., 2003) was associated with a cyclical decline of 3.7 per cent. Crisis returned in 1825 and 1826. According to Turner (2014, pp. 53-4, 62), this crisis ranks alongside 2007/8 as the most severe in modern British history in terms of financial distress and lost output. Indeed, economic activity slumped by 5.3 per cent in 1826.

The beginning of Robert Peel's second term in government saw a slump in economic activity. According to Bordo et al. (2003), the "severe depression" of 1841 was associated with tight money and many bank failures. The slump continued into 1842, which was a year of unrest with riots and a general strike that affected the key industries of coal and textiles. This also coincided with the introduction of the first peacetime income tax in Britain. Given the convincing evidence discussed earlier on the size and sign of the tax multiplier, this may well have been a causal factor.

1921 saw economic activity contract by more than 10 per cent, which is the sharpest year-on-year decline since 1750. There were a number of interesting aspects to this depression. The first is the separation of the Irish Free State from the United Kingdom. The second is the miners' strike that began at the end of March 1921. The third is the contractionary monetary policy pursued to return to the gold standard at the pre-war parity. Bank Rate increased from 5 per cent in the wake of the First World War to 7 per

cent. The deflation that followed led to extraordinarily high real interest rates (Chadha and Dimsdale, 1999).

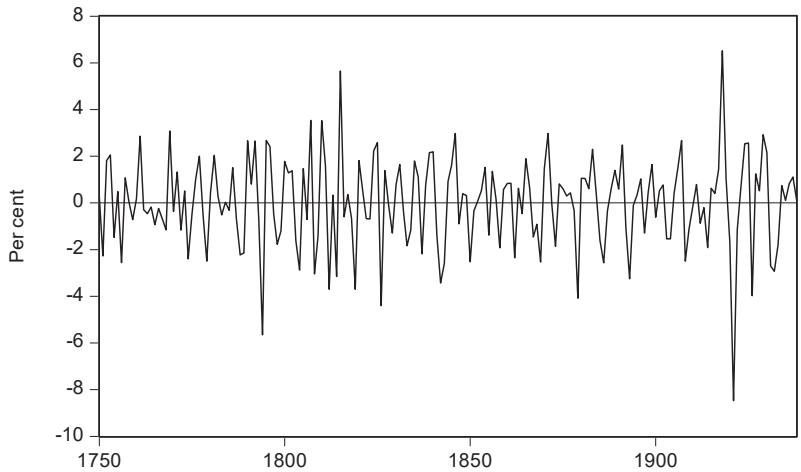

FIGURE 3. UK BUSINESS CYCLE, 1750-1938
Note: Log real GDP at factor cost decomposed into a 2 to 8 year cycle using a MODWT with a Daubechies 4 wavelet filter.
Source: Thomas and Dimsdale (2017).

The British economy fell into recession in 1931, contracting by 5 per cent. In a cross-sectional context, the UK was rocked less than other countries in this period, such as Germany and the United States; in a time-series context, however, it was a severe episode in British economic history. In September 1931, with unemployment of 22 per cent and the price level down at less than a third from the peak in 1920, Britain abandoned the gold standard. However, the Bank of England's policy rate remained at 6 per cent until February 1932. After which monetary policy was eased in steps to 2 per cent in the summer, a nadir at which it remained until the outbreak of the Second World War. Unemployment and the price level began to recover from the mid-1930s. It is unlikely that this was due to Keynesian stimulus, as the government spending multiplier was less than unity (Crafts and Mills, 2013, 2015).

Data

The data used in this dissertation is collected from a range of sources. In each chapter, new data is typically used. A detailed description of the sources and methods involved

in the construction is given in the relevant chapter. The chapters also draw upon a range of secondary sources of data. Again, a discussion of each is given in the respective chapter. However, a recurring source of secondary data is the Bank of England's *A Millennium of Macroeconomic Data* for the UK (Thomas and Dimsdale, 2017). This data set collates and links the highest quality macroeconomic data for the United Kingdom between 1086 and 2016. This data has been used extensively elsewhere, while more discussion can be found in Dimsdale et al. (forthcoming) and Hills et al. (2010).

Methodology

This section introduces the issue of endogeneity and the methods used to overcome it in the literature, from basic vector autoregression (VAR) models to the latest structural vector autoregression (SVAR) and narrative identification methods that are used in this dissertation.

Endogeneity and the Macroeconomy

A major challenge in empirical macroeconomics is the endogeneity of most variables of interest. For example, consider the challenge of analysing the relationship between government spending and output – a subject of heated debate since the interwar period. On one hand, it is possible that changes in government spending cause changes in output (i.e., the fiscal multiplier is non-zero), while on the other hand, changes in output might cause changes in government spending due to either the automatic stabilizers, such as unemployment benefits, or discretionary fiscal policy. This simultaneity leads to serious problems for the workhorse econometric model: ordinary least squares (OLS).

In order to gauge the size and sign of the bias, consider a simple model of the determinants of output:

$$Y_t = \beta G_t + \varepsilon_t^Y \tag{2}$$

and government spending:

$$G_t = \gamma Y_t + \varepsilon_t^G \tag{3}$$

where Y_t is output and G_t is government spending. ε_t^Y is the error term in the output equation and is a function of various macroeconomic shocks, such as demand and supply shocks. ε_t^G is the error term in the government spending equation and captures changes unrelated to output, such as political ideology. The constants have been suppressed for simplicity.

In this set-up, a shock to ε_t^Y will impact G_t in equation 2 via equation 3. This introduces a correlation between the independent variable and the error term in equation 2. Recall a variant of the textbook formula for the OLS estimate of β:

$$\hat{\beta} = \beta + \frac{Cov(G_t, \varepsilon_t^Y)}{Var(G_t)} \tag{4}$$

The formula shows that the *estimate* of the true parameter of interest, $\hat{\beta}$, is equal to the true parameter, β, plus the aforementioned correlation. As a result, simple estimation of β by OLS will lead to biased estimates, unless the variance of G_t is explosive.

The direction of the bias depends on the signs of β and γ. If fiscal policy is countercyclical so that $\gamma < 0$, a negative output shock to ε_t^Y will increase G_t in equation 2 through equation 3. If the fiscal multiplier is positive so that $\beta > 0$, it is easy to see from equation 4 that $\hat{\beta}$ will be biased *downwards* since the covariance between G_t and ε_t^Y is negative.

VARs

VAR models have been a popular solution to the endogeneity issue. "A VAR is an n-equation, n-variable linear model in which each variable is in turn explained by its own lagged values, plus current and past values of the remaining $n-1$ variables (Stock and Watson, 2001)." In order to gauge the basic idea and associated issues, let's continue with the example from above and extend to allow for dynamics by including one lag of the dependent and independent variables:

$$Y_t = \beta_1 G_t + \beta_2 Y_{t-1} + \beta_3 G_{t-1} + \varepsilon_t^Y \tag{5}$$

$$G_t = \gamma_1 Y_t + \gamma_2 Y_{t-1} + \gamma_3 G_{t-1} + \varepsilon_t^G \tag{6}$$

Simple OLS estimation of these equations will still lead to biased estimates of the parameters of interest. However, a little manipulation seemingly overcomes this problem. Collecting the contemporaneous variables from equations 5 and 6 on the left-hand side:

$$Y_t - \beta_1 G_t = \beta_2 Y_{t-1} + \beta_3 G_{t-1} + \varepsilon_t^Y \tag{7}$$

$$G_t - \gamma_1 Y_t = \gamma_2 Y_{t-1} + \gamma_3 G_{t-1} + \varepsilon_t^G \tag{8}$$

In matrix notation this becomes:

$$\begin{bmatrix} 1 & -\beta_1 \\ -\gamma_1 & 1 \end{bmatrix} \begin{bmatrix} Y_t \\ G_t \end{bmatrix} = \begin{bmatrix} \beta_2 & \beta_3 \\ \gamma_2 & \gamma_3 \end{bmatrix} \begin{bmatrix} Y_{t-1} \\ G_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_t^Y \\ \varepsilon_t^G \end{bmatrix} \tag{9}$$

Pre-multiplying both sides by the matrix of coefficients on the left-hand side:

$$\begin{bmatrix} Y_t \\ G_t \end{bmatrix} = \begin{bmatrix} 1 & -\beta_1 \\ -\gamma_1 & 1 \end{bmatrix}^{-1} \begin{bmatrix} \beta_2 & \beta_3 \\ \gamma_2 & \gamma_3 \end{bmatrix} \begin{bmatrix} Y_{t-1} \\ G_{t-1} \end{bmatrix} + \begin{bmatrix} 1 & -\beta_1 \\ -\gamma_1 & 1 \end{bmatrix}^{-1} \begin{bmatrix} \varepsilon_t^Y \\ \varepsilon_t^G \end{bmatrix} \tag{10}$$

And rearranging to give the reduced-form VAR:

$$\begin{bmatrix} Y_t \\ G_t \end{bmatrix} = \begin{bmatrix} \phi_2 & \phi_3 \\ \varphi_2 & \varphi_3 \end{bmatrix} \begin{bmatrix} Y_{t-1} \\ G_{t-1} \end{bmatrix} + \begin{bmatrix} \epsilon_t^Y \\ \epsilon_t^G \end{bmatrix} \tag{11}$$

The reduced-form VAR therefore omits the contemporaneous values of the independent variables.

To estimate the dynamic response of a given variable to a change in another, the standard practice is to estimate impulse response functions (IRFs). To continue with the current example, the impulse response of output to a change in government spending at horizon h is:

$$\frac{\delta Y_{t+h}}{\delta \epsilon_t^G} \tag{12}$$

Note, however, that the reduced-form errors, ϵ^j, are composites of the structural errors, ε^j. $\epsilon_t^Y = \frac{1}{1-\beta_1\gamma_1}(\varepsilon_t^Y + \beta_1\varepsilon_t^G)$, for example, while $\epsilon_t^G = \frac{1}{1-\beta_1\gamma_1}(\gamma_1\varepsilon_t^Y + \varepsilon_t^G)$. As a result, a shock is not, in fact, a government spending shock, but a weighted average of the output and government spending shocks.

SVARs

There are a number of ways of identifying the underlying structural shocks. The most common approach is a Cholesky decomposition (Ramey, 2016). First introduced by Sims (1980), this involves imposing a set of assumptions on the temporal ordering of the variables based on economic theory. In general, this boils down to setting n

structural shocks to zero. In the case of government spending, for example, Blanchard and Perotti (2002) assume that government spending does not contemporaneously react to movements in output (i.e., $\gamma_1 = 0$).

In theory, the Cholesky decomposition is appealing by construction. In practice, however, it can suffer from a number of shortcomings. First, to return to our example, while policymakers might respond to output movements with a lag, the automatic stabilizers surely violate the assumption that there is no contemporaneous effect of changes in output on government spending.

Second, the assumption of no contemporaneous feedback is less likely to hold with low frequency data. With monthly data, for example, the restriction reasonably assumes that HM Treasury does not respond to output changes within the month, but with annual data the restriction assumes that it does not react within the year.

Third, the government spending shock is essentially the movement in government spending that is orthogonal to the final vintage of GDP data. However, Orphanides (2001) argues that policymakers do not have access to ex-post revised GDP data when making decisions but rather forecasts and observable proxies. As a result, the policymaker's reaction function is misspecified and the residuals are therefore an imperfect source of exogenous variation. In the case of monetary policy, this problem has been associated with the "price puzzle" – the increase in prices following a contractionary monetary policy shock (Cloyne and Hürtgen, 2016; Romer and Romer, 2004).

Narrative Identification

An alternative solution to the endogeneity problem is the narrative approach. "Narrative methods involve constructing a series from historical documents to identify the reason and/or the quantities associated with a particular change in a variable (Ramey, 2016)." While examples in the literature are relatively sparse, narrative methods have been used to identify primitive shocks such as banking panics (Jalil, 2015) and oil shocks (Hamilton, 1985), as well as policy shocks such as those to government spending (Ramey and Zubairy, 2018; Ramey, 2011; Ramey and Shapiro, 1998), monetary policy (Cloyne and Hürtgen, 2016; Romer and Romer, 2004; Romer and Romer, 1989), tax changes (Hayo and Uhl, 2014; Cloyne, 2013; Romer and Romer, 2010) and transfers (Romer and Romer, 2016).

The mechanics of the narrative approach are straightforward. Firstly, the narrative record (contemporary newspapers, reports, speeches etc.) is used to identify the size, timing and reasons for a given macroeconomic shock. Each shock is then classified as endogenous or exogenous. The classification relies on identifying those changes in the independent variable of interest that are not contemporaneously correlated with other determinants of the dependent variable. To return to the government spending example, exogenous shocks are those for which $Cov(G_t, \varepsilon_t^Y) = 0$. Finally, macroeconomic variables of interest are then regressed on the new series of exogenous shocks.

An alternative narrative approach is to estimate 3, where Y_t is not the final vintage of GDP data but the forecasts of GDP available to the policymakers at the time of each decision and G_t is not actual government spending but planned expenditure. The residuals from this regression can be used in place of G_t in equation 2 to yield unbiased estimates of β. This is the approach followed in the monetary policy literature (Cloyne and Hürtgen, 2016; Romer and Romer, 2004). An advantage of the quantitative narrative approach is that it avoids human error in classifying endogenous and exogenous shocks.

A related identification method is the external instrument or proxy SVAR. The idea behind this approach is that the narratively-identified shock is an imperfect measure of the true shock. However, it is likely to be correlated with the true shock while simultaneously uncorrelated with other structural shocks. As such, it satisfies both the instrument relevance and exogeneity conditions. Mertens and Ravn (2014) incorporate the Romer and Romer (2010) tax shock into a proxy SVAR, while Ramey and Zubairy (2018) extend and include Ramey's (2011) defence news as an instrument in a local projections framework.[8]

Results

The main results of the dissertation are presented in five chapters. The first two chapters study the micro origins of economic fluctuations. The third, fourth and fifth chapters investigate the macro origins of economic fluctuations.

Monetary Aggregates for Ireland

This chapter constructs new monthly estimates of the narrow money supply and annual estimates of the broad money supply for Ireland between 1840 and 1921. The aggregates were constructed from a range of archival sources and contemporary publications. A controversial hypothesis in economic history is that Ireland was vulnerable to exogenous shocks because it had underdeveloped monetary and financial systems (Mokyr, 1985; Lynch and Vaizey, 1960) with the Great Famine of the 1840s used as a classic example. By standard measures of monetary and financial development, the new estimates show that Ireland led other countries in its European peer group on the eve of the Famine, such as Norway and Sweden, and was decades ahead of others, such as the Netherlands. Other results that emerge from the data are that there was an unprecedented monetary contraction during the Famine and that the failure of the Munster Bank in 1885 was not an isolated event (Ó Gráda, 2012), but a banking crisis.

[8] See Ramey (2016) for a description of other identification methods such as long-run and sign restrictions, estimated DSGE models, factor-augmented VARs and high-frequency identification.

Irish GDP between the Famine and the First World War

A major issue in Irish economic history is the lack of national accounts before the interwar period. The fundamental problem is the scarcity of data for the underlying components of traditional historical national accounts. This chapter develops a new two-stage methodology to estimate the volume of economic activity in data-scarce contexts. The first stage estimates a dynamic factor model for a set of time series representing a wide range of economic activity. However, the factors are unitless and have no economic interpretation. The second stage, therefore, normalizes the factors using existing benchmarks of GDP, which gives the factors an economic interpretation.

A number of results emerge from the new annual estimates of Irish real GDP between 1842 and 1913. First, living standards effectively tripled between the Famine and the First World War. Second, the volume of economic activity fell by 21 per cent during the Great Famine, which is the largest contraction in the known economic history of Ireland (Gerlach and Stuart, 2015). Third, from the late 1890s to the Great War, the standard of living declined. This slump may have been related to the political uncertainty associated with the possibility of Irish independence.

As a proof of concept, we also apply the new method to Swedish data. Not only are the Swedish historical national accounts relatively accurate, but the two economies were similar in this period. This experiment shows that the methodology captures both the short- and long-run movements in existing estimates of real GDP, demonstrating that this method is a viable alternative to traditional historical national accounts.

Did Monetary Policy Matter?

As the "conductor" of the classical gold standard (Eichengreen, 1987), the Bank of England's discount rate was set not to stabilize employment or prices but to maintain a fixed exchange rate. How did these changes in monetary policy affect the economy? Contemporaries and economic historians have long asked this question, reaching a diverse set of answers. Andréadès (1966, p. 316), for example, argues that it had "very injurious effects", while Sayers (1976, p. 44) concludes that it "did not matter".

In this chapter, I provide new estimates of the causal effects of monetary policy on the British economy during the classical gold standard. However, identifying these effects is challenging because monetary policy is not exogenous. In order to resolve this empirical challenge, I use archival sources to reconstruct the Bank of England's real-time information set for all 1,257 monetary policy decisions. In the first stage, I regress the change in Bank Rate on this information set. The residuals from this regression are used to construct an exogenous measure of monetary policy. In the second stage, I include the new series in a VAR to measure the macroeconomic effects of monetary policy.

The new exogenous series of monetary policy is associated with an economically and statistically significant effect on the macroeconomy. Following a one percentage point monetary tightening, unemployment rose by 0.9 percentage points and inflation fell by 3.1 percentage points. This evidence augments the existing literature by resolving the

price puzzle and by documenting the large real effects of monetary policy. The results are robust to more than a dozen checks, including different specifications of the first and second stage regressions and controlling for outliers.

The consensus is that monetary disturbances were not a major source of economic fluctuations in the United Kingdom (Catao and Solomou, 1993; Capie and Mills, 1991). However, I find that monetary shocks accounted for a third of macroeconomic volatility. In the aftermath of the 1907 crisis, for example, my findings suggest that monetary policy raised unemployment by approximately half a million people.

Uncertainty and the Great Slump

The interwar period in Britain is of major interest in the historiography. Conventional accounts of the slump have focused on a number of shocks on both the supply side, such as the reduction in hours worked, and on the demand side, such as the overvaluation of the pound (Solomou, 1996; Broadberry, 1986). However, contemporary businessmen, journalists and politicians cited another factor: uncertainty over economic policy. It is plausible that economic policy uncertainty was important in this period given the volume of extraordinary political events, such as snap general elections, hung parliaments, tariffs and the use of unconventional fiscal and monetary policies.

This chapter revisits the old uncertainty hypothesis using a new narrative index of economic policy uncertainty constructed from the archives of the *Daily Mail*, *The Guardian* and *The Times*. The index confirms that the interwar period was indeed a time of heightened uncertainty. Local projections show that a major uncertainty shock, such as that associated with the break from the gold standard in 1931, reduced output by 2.8 per cent, raised unemployment by 2.0 percentage points and accounted for a fifth of macroeconomic volatility. I also extend the model to identify the *causal* effect using a novel approach based on the narrative record, which reinforces the baseline results.

The Macroeconomic Effects of Banking Crises

How do banking crises affect the economy? This is an important question in light of the outbreak of banking crises around the world in 2008 (Laeven and Valencia, 2012). This chapter answers this question by studying banking crises in the United Kingdom between the Industrial Revolution and the Second World War. To do so, we develop a new annual measure of banking crises by reconstructing the proportion of the banking system suffering runs and failures.

The new series reveals fresh insights about the history of banking crises in the United Kingdom. A number of commonly cited episodes such as 1847, 1878, 1890 and 1914 were not associated with a critical mass of bank failures, while other episodes that have been overlooked were, such as 1841 and 1930. The crises of 1815-6 and 1825-6 were extremely severe, involving more than 100 failures each.

Armed with the new series, we investigate how bank failures affect the economy. We find evidence of nonlinearities, where a cluster of bank failures when there are few

others raises economic activity, which is consistent with creative destruction. Whereas the same cluster of failures when there are many others reduces output, which is in line with previous research on the large economic consequences of severe disruptions to the banking system. These results are robust to a number of checks, such as controlling for potentially confounding factors, changing the econometric specification and the definition of our crisis indicator.

As banking crises may not only affect, but may also be affected by, economic activity, we also attempt to identify the causal effect of banking crises. Using the narrative record to classify endogenous and exogenous crises, we find that the causal effects of banking crises are slightly larger than the baseline estimate.

Discussion

Microeconomic Origins of Business Cycles

This dissertation is connected to an exciting literature that studies the microeconomic origins of business cycles. This research suggests that idiosyncratic shocks at the micro level can have aggregate implications if the industry, sector or region is large or interconnected. In chapters 1 and 2, I study economic fluctuations in Ireland, which was an important region in the United Kingdom. In 1861, for example, Ireland was the second largest region in the United Kingdom in terms of its regional share of GDP. In this section, I focus on the aggregate implications of the new regional statistics.

Table 3 shows the correlation matrix for cycles in the Irish and UK broad money supplies between 1870 and 1921. The cycles have been estimated using a Maximum Overlap Discrete Wavelet Transform with a Daubechies 4 wavelet filter. The diagonal elements are standard deviations and the off-diagonal element is the correlation coefficient. The results show that while the Irish and UK money supplies were highly correlated ($r = 0.70, p < 0.01$), the Irish money supply was 35 per cent more volatile than the UK money supply. The high correlation is unsurprising as the United Kingdom was a currency area in this period, sharing a common currency and monetary policy.

TABLE 3. CORRELATION MATRIX OF CYCLICAL FLUCTUATIONS IN IRISH AND UK BROAD MONEY SUPPLIES, 1870-1921

	Ireland	United Kingdom
Ireland	0.029	
United Kingdom	0.695	0.021

Source: UK data from Capie and Webber (1985).

Table 4 shows the correlation matrix for cycles in Irish and UK real GDP between 1842 and 1913. There are two main results. The first is that economic activity was 65

per cent more volatile in Ireland than in the UK. The second is that there was a positive, although not statistically significant, correlation ($r = 0.17, p = 0.15$) between Irish and UK economic activity.

TABLE 4. CORRELATION MATRIX OF CYCLICAL FLUCTUATIONS IN IRISH AND UK REAL GDP, 1842-1913

	Ireland	United Kingdom
Ireland	0.025	
United Kingdom	0.173	0.015

Source: UK data from Thomas and Dimsdale (2016).

There are a number of implications of this exercise. First, the fact that economic activity was more volatile in Ireland than the United Kingdom implies that volatility in the aggregate was made up of more and less volatile regions. As Ireland was more volatile than the aggregate, Britain must have been less volatile. An interesting consequence of this result is that the formation of the Irish Free State would have stabilized aggregate economic activity in the United Kingdom.

Second, since the Irish economy is only imperfectly measured in existing statistics for the United Kingdom, it is interesting to assess how the new aggregates for Ireland affect our understanding of fluctuations in the United Kingdom. As part of the Bank of England's *A Millennium of Macroeconomic Data* project, Thomas and Dimsdale (2017) construct a new measure of GDP for the United Kingdom by combining recent GDP estimates for Britain (Broadberry et al., 2015) with the new GDP estimates for Ireland. The cyclical component of the sum of the British and Irish series is 4.3 per cent more volatile than the cycle of the old UK series, implying that the volatility of economic fluctuations in the United Kingdom was greater than has been understood.

Third, an important criteria for an optimal currency area is regional business cycle synchronization (Frankel and Rose, 1998). While table 3 shows that the currency area in the United Kingdom led to highly integrated monetary systems, table 4 implies that business cycles in Ireland and the rest of the UK were essentially uncorrelated. If two regional business cycles are orthogonal, a common monetary policy cannot be appropriate for both at the same time. In addition, in times of crises, fiscal policy did not always redistribute funds to stabilize regions. At the height of the Great Famine in 1847, for example, relief funding to Ireland was cut (Read, 2016). This implies that the United Kingdom was not an optimal currency area. At best, UK economic policy did not help stabilize economic activity in Ireland. At worst, it may have been destabilizing.

Macroeconomic Origins of Business Cycles

This dissertation is also connected to a literature that studies the macroeconomic origins of business cycles. I investigate the causal effect of monetary policy, economic policy uncertainty and banking crises on the economy. An interesting implication of my results

is the remarkable constancy of the elasticities of various macroeconomic variables to these shocks across both time and space. In terms of monetary policy, the elasticities for the classical gold standard are between those found for the modern UK (Cloyne and Hürtgen, 2016) and US (Romer and Romer, 2004) economies. In terms of economic policy uncertainty, my results for interwar Britain are in the same ballpark as those obtained for the post-war American economy (Baker et al., 2016; Alexopoulos and Cohen, 2015). In terms of banking crises, the output losses accrued between the Industrial Revolution and the Second World War are of the same order of magnitude to those in the United States in the century before the Great Depression (Jalil, 2015).

In my view, the best way to interpret this finding is not that the size of the elasticities are universal constants but that the signs are likely to hold in most contexts. Tight monetary policy, heightened economic policy uncertainty and banking crises are likely to always and everywhere be contractionary. Indeed, this knowledge enables us to stabilize the economy in the future by counteracting contractionary shocks, such as greater uncertainty, with expansionary shocks, such as looser monetary policy.

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Paper I

THE
ECONOMIC HISTORY REVIEW

Economic History Review, 00, 0 (2018), pp. 1–21

Monetary aggregates for Ireland, 1840–1921†

By SEÁN KENNY and JASON LENNARD*

This article constructs new monetary aggregates for Ireland between 1840 and 1921. Three major findings are gleaned from the data. First, we find that the degree of monetization on the eve of the Famine was comparatively high. Second, we find an unprecedented monetary contraction during the Famine. Third, in contrast to previous research, we find that the failure of the Munster Bank in 1885 had ramifications for confidence in, and the stability of, the banking system.

This article presents new monthly estimates of the narrow money supply and annual estimates of the broad money supply in Ireland between 1840 and 1921. The aggregates are constructed from a range of archival sources and contemporary publications. The period under investigation covers the Great Famine, the agricultural depressions of the late 1850s and 1870s, the failure of the Tipperary and Munster banks, and the First World War. It was also a time of rising living standards, as reflected in measures such as wages, consumption, literacy, life-span, height, and birth weight.[1]

This article is partly motivated by an old debate regarding the degree to which Ireland was monetized and financially developed on the eve of the Famine.[2] It has been argued that it was underdevelopment in this regard that left the country vulnerable to exogenous shocks. The article is also motivated by the dearth of macroeconomic time series before the interwar period. A notable example here is the lack of annual national accounts. In recent years, however, new data have been constructed for the stock market, the grain trade, and the production of various goods, among others.[3] This growing body of research sheds much-needed light on the Irish economy in the nineteenth century.

The new data build on earlier work by O'Rourke, who summed notes in circulation and gross deposits for this period, by adding series for coins and reserves, which varied in importance over time, as well as correcting the deposit series for adjustment items and missing banks.[4] It also contributes to the recent

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† Earlier versions of this article were presented at the Sound Workshop in Lund, the Irish Quantitative History Group Annual Meeting at Trinity College Dublin, and the Economic History Society's Annual Conference at the University of Cambridge. Thanks to Eoin Drea, Dennis and Valerie Fairbrass, Frank Geary, Lars Jonung, Liam Kennedy, Eoin McLaughlin, Antoin Murphy, Anders Ögren, Cormac Ó Gráda, Philip Ollerenshaw, Sarah Poutch, John Turner, the National Library of Ireland, and the Bank of Ireland for help and comments.

[1] Ó Gráda, *Ireland*, p. 250.

[2] Lynch and Vaizey, *Guinness's brewery*; Mokyr, *Why Ireland starved*.

[3] Hickson and Turner, 'Pre- and post-Famine indices'; eisdem, 'Rise and decline'; Grossman, Lyons, O'Rourke, and Ursu, 'Monthly stock exchange index'; Brunt and Cannon, 'Irish grain trade'; Bielenberg, *Ireland.*

[4] O'Rourke, 'Monetary data'.

revival of interest in monetary history. For Ireland, consistent monetary statistics have been compiled for the period 1933 to 2012 by Gerlach and Stuart.[5] In combination with the estimates provided in this article, the growth and development of the monetary system can now be traced back more than 175 years. Internationally, new monetary aggregates have recently been constructed for nine Balkan countries, Norway, Sweden, and the UK.[6]

The data yield three major findings. First, we find that, by standard measures, Ireland was comparatively well monetized in 1845. On the eve of the Famine, it was more monetized than other European countries for which data is available, such as Norway and Sweden, and was in fact decades ahead of others, such as Germany and the Netherlands. Similarly, by standard measures of financial development, Ireland was not a backwater, but comparatively advanced. Second, the monetary contraction during the Famine was the biggest fall recorded in Irish monetary history since 1840. The broad money supply collapsed by 27 per cent, the monetary base by 48 per cent, and currency in the hands of the public, the population's liquidity, by more than half. Third, while previous research has argued that there was no fear of systemic collapse after the failure of the Munster Bank in 1885, the new data do point to problems in the banking system. The deposit–currency ratio (a measure of confidence in the banking sector) and the reserve–deposit ratio (an indicator that declines during the early stages of banking panics) plunged during this episode.

The article is organized as follows. Section I describes the economic and monetary context of the times. Section II outlines the construction of the aggregates. In section III the results are presented in three parts: the first compares the new and existing estimates, the second focuses on the low-frequency aspects of the data in terms of growth and development, and the third on the high-frequency aspects in terms of cycles and seasonality. The final section provides some conclusions.

I. Context

I.1. Economic context

According to Mokyr, on the eve of the Great Famine in 1845, Ireland's economic position was 'significantly inferior to other European countries'.[7] As a consequence of the catastrophe, the population declined by 20 per cent between the censuses of 1841 and 1851, and by almost half by the turn of the next century.[8] New benchmarks of national income, however, place Ireland among the world's richest on a per capita basis by 1871.[9] This was still the case toward the end of the sample period in 1911. The role of emigration in the convergence process, however, is a subject of debate.[10] Another puzzle concerning Irish development in the

[5] Gerlach and Stuart, 'Money, interest rates and prices'.

[6] SEEMHN, *South-eastern European monetary and economic statistics*; Klovland, 'Monetary aggregates'; Edvinsson and Ögren, 'Swedish money supply'; Palma, 'Reconstruction of money supply'.

[7] Mokyr, *Why Ireland starved*, p. 11.

[8] O'Rourke, 'Did the Great Irish Famine matter?'.

[9] Geary and Stark, 'Examining'.

[10] O'Rourke and Williamson, 'Around the European periphery'; Ó Gráda and O'Rourke, 'Migration as disaster relief'; Geary and Stark, 'Examining'.

nineteenth century is the sluggishness of occupational structural change. For example, agriculture's share of the labour force in 1911 (47 per cent) was only slightly below the level in 1841 (53 per cent).[11]

One commonly cited explanation for industrial stagnation is a lack of capital investment.[12] Barrow emphasizes that had Irish joint-stock banks been presented with a corresponding volume of good bills or sound loan applications to deposits, savings would have returned into local circulation.[13] However, savings were typically invested for safety rather than growth in government stock, short-term loans or the London discount market, where they may have achieved a higher return.[14] Seen as part of the single economy of the UK, Irish savings flowed to the centre 'whence they would flow out again to where opportunity beckoned'.[15]

I.2. Monetary context

The structure of the Irish banking system in the nineteenth century can trace its roots to a wave of legislation passed in the 1820s, which initiated a move away from a large number of small, undercapitalized partnerships towards a small number of large, well-capitalized joint-stock banks. These retained unlimited liability and could form freely.[16] A condition of the Banking Copartnership Regulation Act of 1825, however, was that these banks could not issue notes if they were based within 65 miles of Dublin. This exclusion zone was attacked continuously as unjust and was even described as 'a modern Pompeii'.[17]

While joint-stock banking legislation applied across the UK, important regional differences emerged which were influenced by monetary culture. The Scottish and Irish systems depended on small notes to a greater degree than gold coin, which banks held purely as a precaution against panic. The law protected this preference despite a ban on notes under £5 in England and Wales in 1826.[18] The Irish banks, uniquely in the UK, were legally obliged to redeem notes at branch in gold due to legislation passed in 1828.[19]

The Bankers (Ireland) Act of 1845 marked the end of this period of relatively competitive banking and the beginning of a new era of stability.[20] The Act can be thought of as an extension of the Bank Charter Act of 1844 to Ireland. It abolished the exclusion zone, prohibited any new banks of issue, and imposed reserve requirements on those that already issued notes. Beyond a fixed fiduciary limit, the note circulation had to be backed one for one with specie, of which no more than £1 in 4 could be in silver coin, with the rest in gold coin. At the time of

[11] Geary, 'Deindustrialization in Ireland'; Geary and Stark, 'Examining'.
[12] Ó Gráda, *Ireland*, p. 349.
[13] Barrow, *Emergence*, p. 194.
[14] Ibid., pp. 196–7; Ó Gráda, *Ireland*, pp. 349–50.
[15] Barrow, *Emergence*, p. 197.
[16] See Hickson and Turner, 'Genesis of corporate governance', for a discussion of legislation concerning Irish commercial banking in this period.
[17] *Freeman's Journal*, 12 June 1838, p. 4; *Freeman's Journal*, 3 Aug. 1839, p. 3. This newspaper had nationalist leanings for most of its existence and therefore may not be considered an impartial source.
[18] Barrow, *Emergence*, pp. 94–5.
[19] Ibid., pp. 170–1.
[20] Ó Gráda, *Ireland*, p. 358.

the Act, seven well-capitalized joint-stock commercial banks existed, with diffused ownership and separation of ownership from control.[21]

At the centre of the system was the Bank of Ireland, which acted as banker to the state, managing the public debt and the exchequer balance.[22] In times of crisis, the Bank behaved like a quasi-central bank. At the end of the 1790s, it acted as lender of last resort, and did so to varying degrees on other occasions, such as in 1826, 1836, 1839, 1847, 1857, 1866, and 1885.[23] In some of these instances, the Bank cooperated with its sister bank, the Bank of England. In 1857, for example, College Green provided £250,000 to other Irish banks, while the Bank of England provided an additional £1.2 million.[24] During these infrequent events, there would have been monetary implications in the form of higher till money (a component of bank reserves) in Ireland at the expense of Britain.

In normal times, the banks of Ireland and England maintained a close working relationship to 'facilitate commercial relations between the two countries'.[25] The Bank of England was appointed its London agents as early as 1821 and the Bank of Ireland continued to consult with the former on issues such as Irish debt finance and banking legislation even after political independence in 1922.[26] Throughout the nineteenth century its interest rate policy was governed by the Bank of England's, and the Irish banks in turn followed the prevailing Bank of Ireland rate.[27]

The relationship between the banks of England and Ireland was linked to the close integration of the two monetary systems. The external base for the growth of circulation and deposits was the net result of money transactions between Ireland and the British exchequer plus the excess of domestic receipts from abroad over domestic payments abroad.[28] For example, farmers typically sold their produce at market to merchants for export. The merchants, in turn, exported the produce to Britain, usually receiving English bills as payment which they presented for discount upon their return to Irish banks.[29] At the end of the process, the Irish banks held a claim on British gold which was cancelled upon receipt of payment for the bills they held until maturity. This ultimately led to a reduction in British reserves and an increase in the reserves of the Irish banks. As savings in rural areas ran ahead of investment and urban demand was insufficient to absorb these external agricultural surpluses, the result was an accumulation of external assets by the Irish banking sector.[30] In the event of trade deficits transpiring, which were presumably extreme during the Famine, this process would have been reversed, resulting in a depletion of Irish reserves.

[21] Bodenhorn, 'Free banking in Ireland'; Hickson and Turner, 'Genesis of corporate governance'.
[22] Hall, *Bank of Ireland*, pp. 190–1.
[23] Ó Gráda, 'Moral hazard'; idem, 'Last major Irish bank failure'.
[24] *Report from the S.C. Appointed to Inquire into the Operation* (P.P. 1858, LXXVIII), p. 285.
[25] Hall, *Bank of Ireland*, p. 136.
[26] Ibid., p. 136; Ó Gráda, *Ireland*, p. 373.
[27] *Report from the S.C. Appointed to Inquire into the Operation* (P.P. 1858, LXXVIII), pp. 267–8.
[28] McGowan, 'Money and banking in Ireland'.
[29] *Report from the Secret Committee of the House of Lords* (P.P. 1848a, VIII), p. 450.
[30] Barrow, *Emergence*, p. 194; McGowan, 'Money and banking in Ireland'.

II. Data and methodology

In this section we discuss the construction of the monetary aggregates. However, in the interest of space, a greater degree of detail is presented in online appendix S1. Interested readers are directed there for a more thorough discussion.

II.1. Definition

The two monetary aggregates, narrow money ($M0$) and broad money ($M3$), constructed in this article are defined as:

$$M0 = PC + R \tag{1}$$

$$M3 = PC + D \tag{2}$$

where PC is notes and coins in circulation with the public, R is banks' reserves, and D is net sterling commercial bank deposits held by the public. In terms of geographic scope, both PC and D refer only to money held in Ireland, while a component of R, bankers' balances, refers to money held with British banks such as the Bank of England. This treatment more accurately reflects the role of $M0$ as the ultimate banking reserve. In the underlying sources, we have used the last observation for each period so that the monthly $M0$ series is month end and the annual $M0$ and $M3$ series are year end.

A number of exclusions are implicit in this definition. First, public (that is, government) deposits—which were held at the Bank of Ireland—are not included. Second, we have also omitted foreign currency deposits. Technically, our $M3$ series is therefore sterling $M3$. In any case, we have not found any evidence of foreign currency deposits in Ireland between the Famine and independence, so that it is likely that $M3$ and sterling $M3$ were equal to one another. Third, the deposits of savings banks are also not included. This exclusion, in addition to the two above, ensures comparability with Capie and Webber's series for the UK.

II.2. Currency in the hands of the public (PC)

In this section we briefly discuss the construction of the series for coin and notes. Unlike elsewhere in the wider UK, gold coin did not circulate in Ireland among the public in this period. However, it was an important component of bank reserves. Therefore, our series for gold coin is equal to that held by the banks. In contrast, both silver and copper coins (later bronze) did circulate among the Irish public.

The silver and copper coin series were constructed using the benchmark stocks displayed in table 1, the official additions and withdrawals through the banking system that were recorded in the daily account books of the Royal Mint, and a residual.[31] The residual captures unobserved flows arising from factors such as

[31] TNA, MINT 12/9, 12/18, 6/51–7, 6/65, 6/5–14, 6/16–8, 26/9–12.

Table 1. *Coin stocks, 1825–1922*

Metal	*Stock (£)*	*Source*
Silver		
Sept. 1826	1,448,452	TNA, MINT 12/18
April 1871	1,000,000	TNA, MINT 9/242
June 1914	2,098,243	TNA, MINT 20/757, 26/12
March 1922	2,962,667	TNA, MINT 20/757
Copper		
July 1825	212,764	TNA, MINT 12/9, 12/18
April 1871	72,430	TNA, MINT 6/6-8
March 1922	66,660	TNA, MINT 20/757

migration to the colonies and trade with Britain. The level of the silver or copper coin series C at time t is:

$$C_t = \left(\alpha + \sum_{i=0}^{k} A_{t-i} - \sum_{i=0}^{k} W_{t-i} \right) \varepsilon_t \tag{3}$$

where α is the opening stock, A and W are official additions and withdrawals respectively, and ε is an error term which captures all unobservable flows.[32] It is calculated as a linearly descending ratio from the previous benchmark (set to 1) to the next benchmark (to which 1 descends). The terminal value of the ratio is calculated by dividing the Royal Mint's estimate by the unadjusted stock at the benchmark year.

A small number of banks issued notes in Ireland in 1840: the Bank of Ireland; the Belfast, National, Northern, Provincial, and Ulster joint-stock banks; and Ball & Co., a private bank in Dublin.[33] Data are available consistently over this stretch of history as a consequence of legislation passed in 1833, which required every bank in the UK to inform the Stamp Office in London of its weekly circulation.[34] As a result, aggregate circulation figures for the Irish banks were published in, among other places, the *Banking Almanac* and *Thom's Irish Almanac*.[35]

II.3. Deposits (D)

D is the sum of private sector deposits held in the joint-stock and private banks less adjustment items. An aggregate gross deposit series for the major joint-stock banks was collected officially from 1840 and continued beyond 1921.[36] The official statistics include the private deposits of the Bank of Ireland, the Irish deposits of

[32] As in Capie and Webber, *Monetary history*, p. 202.
[33] *Report from the S.C. of Banks of Issue* (P.P. 1840, IV), p. 741.
[34] 3 & 4 Will. IV c. 83.
[35] For the years 1840–5, we use figures in the *Banking Almanac*, 1849; for the years 1846–1921, we use figures in *Thom's Irish Almanac and Official Directory with the Post Office Dublin City and County Directory* (hereafter *Thom's Irish Almanac*), 1850–1923.
[36] 1840–63: Hancock, *Report on deposits*; 1864–72: idem, *Report on statistics*; 1873–1902: *Banking and Railway Statistics, Ireland*, 1893, 1903; 1903–11: *Banking, Railway and Shipping Statistics, Ireland*, 1912; 1912–21: Saorstát Éireann, *Statistical Abstract*, 1931.

the National and Provincial banks of Ireland, and those of the Belfast, Hibernian, Munster, Northern, Royal, and Ulster banks.

The official series, however, omits some small, short-lived joint-stock banks and a handful of private banks. In order to address this, we follow the approach of Capie and Webber and Collins by estimating the gross deposits of the population of commercial banks from the available sample based on the assumption of a positive correlation between the size of a bank's branch network and the level of its deposits:[37]

$$D_t = B_t \frac{\sum_{i=1}^{n} d_{it}}{\sum_{i=1}^{n} b_{it}} \tag{4}$$

where B_t is the number of branches in the population of commercial banks, and d_{it} and b_{it} are the level of deposits and number of branches respectively of sample bank i.[38] In other words, the average deposit level per branch in the sample is multiplied by the total number of branches in the population.

The final step is to deduct two adjustment items from D_t to yield total net deposits. The first is interbank deposits; the second is cheques in collection and items in transit. The level of the two items was not systematically recorded in this period. As a result, we calculate ratios of the items to total deposits for a discrete number of periods in which data are available and multiply them by the new series of gross deposits to achieve a time-varying series for the full sample, as in Capie and Webber.[39]

II.4. Reserves (R)

The reserves of the banking system (R) consist of banks' till money plus their balances with other banks. However, a nineteenth-century note-issuing Irish bank would typically report a broader level of reserves than this that also included the reserve against the note issue. This is not a component of reserves, and therefore $M0$, because it did not add to the *ultimate* reserve, as it can only be released from the vaults by the cancellation of a circulating bank note.

The first step in arriving at R is to calculate a series for total reserves for the Irish banking system as a whole. The calculations are based on both published and unpublished balance sheets for a sample of banks.[40] A cash to demand liabilities ratio is calculated for the sample, and is scaled up by multiplying it by our own series of the demand liabilities of the entire banking system. The sub-components are then calculated as follows. Banks' reserve against the note issue was published in *Thom's Irish Almanac* every four weeks from January 1846.[41] This information was not systematically recorded before the Bank Act, so we have spliced backwards

[37] Capie and Webber, *Monetary history*, p. 242; Collins, 'Long-term growth'.
[38] Data on branch numbers have been collected from Barrow, *Emergence*, p. 220, for the years 1840–4, and from the *Banking Almanac*, 1845–1922, for subsequent years.
[39] Capie and Webber, *Monetary history*, pp. 280–304.
[40] Royal Bank of Scotland Archives, Edinburgh (hereafter RBSA), NB/118; *Thom's Irish Almanac*, 1852–62; *Economist*, 1878–1922.
[41] *Thom's Irish Almanac*, 1850–1923.

using changes in the Bank of Ireland's reserves of specie.[42] In the absence of any consistent aggregate data on bankers' balances, we multiply the total reserve series by the National's ratio of balances with other banks to its total reserves.[43] As this ratio is only available for 12 years, it was therefore necessary to linearly interpolate the missing values. The series for till money has been calculated as a residual by deducting reserves against the note issue and bankers' balances from the total reserve series.

III. Results

III.1. Comparison with existing estimates

While there are no explicit previous estimates of the narrow or broad money supplies, O'Rourke has constructed a 'proxy series for *M*3' by summing notes in circulation and the gross deposits of a sample of joint-stock banks.[44] The construction of the new series differs in four main ways. First, coins are included; these were an important component of currency in the hands of the public. Second, the reserves of the banking system are also taken into account. Third, the gross deposits of a sample of joint-stock banks are scaled up to account for missing joint-stock banks and private banks. Fourth, the subsequent gross deposit series for the population of commercial banks is corrected for adjustment items. The construction of these components has an additional advantage in that it allows for the simple calculation of the narrow money supply as well as a number of fundamental statistics for monetary analysis such as the money multiplier, the deposit–currency ratio, and the reserve–deposit ratio.

As can be seen in figure 1, the new and existing estimates are very similar, with a correlation between the first differences of 0.99. The close correspondence of the two series, driven by the importance of the gross deposit series that is common to both, is encouraging. There are, however, important differences that are worthy of discussion. Figure 2 shows the percentage difference between the two series. The root mean square error is 4 per cent, while the difference in one year was as a large as 14 per cent. These errors are largest around important events such as the Famine, the agricultural crisis of the late 1850s, and the Munster crisis of 1885. This is because during distress periods the new components are most acutely affected as reserves are depleted in a flight to coin. In the new series, this reduces net deposits by a given quantity but is perfectly offset by an increase in currency in the hands of the public. In the existing aggregate, the deposit series falls but there is no offset as the absence of a coin series serves as a leak. As a result, the existing series overstates monetary contraction in times of crises.

The differences are also highly persistent with an autocorrelation coefficient of 0.76. The new series is systematically higher than O'Rourke's up until 1871, as the inclusion of new components that raise the broad money supply, such as coin and the deposits of previously omitted banks, outweighs the inclusion of new components that lower it, such as reserves and interbank deposits. After 1871,

[42] *Report from the S.C. of Banks of Issue* (P.P. 1840, IV), pp. 731–2; *Second Report from the S.C. on Banks of Issue* (P.P. 1841, V), pp. 290–7; *Second Report from the S.C. on Commercial Distress* (P.P. 1848b, VIII), pp. 280–352.
[43] RBSA, NB/118.
[44] O'Rourke, 'Monetary data'.

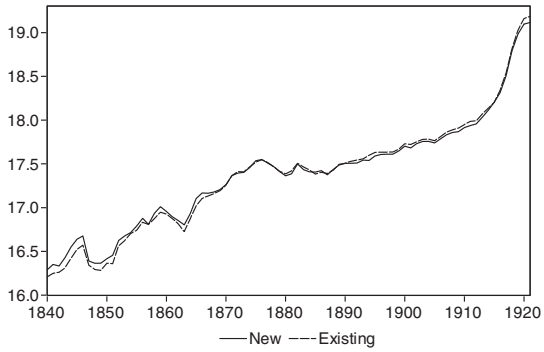

Figure 1. *Comparison of new and existing broad money series, 1840–1921*

Notes and sources: Natural logarithm on *y*-axis. See section II for source of new monetary data. Existing series is the sum of annual average bank note circulation and end of year joint-stock bank deposits from O'Rourke, 'Monetary data'.

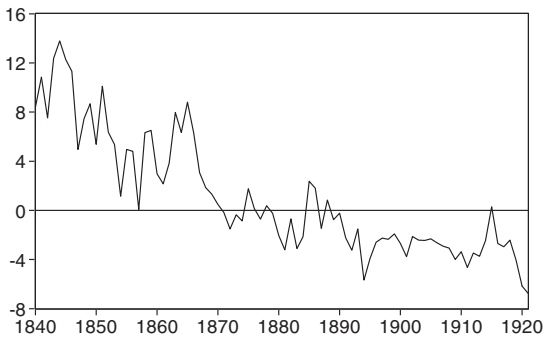

Figure 2. *Relative difference between new broad money series and existing estimates, 1840–1921 (%)*

Note: Calculated as: $(New/Existing) - 1$.
Source: See fig. 1.

the situation is reversed as the inclusion of new components that raise the broad money supply is outweighed by the inclusion of new components that lower it. A higher broad money supply at the beginning of the sample has implications for the monetization debate, which will be explored in the next section.

III.2. Growth and development

The new annual series of narrow and broad money are shown in figure 3. The upper panel shows the development of the narrow money supply, while the lower panel traces the growth of broad money. The data are available in online appendix S2. The narrow money supply more than tripled between 1840 and 1921. The increase can be decomposed into its underlying components: 24 per cent was due to an increase in currency in the hands of the public, while 76 per cent was due

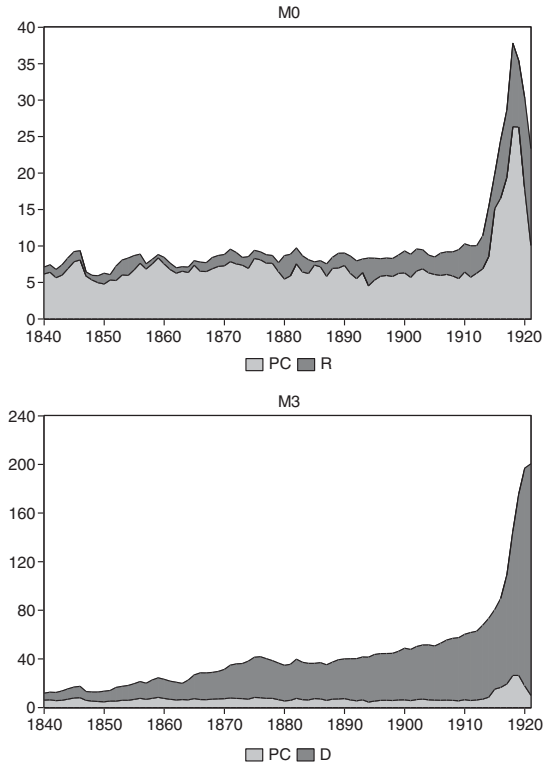

Figure 3. *New annual narrow and broad money series, 1840–1921 (£ millions)*
Source: See section II for source of monetary data.

to an increase in bank reserves. The broad money supply increased by a factor of 16 over the same period. A staggering 98 per cent of the monetary expansion can be attributed to the growth of net deposits and only 2 per cent to increases in currency. Note that even before the war, the broad money supply had increased by a factor of 6, with 99 per cent due to deposit growth and just 1 per cent to currency. This divergent tale of two components can be attributed to the 1845 Bank Act's effective ceiling on note issuance, which channelled credit through 'uncontrolled' deposit creation whereby cheques circulated in place of notes.[45]

Table 2 reports average growth rates for both narrow and broad money for a number of sub-periods.[46] The division is guided by Lynch and Vaizey's argument that the growth of the money supply accelerated between 1846 and 1864 as a consequence of the Famine.[47] In the pre-Famine period, the average annual growth

[45] Barrow, *Emergence*, p. 185.
[46] Average growth rates are calculated econometrically throughout.
[47] Lynch and Vaizey, *Guinness's brewery*, pp. 168, 170.

Table 2. *Average annual growth rates of the narrow and broad money supplies (%), 1840–1921*

Period	*M*0	*M*3
1840–5	5.2	7.2
1846–64	0.7	3.3
1865–1913	0.3	1.5
1914–21	7.9	17.9
1840–1921	1.0	2.5

Source: See section II for source of monetary data.

rate was surprisingly high at 7.2 per cent. After the Famine, there appears to have been a deceleration of growth down to 3.3 per cent. Even if 1848 is taken as the starting point, the post-Famine trough, the average growth rate was only marginally higher at 3.8 per cent. As a result, Lynch and Vaizey's further claim, that 'the total increase of deposits plus coins and notes in circulation [an almost identical measure to *M*3] rose by nearly three quarters between 1846 and 1864', is also subject to revision.[48] The new data show that the broad money supply increased by 29 per cent in this period. In fact, the money supply grew by more in the six years before the Famine (42 per cent) than it did in the two decades after. A further moderation occurred between 1865 and 1913, although an average growth rate per annum of 1.5 per cent sustained over nearly 50 years amounts to a 2.5-fold increase. The discussion of the monetary expansion during the Great War will be delayed until the next section. In all, narrow money grew, on average, by 0.4 per cent up until 1913 or by 1 per cent over the full sample, while broad money growth averaged 2.2 per cent prior to the war or 2.5 per cent over the entire period.

The differential between narrow and broad money growth had implications for the money multiplier. The multiplier, calculated as the ratio of the broad to narrow money supplies, is a 'measure of financial intermediation' or 'financial depth'.[49] In figure 4, which plots the first estimates of the multiplier for Ireland in this period, it can be seen that the ratio increased steeply from 1.6 in 1840 to 8.6 in 1921. This impressive growth indicates that there was a great deal of financial development in Ireland during this period. Comparisons will be drawn in the next section.

The new data are relevant to an important debate in Irish economic history. Lynch and Vaizey argue that Ireland was a 'dual economy', with 'around 6 million people living in the subsistence economy when the Great Famine came in 1845, and about 2.0 million in the maritime economy around Dublin, Belfast, Cork, Waterford, Limerick and Galway'.[50] The defining characteristic of the subsistence economy was a distinct lack of monetization. In this view, 'because of the lack of money there was no organized retail and wholesale trade in foodstuffs in rural Ireland, and the means of purchase of a substitute for the potatoes did not exist'.[51] Mokyr subsequently found no evidence of regional variation in the degree of

[48] Ibid., p. 170.
[49] Allen, Capie, Fohlin, Miyajima, Sylla, and Wood, 'Financial systems for growth'; Hansson and Jonung, 'Finance and economic growth'.
[50] Lynch and Vaizey, *Guinness's brewery*, p. 10.
[51] Ibid., p. 165.

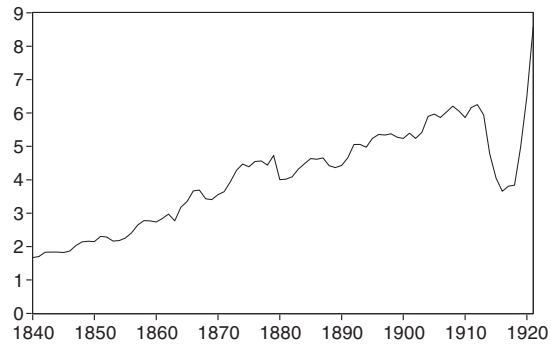

Figure 4. *M3 multiplier, 1840–1921*
Note: Calculated as: *M*3/*M*0.
Source: See section II for source of monetary data.

monetization, but did find that 'Ireland as a whole was seriously behind the rest of Europe in its commercial and financial development'.[52]

The degree of monetization and financial development can be measured using the new data. A standard measure of monetization is the 'monetization ratio', which is measured as the ratio of broad money to nominal GDP.[53] Mokyr has estimated that nominal GDP stood at £75–85 million on the eve of the Famine.[54] Using a figure of £80 million in the denominator produces a ratio of 21 per cent in 1845 (the lower bound increases this to 22 per cent; the upper reduces it to 20). By comparison, it was 18 per cent in Norway and 16 per cent in Sweden in the same year.[55] These were two countries of roughly comparable economic development for which data are available. Furthermore, as the international picture clears in the second half of the nineteenth century with the availability of more data, we see that Ireland was *decades* ahead of others; it was more monetized in 1845 than Canada, Finland, Germany, and the Netherlands were at the beginning of the 1870s.[56]

In terms of financial development, the multiplier, a measure of financial intermediation or depth, stood at 1.8 in Ireland in 1845, but only 1.3 in Norway and 1.4 in Sweden. As with the degree of monetization, at this point Ireland was decades ahead of other European countries such as Finland, France, Italy, and the Netherlands. This view finds support in Barrow, who noted a great improvement in the spread and quality of banking services before the Famine, and a contemporary banker in 1841, who claimed that, in this regard, 'Ireland has made more progress towards improvement within the last 15 years than it ever made in any 100 years preceding'.[57] It is hard to reconcile the hypothesis that Ireland was underdeveloped in terms of monetization and financial development with the new evidence.

[52] Mokyr, *Why Ireland starved*, p. 24.
[53] McLoughlin and Kinoshita, 'Monetization'.
[54] Mokyr, *Why Ireland starved*, p. 11.
[55] Calculated from Edvinsson and Ögren, 'Swedish money supply'; Schön and Krantz, 'New Swedish historical national accounts'; Klovland, 'Monetary aggregates'; Grytten, 'Gross domestic product'.
[56] See tab. 3 for source.
[57] Barrow, *Emergence*, pp. 189–90; *Second Report from the S.C. on Banks of Issue* (P.P. 1841, V), p. 250.

Table 3. *Irish monetization relative to mean of 12 advanced countries (%), 1871–1911*

	Monetization ratio		*Multiplier*	
	Ireland	*Other*	*Ireland*	*Other*
1871	34	28	3.6	2.7
1881	34	36	4.0	3.1
1891	40	43	4.7	3.9
1901	40	53	5.4	4.5
1911	52	61	6.2	5.2

Notes and sources: See section II for source of Irish monetary data. Irish GDP data calculated as Ireland's share of UK GDP, from Geary and Stark, 'Regional GDP in the UK', multiplied by Feinstein's compromise estimates of GDP at factor cost in Mitchell, *British historical statistics*, p. 836, which assumes that the Irish and UK deflators were equal. 'Other' ratios calculated from Jordà, Schularick, and Taylor, 'Macrofinancial history'. Five countries were omitted from the sample due to missing data.

The impressive development of these metrics continued throughout the nineteenth century. Table 3 presents the monetization ratio and the money multiplier for Ireland and a constant sample of 12 now advanced countries.[58] The table shows that the monetization ratio was higher than average in 1871, lagging only behind France and the UK. On the eve of the First World War, the ratio had increased to 52 per cent. Although this was lower than the sample average, the degree of monetization exceeded that of Australia, Canada, Italy, Japan, the Netherlands, the UK, and the US.[59] In terms of the multiplier, Ireland was always above average, and from the 1890s even forged ahead of the UK.[60]

III.3. Cycles, booms, and busts

In this section, the higher-frequency aspects of the new aggregates are explored. The upper panel of figure 5 displays the cyclical component of the natural logarithm of the broad money supply, estimated with a Hodrick–Prescott filter with lambda set to the conventional value of 100.[61] The vertical lines represent the unfolding of the major economic events that were discussed in the introduction.

The first result that emerges from the figure is the sharp contraction during the Famine. From the peak in 1846 to the trough in 1849, the level of the broad money supply contracted by 27 per cent. The magnitude of this contraction had no equal during the years between 1840 and 1921, nor did it in the period between 1933 and 2012 studied by Gerlach and Stuart.[62] Two-thirds of this decline came from a reduction in currency in the hands of the public, while the remaining one-third came from a fall in deposits. As a result of the collapse of currency, narrow money fell by 37 per cent between 1846 and 1849, and did not recover until as late as 1871.

[58] The sample of countries includes Australia, Canada, Denmark, Finland, France, Germany, Italy, Netherlands, Norway, Sweden, the UK, and the US.

[59] The monetization ratio is the reciprocal of velocity. Bordo and Jonung, *Demand for money*, p. 149, find that velocity follows a U-shaped pattern over time. However, the inflexion point was not reached until after the Second World War.

[60] Calculated from data in Capie and Webber, *Monetary history*.

[61] Other values of lambda were considered, such as 6.25 (the Ravn–Uhlig rule). In this instance, the choice of lambda does not materially affect the results. The correlation coefficient between the two cycles is 0.87.

[62] Gerlach and Stuart, 'Money, interest rates and prices'.

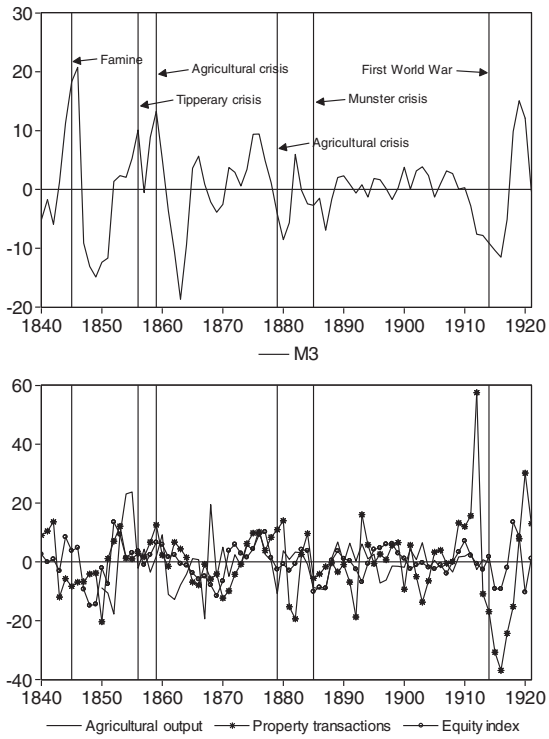

Figure 5. *Cyclical components of Irish macroeconomic time series, 1840–1921 (%)*

Notes and sources: Filtered with a Hodrick–Prescott filter with $\lambda = 100$. See section II for source of monetary data. Value of agricultural output from Turner, *After the Famine*, p. 108; property transactions from O'Rourke and Polak, 'Property transactions in Ireland'; and equity index based on figures in Hickson and Turner, 'Pre- and post-Famine indices', and Grossman et al., 'Monthly stock exchange index', spliced using the approach discussed in the latter.

This gives an impression of the severity and long-lasting impact of the Famine on the Irish economy.

The annual series masks a more dramatic decline at the monthly level. Figure 6 shows the new monthly series for the monetary base. The peak to trough decline between November 1845 and August 1849 totalled 48 per cent. Furthermore, currency in the hands of the public, the *liquidity* of the population, fell by more than 50 per cent. To our knowledge, the scale of this contraction has no precedent in modern economic history. According to the managing director of the Provincial Bank of Ireland in 1848, the collapse in currency was primarily attributable to the lack of provisions available to sell as 'that which produced circulation in Ireland had almost ceased to exist'.[63]

The lower panel of figure 5 shows the equivalent cyclical components of other indicators such as the value of agricultural output (1850 to 1913 only), property

[63] *Second Report from the S.C. on Commercial Distress* (P.P. 1848b, VIII), pp. 45–6.

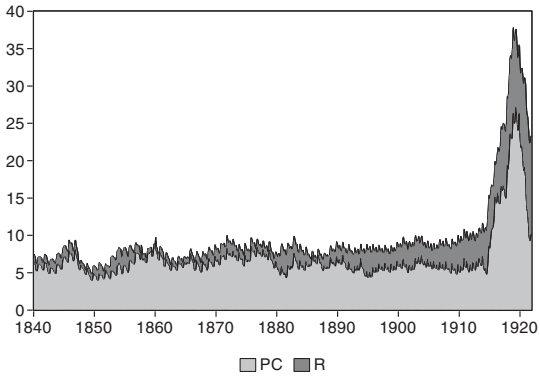

Figure 6. *New monthly narrow money series, 1840–1921 (£ millions)*
Source: See section II for source of monetary data.

transactions, and the stock market. The collapse in the money supply concords with reductions in both property transactions and the equity index. The stock market, for example, fell 15 per cent below trend in 1848, its lowest ebb between 1840 and 1921. The similar behaviour of the four series is encouraging, as it implies that the scale of the monetary contraction is not idiosyncratic. Interestingly, despite the decline in the broad money supply, consumer prices increased by 24 per cent between 1846 and 1847.[64] These facts jointly give an impression of the severity of the supply shock.

After the Famine it took until 1854 for the broad money supply to exceed its pre-crisis level. Three shocks in the second half of the 1850s, however, posed a threat to banking stability. First, in 1856 the Tipperary Bank failed due to 'gigantic' fraud by one of its owners, John Sadleir.[65] As a consequence, the public temporarily lost confidence in the banking system, which resulted in the Belfast, the National, and David La Touche & Co. seeking help from the Bank of Ireland. The deposit–currency ratio, which is a measure of confidence in the banking system, fell at the end of 1856 relative to 1855.[66] In addition, the reserve–deposit ratio, which typically declines in the initial stages of a banking panic, fell by nearly half, from 15 per cent (a typical level in the first half of the 1850s) to 9 per cent.[67]

The second shock was the international crisis of 1857 in which the reserve–deposit ratio fell further still to 5 per cent. Although the depletion of reserves was about to become more severe, 1857 was a local nadir that had no comparison prior to this point. Around these years, the other cyclical indicators behaved in a similar fashion to the money supply, rising above trend in the early 1850s and falling back in the wake of the crises.

[64] Geary and Stark, 'Trends in real wages'.
[65] *Bankers' Magazine*, 1857.
[66] James, 'Causes of the German banking crisis'; Capie and Mills, 'Money and business cycles'.
[67] Friedman and Schwartz, *Monetary history*, p. 57.

The agricultural crisis of 1859 was the third and final shock of the 1850s. Between 1859 and 1861, the value of agricultural output fell by 15 per cent.[68] The broad money supply contracted by 11 per cent between these years, and in fact continued to do so until 1863, by which point it had declined by 19 per cent. The thinning of reserves that began in 1856 continued to 1859, at which point the reserve–deposit ratio stood at just 2.7 per cent (the second-lowest point in the sample). Despite the fragility of the situation, there were no bank failures around this time. In the wake of the depression, rapid monetary expansion followed of more than 5 per cent per year until the next agricultural crisis struck in the late 1870s. While both the broad money supply and the value of agricultural output rose slightly during this crisis, a cyclical decline is observed in both series due to the rapid trend growth of the time.

The second contraction associated with a banking failure was the Munster crisis of 1885, during which there was a cyclical decline of 2.7 per cent in the broad money supply. Previous research has suggested no contagion or fear of systemic collapse associated with the failure.[69] In the early stages of a panic, bank reserves and deposits typically fall, while currency increases as the public withdraws deposits in a flight to safety. The new data can therefore shed light on this issue.[70] Between 1884 and 1885, reserves fell by £1.5 million (a 77 per cent decline—the largest in the sample period) and deposits by £1.2 million (a 4 per cent decline), while currency in the hands of the public increased by £1.2 million (a 19 per cent increase). As a result, the deposit–currency ratio, a barometer of confidence in the banking system, fell by 19 per cent. This was the largest annual decline prior to the First World War. Moreover, the reserve–deposit ratio, which typically initially falls during a banking panic, plunged from 6.3 per cent in 1884, which was normal for the early 1880s, to 1.5 per cent in 1885.[71] The interpretation is that reserves had dwindled to the extent that only 1.5 per cent of deposits could be paid out, or that £1 of reserves was stretched to cover £65 of deposits. This event marked the lowest point in the sample for the reserve–deposit ratio.

An independent measure of problems in the banking sector is the absolute return on bank shares, assuming relatively efficient markets.[72] Indices of Irish bank share prices show a 28 per cent decline in 1885, which ranks as the largest absolute return in any year between 1825 and 1913.[73] In addition, contemporary qualitative evidence also supports the claim that 1885 was a period of instability. According to Hall, the Chancellor of the Exchequer informed the Bank of Ireland that 'the Government was more concerned in preserving the other Irish banks than in the resuscitation of the Munster Bank' and that 'information had reached the Treasury which seemed to indicate that some of those concerns had also

[68] Turner, *After the Famine*, p. 108.
[69] Ó Gráda, 'Last major Irish bank failure'; Turner, *Banking in crisis*, p. 50.
[70] Friedman and Schwartz, *Monetary history*, p. 57.
[71] Note that the Munster Bank (or the Munster and Leinster Bank) did not publish a balance sheet in the *Economist* for Dec. 1885. As such, it is not included in the calculation of the aggregate reserve series in that year. This is not, however, responsible for the decline as the Munster's reserve–deposit ratio in the first half of the 1880s was significantly lower than the sample average. Thus, excluding the Munster Bank throughout would yield an even sharper decline.
[72] Campbell, Coyle, and Turner, 'This time is different'.
[73] Hickson and Turner, 'Pre- and post-Famine indices'; eisdem, 'Rise and decline'.

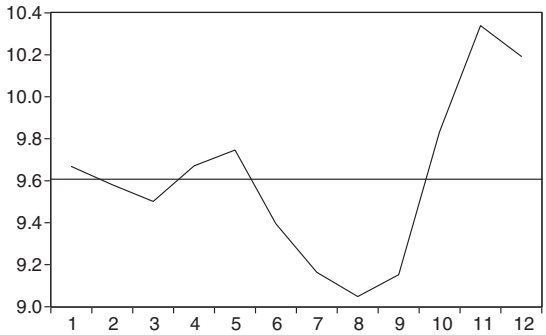

Figure 7. *Monthly mean of narrow money, 1840–1921 (£ millions)*
Note: Horizontal line represents sample mean of £9,607,588.
Source: See section II for source of monetary data.

experienced pressure'.[74] The *Economist* reported that even the Bank of Ireland experienced a run on some of its branches.[75] The Bank's withdrawal of support to the Munster Bank may have led to a change in expectations about its willingness to act as lender of last resort. Diamond and Dybvig argue that such shifts have played a causal role in bank runs in other historical contexts.[76]

The First World War witnessed dramatic monetary expansion in Ireland. The broad money supply grew by 18 per cent per year and the increase of 33 per cent between 1917 and 1918 was the strongest year of growth in the known monetary history of Ireland. By 1918 the broad money supply stood at twice its prewar level. The money multiplier, and its close counterpart, the deposit–currency ratio, fell during this period, which implies a reduced degree of confidence in the banking system. The flight to hard currency is hardly a surprising response to the uncertainty of war, and can also be seen in comparable data for the UK.[77] The growth of base money, in both cases, was made possible by the issuance of currency notes. Interestingly, there was also strong growth in both equity prices and property transactions, which may have been related to the monetary expansion.

In addition to fluctuations at business cycle frequencies, the narrow money supply exhibited a regular seasonal pattern. Figure 7, which plots mean monthly levels, shows that narrow money was typically higher around the time of the harvest in the autumn and lower at other times of the year. In 1841 the inspector of the Provincial Bank of Ireland described a similar path, 'from about the 1st of October on to about the 1st of February the circulation is increasing, and from the 1st of February down to the 1st August it is usually diminishing when it reaches its minimum, and it expands again after the harvest'.[78] This seasonal pattern was also observed by Gilbart in 1852.[79]

[74] Hall, *Bank of Ireland*, p. 291.
[75] *Economist,* 26 Dec. 1885, p. 1573.
[76] Diamond and Dybvig, 'Bank runs'.
[77] Capie and Webber, *Monetary history.*
[78] *Second Report from the S.C. on Banks of Issue* (P.P. 1841, V), p. 244.
[79] Gilbart, 'On the laws of the currency in Ireland'.

The seasonal pattern in the narrow money supply was therefore partly related to the income of merchants and farmers, as one would expect from a classic money demand function where money is related to the nominal interest rate and output. In this way, the seasonality in the narrow money supply would not only be reflective of the regular intra-year fluctuations in agricultural income but also of wider national income.

A similar seasonal rhythm has been observed in the American money supply prior to the creation of the Federal Reserve system in 1914. As in Ireland, the demand for currency peaked in the spring and autumn. Miron observed that the seasonal variations in the money supply were associated with banking panics.[80] The logic runs that the seasonal increase in economic activity raised the demand for currency and credit, which drove up market interest rates and, as a consequence, pushed the reserve–deposit ratio down, leading to increased vulnerability. There were, however, only six joint-stock bank failures during the sample period, which makes it difficult to identify a seasonal pattern. Where the month of failure has been identified in the literature, there seems to be a fairly even distribution across the year. In each case, other causes have been cited, such as a combination of fraud (Tipperary Bank, Dublin Banking Company), poor capitalization (London and Dublin Bank), international shocks (the English and Irish Bank, the Union Bank), and longer-term and institutional factors (Munster Bank).[81]

It is possible to crudely assess whether seasonality was increasing or decreasing over time by splitting the sample in December 1880 to give two equal sub-periods of 492 months each. The coefficient of variation of the monthly means declined by 36 per cent from 0.050 in the 1840–80 sub-sample to 0.032 in the 1881–1921 sub-sample. The reduction in the seasonality of the narrow money supply may be related to structural change.

IV. Conclusion

This article has constructed two new monetary aggregates for Ireland between 1840 and 1921. The first is an annual series of the broad money supply, which builds on an earlier proxy. There are few macroeconomic time series of this length and nature available for this period. The second is a monthly series of the monetary base, which has never been attempted before for this time in Irish economic history. It is one of only very few high-frequency macroeconomic series available. The aggregates have been constructed from a wide range of archival material and contemporary publications. In keeping to standard monetary definitions, the series enable comparisons across both time and space.

The new data yield three major results. First, we find that Ireland was comparatively well monetized and financially developed on the eve of the Famine. Previous literature has cited low levels of these measures as a source of vulnerability to exogenous shocks. However, the data show that not only did Ireland lead Norway and Sweden in 1845, but it was decades ahead of other countries such as Germany in the case of monetization and France with respect to financial development.

[80] Miron, 'Financial panics'. See Mankiw and Miron, 'Should the Fed smooth interest rates?', for a discussion of the seasonality of interest rates during the pre-Fed period.

[81] Barrow, *Emergence*, pp. 161, 163; Hall, *Bank of Ireland*, pp. 221, 250; Ó Gráda, 'Last major Irish bank failure'.

Second, the monetary contraction during the Famine was the largest during any event in the economic history of Ireland since 1840 and perhaps even in economic history more generally. The broad money supply collapsed by 27 per cent, the monetary base by 48 per cent, and currency in the hands of the public, the nation's liquidity, by more than half. Third, in contrast to the previous literature, we find that the rest of the banking system was not insulated from the failure of the Munster Bank in 1885. Classic signs of problems in the banking system surfaced, such as a depletion of reserves stemming from a flight from deposits to currency.

In addition to these major findings, there are a number of other interesting results. The broad money supply grew on average by 2.5 per cent per year during the sample period, which led to a 16-fold increase, of which 98 per cent was due to the growth of deposits. This growth was unevenly distributed across the sample. There was rapid monetary expansion in the pre-Famine years and a slowdown in the two decades after. The growth in the post-Famine money supply was lower than has previously been suggested. We also find evidence of banking fragility in the 1850s, marked by a sharp decline in the reserve–deposit ratio, which was driven by successive shocks in 1856, 1857, and 1859. In addition, while the monetary expansion during the First World War was generally impressive, the 33 per cent increase in 1918 was the biggest increase in a single year in the known monetary history of Ireland. Finally, we identify strong seasonality in the monthly narrow money series, which declined markedly in the late nineteenth century.

Date submitted *18 February 2016*
Revised version submitted *15 May 2017*
Accepted *17 May 2017*

DOI: 10.1111/ehr.12607

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Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

S1. Monetary aggregates for Ireland: construction
S2. Monetary aggregates for Ireland: data

Online Appendix S1. Constructing monetary aggregates for Ireland

This appendix provides extra detail on the construction of monetary aggregates for Ireland between 1840 and 1921. It is intended for the interested reader and for those that wish to recreate the series.

A1 Currency in the Hands of the Public (PC)

A1.1 Coin

As Ireland was a part of the United Kingdom during the sample period, and the issuance and withdrawal of coin in the United Kingdom was the responsibility of the Royal Mint, their records are our main source of coin stocks and flows. The Records of the Royal Mint are held at the National Archives at Kew in London. We follow the convention of the National Archives by citing a file as MINT X/Y where MINT refers to the fact that it is a record of the Royal Mint, X to the division number and Y to the file number. Note that the numbering of the sources at the archive was not always chronological.

Gold Coin

Our gold coin series comprises only that in the Irish banking system as gold coin did not circulate among the public. As a consequence of the suspension of cash payments in Ireland on 2 March 1797 gold coin never regained prominence in Ireland as a medium of exchange. When cash payments were eventually restored in 1821, people had become accustomed to paper money transactions in the intervening years. In 1826 "no gold circulated" and Bank of Ireland notes were preferred to gold by the people in normal conditions.[1] Deposits were lodged in the paper of the Bank of Ireland or any other bank with the average citizen preferring "a good note to a sovereign."[2]

Even where gold was given as payment during the period, a given trader having gold "forced upon them" would "immediately turn to some of the merchants in the town and beg to get a bank note for it."[3] While a culture of metallic currency prevailed in Ulster in 1801, by 1848 a Northern Bank director stated that the region had "never any gold circulation."[4] It was rarely demanded in time of panic. Instead, Bank of Ireland notes were preferred to gold by the people and the "only" gold demand came from those emigrating to America.[5]

[1] P.P., 1826a, pp. 10, 13.
[2] P.P., 1826a, pp. 27, 37.
[3] P.P., 1826a, p. 12.
[4] See Ó Gráda, *Ireland*, p. 60; P.P., 1848, p. 82.
[5] P.P., 1826a, pp. 10, 13; P.P., 1848, p. 86.

In 1868 a Director of the Bank of Ireland stated that sovereigns were never in circulation in Ireland and, appearing before the 1875 committee, the Secretary of the Bank of Ireland admitted that they had not imported gold in over thirty years.[6] This situation continued until the outbreak of World War I where much of the remaining gold in the banking system was concentrated in the Bank of England, from where it would not return as there appeared no advantage in doing so.[7] A century after the assimilation of the currencies, the entire coinage in active circulation consisted solely of British silver and copper coins.[8]

There were other mechanisms in which gold could have entered Ireland. Trade between the islands created flows of gold which were inconvenient to both the public and the banks. Indeed, 3 pence for each sovereign was charged at the Bank of Ireland tills upon receipt of sovereigns "with a view to putting a stop to the import of gold which is not required", as they had to be shipped back to Britain at the expense of the Irish banks.[9] By 1840, hoarding by the poor was largely absent due to the advent of the savings bank system where it would find a better return.[10] Indeed, even the clearing system of the banks avoided gold. Each bank held exchequer bonds in lieu of gold as a means of settlement instead of keeping the gold in the country uselessly.[11]

Gold, however, remained a crucial component of reserves against the note issue, despite its evidently complete absence in the public holding of currency. The law which had required the notes of banks to be redeemable at branch survived the Bankers Act 1845, ensuring that Irish banks had an "exceptionally wide distribution of gold."[12] Due to these considerations, we take gold held in banks as the entire volume of gold coin.

Silver Coin

In this section, we describe and justify the choice of the opening and closing stocks, which are mainly based upon archive material from the Royal Mint or recoinages.

September 1826: £1,448,452

While our monetary series start in 1840, mainly due to the availability of deposit data, the obvious starting point for coin is the assimilation of the currencies in the 1820s. The first stock is the sum of silver received in Ireland from the Royal Mint between 12 June 1823 and 23 September 1826. The old Irish silver was then demonetized in 1826 and returned to London via the Bank of Ireland who had drawn them in from the public. Of the total, £500,000 was on account of the Public Service in Ireland.[13] The "further supply of £500,000"

[6] P.P., 1868, p. 104, P.P., 1875 p. 159.
[7] Colbert, 'The Free State Currency Problem'.
[8] McGowan, 'Money and Banking in Ireland'.
[9] P.P., 1875, p. 159.
[10] Barrow, *The Emergence of the Irish Banking System*, p. 193.
[11] P.P.,1875, p.161.
[12] 9 Geo. IV, c. 81; Colbert, 'The Free State Currency Problem'.
[13] MINT 12/18, 12/21, 8/35, 6/51.

was suggested by the Bank of Ireland in a letter to the Chancellor of the Exchequer for the circulation of the country.[14] This left a total of £948,451 arriving through the banking system, which matched the sum of withdrawals and is supported by a contemporary in banking who stated a figure of "nearly £1,000,000 in silver coins".[15]

April 1871: £1,000,000

The next stock comes from correspondence between the Bank of Ireland and the Royal Mint.[16] The coins of 1826 were now "mere silver discs which it becomes increasingly difficult to pass."[17] The subsequent withdrawals totaled £410,100, which almost equaled the "one half of which is unfit for circulation" that the Bank of Ireland had specified.[18]

June 1914: £2,098,243

The next stock is a reworking of the Royal Mint's rounded estimate of "£2 millions". It was calculated as the *approximate* ratio of Irish bank silver holdings to UK bank silver holdings multiplied by the circulation of silver coin in the UK. We improve on this method by obtaining the actual share of Irish banks' holdings as a percentage of UK banks' holdings and multiply it by the UK circulation to arrive at a figure for the Irish circulation of £2,098,243 $\left[\left(\frac{576,776}{8,246,555}\right) \times 30,000,000\right]$.[19]

March 1922: £2,962,667

The closing stock reworks another estimate by the Royal Mint. As a consequence of the emergence of the Free State, the Royal Mint estimated the amount of coin in that part of Ireland only. The report calculated, from assumptions regarding coin per head, shares of denominations and population, that there was £2 million in silver coin in the Free State. If we use the same assumptions, but replace the assumed 3 million people in the Free State with the recorded population for the whole of Ireland of 4.444 million, it yields a new figure of £2,962,667.[20] Brennan's estimate of £1.5 million, which O'Rourke rightfully suggests must refer to the Irish Free State, was later dismissed as "surely a very low figure" by British Treasury officials.[21] The stock "must exceed" that as it would only "be equivalent to about twice the Bank holdings".[22]

Copper and Bronze Coin

[14] Bank of Ireland Minute Book, 14 September 1824.
[15] MINT 6/51, 12/18; P.P., 1868, p. 104.
[16] MINT 9/242.
[17] *Ballinrobe Chronicle*, 18 July 1868.
[18] MINT 6/8-9, 9/242.
[19] MINT 26/12.
[20] Mid-year. *Detailed Annual Report of the Registrar General for Saorstát Éireann*, 1923.
[21] O'Rourke, 'Monetary Data and Proxy GDP Estimates'; UCD Archives, P67/174; MINT 20/757.
[22] MINT 20/757.

July 1825: £212,764

As with silver coin, it was necessary to extend the copper series back to the assimilation of the currencies to arrive at an opening stock. The Assimilation of the Currencies Act 1825 instructed that Irish copper be called in to be fully replaced with the new British coin but it was largely mismanaged.[23] One newspaper explained that "no great change in the currency of a country was ever before attempted with so little foresight and attention."[24] The public was not forthcoming with old English copper, as it carried a one thirteenth premium on the old Irish copper "harps". This culminated in a Royal Proclamation on 12 July that gave Irish copper legal status equal to British coin.[25]

The result of this was that the old Irish coin still in circulation plus the new additions would now become legal tender and shipments of new coin ceased in May 1826.[26] A total of £35,084 in new copper coin had been added of which £18,750 was shipped to customs houses and £16,334 added through the banking system.[27] The total copper coin withdrawn officially during the period 1825-7 amounted to £59,426.[28] In contrast to the official additions, withdrawals of old copper coin through customs continued into 1827 and amounted to £22,896 compared with £36,530 through the banks.[29] Due to the fact that the full replacement of coin was never completed, we are subsequently left with the problem of ascertaining the stock of copper coin *before* the official shipments began. Three estimates are provided: the first in 1826 by the Treasury and two subsequent documents considering a recoinage in 1831 by the Royal Mint.[30] However, the source we choose avoids rounding and documents each shipment since 1804, which totaled £212,764 on net.[31]

December 1869: £72,430

The next stock is calculated at the time of a complete recoinage. In the 1860s copper coin was gradually replaced by bronze coin, and completely demonetized in the United Kingdom in December 1869.[32] Thus, our stock is calculated as the sum of additions of new bronze coin up until the month of demonetization.

March 1922: £66,660

The closing stock is calculated in an identical manner to the closing stock for silver.

Issues

[23] 6 Geo IV, c. 79.
[24] *Freemans Journal,* 24 July 1826.
[25] Barrow, *The Emergence of the Irish Banking System*, p. 27; MINT 12/14.
[26] MINT 8/35.
[27] MINT 12/18, 6/51, 8/35, 12/13, 12/18, 12/21, 12/20.
[28] MINT 12/13.
[29] MINT 8/35.
[30] P.P., 1826b; MINT 12/13, MINT 12/9, 12/18.
[31] MINT 12/9, 12/18.
[32] Craig, *The Mint*, p. 325.

In extreme events, such as silver scarcities, there is evidence that the banks may have bypassed the Royal Mint in their procurement of silver coin. While we have the minute books for some banks for some years, we are not able to systematically incorporate these qualitative sources into our series for silver coin. However, these are, of course, captured in the residual, although the chronology will be imperfect. Additionally, we cross checked additional sources where possible during such acute periods. For instance, the Mint daily account books show no silver additions in the early 1850s despite the "unusually low" levels according to a circular of the Provincial Bank of Ireland, which explained that the "the Mint [are] not at present coining" due to the needs of the Crimean War. [33]

The Royal Mint's daily account books document both the buyer (for additions) and seller (for withdrawals) of coin. In general, the parties involved in the transactions were banks. Thus, we can ascertain if the sales of silver, for instance, were bound for Ireland by the name of the purchasing bank. However, in the case of withdrawals of copper coin during the transition to bronze coin in the 1860s, the sums sold, and thus the actors involved, were small. During this period, the sellers of old bronze coin were listed as "sundry persons", from which it is impossible to ascertain if this related to coin originating from Ireland. However, the public were incentivized by a 2 per cent premium on the old copper coins.[34] Thus, we assume that 98.04 $(100/102)$ per cent of that added in new bronze coin in each month between July 1861 and December 1869 was withdrawn in old copper coin. Prior to the recoinage, copper coin was not systematically withdrawn in the United Kingdom through the Royal Mint, nor was it until as late as 1908 via the Comptroller and Accountant General of the Post Office.[35] From that year, the Annual Reports of the Deputy Master and Comptroller of the Royal Mint record annual totals of bronze coin withdrawn from Ireland. For the monthly $M0$ series, the annual total is apportioned evenly across each month. In any case the annual totals were very small; the maximum was £780 in 1909.

Undoubtedly, the use of a residual to capture a broad range of unobservables is not ideal as it influences the series in certain periods. However, emigration was a dominant force that led to extensive outward unofficial flows. As Mokyr stated, between Waterloo and the Famine 1.5 million people left Ireland, while more than 4.5 million people emigrated between 1850 and 1913.[36] Both silver and copper were carried to Britain and the colonies as legal tender, often earning a considerable premium.[37] Even if we were to obtain an estimate of the average coin carried per emigrant, as is the approach of Capie and Webber for gold coin, there are problems with the existing emigration statistics, which suffer from "weaknesses and

[33] MINT 6/57, 6/5, 6/6; *Provincial Bank of Ireland Minute Book*, 10 June 1853.
[34] Craig, *The Mint*, p. 325.
[35] MINT, 26/9.
[36] Mokyr, *Why Ireland Starved*; O'Rourke, 'The Economic Impact of the Famine in the Short and Long Run'.
[37] British copper and silver coin traded at a premium of 12.5 per cent against the Canadian equivalent where copper coins of "every nation" traded at half a British penny. See McGregor, 'Emigration to British America'.

ambiguities" and display "important discrepancies".[38] Indeed, the only document that covers overseas emigration by destination has been labeled a considerable underestimate.[39]

A1.2 Notes

The new series of bank notes in circulation refers solely to those issued by Irish banks. In line with the available evidence, we have not included Bank of England notes in the monetary series. Hall states that "the 1845 Act specifically provided that these notes were not legal tender in Ireland, and since that date Bank of England paper practically ceased to circulate in the country."[40] In addition, in 1858, Charles Haliday, the Governor of the Bank of Ireland, and John Barlow, a former Governor, told the Select Committee on the Bank Acts that Bank of England notes did not circulate in Ireland.[41] Equally, we have not made any adjustment for Irish bank notes circulating in Britain because, according to Barrow, post bills as opposed to bank notes were used to make payments across the Irish Sea.[42] In other words, Irish produce sold to Britain was paid for in bills or gold coin, which was an inconvenience to those who returned with it as we have noted in section A1.1. We have not seen any evidence that Scottish and English bank notes circulated in Ireland. Furthermore, one could assume that if Bank of England notes (which presumably enjoyed the highest status in the UK) did not circulate, then it is difficult to conceive that the Irish public circulated English or Scottish bank notes.

However, currency notes were made legal tender in Ireland following the outbreak of the First World War.[43] From August 1914 currency notes arrived in Ireland through the banking system, which received them from the Bank of England in exchange for specie. The value of currency notes in the hands of the Irish public during the war is unknown. The available evidence suggests that it was small. In September 1922, when the volume of currency notes outstanding in the United Kingdom was still near its peak, it was estimated by the Irish Ministry for Finance that £3.88 million circulated in the *Free State.*[44] However, this included the amount in banks, which following the introduction of currency notes had agreed to use these notes as reserves for their own issuance.[45] In addition, the public had little incentive to exchange notes given that Irish bank notes were legal tender and that currency notes could only be converted into specie at the Bank of England. If we adjust the estimate of currency notes in the Free State to the whole of Ireland on the basis of population, the worst case scenario is that by the end of our period, we underestimate $M3$ by roughly 2 per cent, while the pre-1914 data is unaffected.[46] In consideration of these facts, we have decided to make no

[38] Hatton and Williamson, 'After the Famine'; Ó Gráda, 'A Note on Nineteenth Century Emigration Statistics'.
[39] Ó Gráda, 'A Note on Nineteenth Century Emigration Statistics'.
[40] Hall, *The Bank of Ireland*, pp. 235-6.
[41] P.P., 1858, p. 270.
[42] Barrow, *The Emergence of the Irish Banking System*, p. 172.
[43] 4 & 5 Geo. V, c.14.
[44] UCD Archives, P67/173.
[45] Hall, *The Bank of Ireland*, p. 322.
[46] Population figures from Mitchell, *British Historical Statistics*, pp. 11-3.

direct adjustment for currency notes in the hands of the public, although their role as reserves is perfectly captured by the statistics in *Thom's Irish Almanac*.

A2 Deposits

From the late 1870s *The Economist* published figures for the deposits of the Irish joint-stock banks. However, the official series has been preferred for three reasons. Firstly, it runs consistently over the entire period. Secondly, while the correlation is high between the two, the level of *The Economist* series is systematically higher, which is a result of the unwanted inclusion of public deposits at the Bank of Ireland and the English deposits of the National and Provincial. Thirdly, because the official returns were anonymous, the deposit figures were therefore less likely to be biased.

Despite its merits the official series also has weaknesses. Firstly, the statistics exclude the joint-stock banks that failed within a few years of establishment. However, the omitted banks, Dublin Banking Company, English and Irish Bank, London and Dublin Bank, Provident Bank of Ireland, Tipperary Joint Stock Bank and the Union Bank of Ireland, were small in terms of their branch network and therefore would have had relatively small deposits.[47] The average coverage of the official series in terms of branches is 96 per cent.[48] Secondly, the private banks of Dublin were another blindspot of the official statistics. Six were active during the period: Ball & Co.; Boyle, Low, Pim & Co.; David La Touche & Co.; Guinness, Mahon & Co.; James B. Kennedy & Co.; and Robert Gray & Co.[49] Thirdly, prior to 1864 an unknown number of banks did not include sight deposits in their official returns.[50] Unfortunately, these returns were anonymous so it is not possible to retrospectively ascertain how many banks did this. However, it is unlikely that sight deposits were significant before this point. The scraps of evidence from the available balance sheets show that the ratio of sight to time deposits in 1859 was 1:3 at the Northern Bank and 1:13 at the Ulster Bank.[51] Furthermore, the Bank of Ireland did not pay interest on demand deposits until at least 1875.[52] Due to all of the above considerations, we deem the existing series to be sufficiently consistent in its construction.

[47] In the 1860s two foreign and colonial banks briefly had branches in Dublin: the European Bank and the General Exchange Bank. Neither have been included in the series because these banks mainly offered foreign exchange services. See Hall, *The Bank of Ireland*, pp. 249-50 for a discussion. Also, Capie and Webber do not include such foreign and colonial banks in their series for the wider United Kingdom.

[48] Data on branch numbers has been collected from Barrow, *The Emergence of the Irish Banking System*, p. 220 for the years 1840-4 and from the *Banking Almanac* for subsequent years. The information in this publication referred to the year before it was published. It includes head offices in Ireland but excludes head offices and branches in Britain, also excludes agencies and sub-branches. In a handful of cases, there was a lag between the establishment of a new bank and its inclusion in the *Banking Almanac*. In these cases, we assume that the bank had a single office.

[49] An R. Cane & Sons appears in a list of banks based in Dublin in the *Merchant's and Bankers' Almanac* for 1861, however, we adopt the rather strict policy of only including the private banks listed in *Thom's Irish Almanac*.

[50] Sight deposits are referred to as "cash balances" in the underlying sources.

[51] Ollerenshaw, *Banking in Nineteenth-Century Ireland*, pp. 91-2.

[52] P.P., 1875, p. 161.

The interbank deposit to gross deposit ratio is taken from an observation in 1875, when eight of the nine joint-stock banks in Ireland filed returns to the Select Committee on Banks of Issue.[53] The summary of these returns show 0.92 per cent (£296,125/£32,077,872) of gross deposits belonged to banks, while the rest belonged to the public. Thus, we multiply D_t by this coefficient for all time periods in order estimate an interbank deposit series. This static approach might introduce bias if this proportion changed significantly over time. Unfortunately, the existing evidence on this subject is scarce. Using the balance sheets of the largest bank, the National, we can ascertain that in 1861 the same ratio stood at 0.7 per cent. In later years, the balance sheets are comparatively highly aggregated. In 1899 the ratio, with the erroneous inclusion of drafts and acceptances, was 2.2 per cent, which stands as an absolute upper bound.[54]

Cheques in collection and items in transit were calculated in an identical manner to Capie and Webber.[55] While one may conjecture that cheques were not as significant in the earlier sample period, the evidence of contemporaries suggests that cheques circulated extensively as early as 1837 as a means of evading a law which had prohibited the drawing of bills of less than £50.[56] Therefore, although there are limitations to the approach, we employ Capie and Webber's static ratio. The resulting series needs a final adjustment before being deducted from D_t. In the process of clearing cheques, there is an interval between the time when the payee's account is credited at one bank and the time when the drawer's account is debited at another. During this period the value of the cheque appears as a deposit liability in both banks' balance sheets. We follow the Bank of England's policy, and by extension Capie and Webber's, by deducting 60 per cent of the estimated cheques and items in transit from the final gross deposit series.[57]

Thus, combining the adjustments for interbank deposits and cheques and items in transit, the effective multiplier that we apply to our estimated gross deposit series is 0.0236 $[0.0092 + (0.024 \times 0.6)]$.

A3. Reserves (R)

The calculation of a reserve series is based upon both published and unpublished balance sheets, which increased in quantity over time. For this reason, we will begin in the data rich years of 1912 to 1921 and work backwards. In this period, the joint-stock banks of Ireland published disaggregated year-end balance sheets in *The Economist*.[58] Each bank reported figures for cash in hand and at the Bank of England, deposits and notes in circulation. Using this data, we calculate a cash to demand liability ratio for the joint-stock banks and multiply it by our own series of the demand liabilities of the entire banking system. Between 1877 and

[53] P.P., 1875, p. 559.
[54] Royal Bank of Scotland Archives, NB/118.
[55] Capie and Webber, *A Monetary History of the United Kingdom,* p. 298.
[56] P.P., 1837, p. 264.
[57] Bank of England, 'Reserve Ratios: Further Definitions'; Capie and Webber, *A Monetary History of the United Kingdom,* pp. 302-3.
[58] *The Economist*, various years.

1912, *The Economist* reported a broader cash measure, which included erroneous non-cash items such as loans at call. Therefore, in order to overcome the change in levels, we have spliced backwards from 1912 using the growth rate in the broader cash to demand liability ratio. The level of the ratio in 1877 is linked with changes in the Bank of Ireland and the National's cash ratio back to 1840.[59] There were no balance sheets available for 11 of the 38 years in this period. The missing observations were filled with linear interpolation.

This approach could yield misleading reserve ratios in two circumstances. Firstly, if the ratio of true-cash items to non-cash items varied between 1877 and 1912, then our estimate is likely to be biased accordingly. Between the turbulent years of 1912 and 1921, the ratio was relatively stable around an average of 2.42 with a standard deviation of 0.46. Secondly, if the reserve ratios of the Bank of Ireland or the National were idiosyncratic between 1840 and 1877 then our estimate will also be biased. It is impossible to avoid this potential hazard given the lack of suitable balance sheets in sources such as the *Banking Almanac*, *Bankers' Magazine*, *Freeman's Journal,* Parliamentary Papers and the archive material of the Bank of Ireland, National and Provincial that we have been able to access. However, there was a statistically significant positive correlation between the reserve ratios of both the Bank of Ireland (1885-1921: 0.94) and the National (1877-1921: 0.85) and the banking system as a whole.

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Paper II

European Review of Economic History, 1–22
doi:10.1093/ereh/hey003

Irish GDP between the Famine and the First World War: estimates based on a dynamic factor model

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A major issue in Irish economic history is the lack of national accounts before the interwar period. This paper constructs new annual estimates of real GDP between 1842 and 1913 based on a novel two-stage econometric approach. Our results show that while living standards approximately tripled in this period, development was uneven with contractions in economic activity not only during the Great Famine but also between the late 1890s and the First World War. As a proof of concept, we also apply our methodology to Swedish data. The resulting estimates closely match existing historical national accounts.

1. Introduction

Historical national accounts (HNAs) are a major input into important economic and historical debates, such as comparisons of living standards across time and space, and the causes and consequences of major macroeconomic events. In recent years there has been a wave of HNAs back to the Middle Ages for a number of European countries such as Britain (Broadberry *et al.* 2015a), Germany (Pfister 2011), Holland (van Zanden and van Leeuwen 2012), Italy (Malanima 2011), Portugal (Palma and Reis 2016), Spain (Álvarez-Nogal and Prados de la Escosura 2013), and Sweden (Schön and Krantz 2012).

Ireland lies on the periphery of this development with no consistent HNAs before the 1930s (Gerlach and Stuart 2015) except for some scattered benchmark estimates for the nineteenth and early-twentieth centuries (Geary and Stark 2015). The fundamental problem is the scarcity of data for the underlying components of traditional HNAs. As a result, we know less about the macroeconomic impact of the Great Famine of 1845, for example, than we do of the Black Death in England 500 years before.

This paper proposes a solution to the standstill, which can be applied in other contexts in economic history for which similar conditions prevail. Building on the business cycle literature that identifies the cycle using factors models (Sarferaz and Uebele 2009; Ritschl *et al.* 2016), we develop a two-stage approach to estimate GDP. In the first stage, a dynamic factor model is estimated to identify the common movement in a set of key macroeconomic variables. The data set includes those sub-components of GDP that are available (on the expenditure, income, and output sides), as well as the growing body of high-quality macroeconomic time series that are in theory correlated with GDP, such as monetary aggregates (Kenny and Lennard 2017) and share prices (Hickson and Turner 2008; Grossman *et al.*

2014). A problem with dynamic factor models is that the resulting index is unitless. In the second stage, we therefore normalize the index against existing benchmarks of GDP. This normalization gives the index an economic interpretation.

As a proof of concept, we apply the new method to Swedish data. Not only are the Swedish HNAs relatively accurate, but the two economies were similar in this period, consisting of large agricultural and external sectors. This experiment shows that the methodology captures both the short- and long-run movements in existing estimates of real GDP, which demonstrates that our method is a viable alternative to traditional HNAs.

A number of results emerge from the new estimates of Irish real GDP between 1842 and 1913. First, living standards effectively tripled between the Famine and the First World War. Second, the volume of economic activity contracted by 21 percent during the Great Famine. This contraction is the largest in the known economic history of Ireland (Gerlach and Stuart 2015). Third, from the late 1890s to the Great War, the standard of living declined. This slump may have been related to the political uncertainty associated with the possibility of Irish independence.

Section 2 discusses the existing literature on Irish GDP prior to the First World War. Sections 3 and 4 set out the methodology and data, respectively. Section 5 presents the new annual estimates of real GDP. Section 6 assesses the sensitivity of the results to a number of alternative specifications. The final section concludes.

2. Historical national accounts for Ireland

There are numerous, potentially irreconcilable, challenges in constructing HNAs for Ireland. The fundamental issue is that, whether calculated on either the expenditure, income or output side, HNAs require a critical mass of time series data. Although a great deal of work has gone into the production of such data, the critical mass has seemingly not been reached. In fact, as a consequence of the integration of Ireland and Great Britain in the nineteenth century, there are real limitations to the volume of statistics that can ever be collected in the future.[1] On the expenditure side, for example, comprehensive trade data is lacking between 1825 and 1904 (Solar 1990a). Not only is this a component of GDP, probably an important one in the Irish case, it is also used to calculate consumption. In terms of income, while the income tax returns are a promising source of information, there are serious issues relating to their reliability and consistency over time.[2] Finally, on the output side, among other issues, progress is limited by the lack of an input-output table, which has been used in the case of Britain, for example, to establish sectoral weights (Broadberry *et al.* 2015a).

In the absence of HNAs, two approaches have typically been followed in the literature. The first approach has been to construct proxies of GDP. O'Rourke (1998) multiplied estimates of velocity by a measure of the broad money supply to give nominal "GDP" for the years between 1845 and 1913. However, if velocity were known, then so would GDP, as the former can only be calculated by dividing the latter by the money supply. Therefore, O'Rourke regresses velocity on a number of variables for other European countries, and plugs in Irish data to get an out-of-sample forecast of Irish velocity. The exercise showed that GDP fell in nominal terms by a quarter during the Famine, but was three times as high

[1] The United Kingdom consisted of the kingdoms of Great Britain and Ireland between 1800 and 1921. In this paper, references to the United Kingdom relate to both kingdoms, while references to Great Britain relate to that kingdom alone.

[2] See Begley *et al.* (2010) for details.

on a per capita basis by the First World War. However, O'Rourke notes that "it would be foolish to use such numbers to track annual variations in GDP, or even to estimate growth rates over the period as a whole."

The second approach has been to produce point estimates of national income and expenditure.[3] Mokyr (1985, p. 11) placed income on the eve of the Famine at £75–85 million, or £9–10 per capita. However, the calculations involved rest upon the assumption that the income of the poorest two-thirds of the population, which can be approximately measured, "received about a third of total income" (Mokyr 1985, p. 11). The next point estimates relate to the twentieth century. Bielenberg and O'Mahony (1998), making use of the first census of production, valued GDP on the expenditure side at market prices at £144 million in 1907. Cullen (1995), also making use of the 1907 census of production in addition to the 1911 census of population, estimated that GNP on the income side at market prices amounted to £139 million in 1911.[4]

At the frontier of the literature are the point estimates for 1861, 1871, 1881, 1891, 1901, and 1911 produced by Geary and Stark (2002, 2015). This too is a proxy or "short-cut" approach relative to HNAs because it distributes UK GDP on the basis of regional sectoral productivity (as measured by wages) and employment. The estimates are limited to every tenth year because they rely on employment information contained only in the census returns of those years. The numbers show that real GDP increased from £97.2 million in 1861 to £123.5 million in 1911.

3. Methodology

This paper develops a new two-stage methodology to estimate the level of real GDP. The first stage estimates a dynamic factor model for a set of time series representing a wide range of economic activity. However, the factors are unitless and have no economic interpretation. The second stage, therefore, normalizes the factors using existing benchmarks of GDP, which gives the factors an economic interpretation.

Dynamic factor models have been used previously in the estimation of business cycle fluctuations in both contemporary (Stock and Watson 1989) and historical (Sarferaz and Uebele 2009; Ritschl *et al.* 2016) contexts. The basic idea is that a time series is likely to be influenced by one or potentially more common factors as well as an idiosyncratic component. For example, consider the money supply and construction. The series might be driven by a number of common components such as economic activity and interest rates. In addition, each series might also be made up of idiosyncratic shocks, such as the introduction of a new payments technology in the case of the money supply and a land-use planning reform in the case of construction. Factor analysis enables the estimation of these unobserved common factors from which the business cycle is then identified. We extend this approach to estimate not only the business cycle but also the level of GDP.

To make the discussion more concrete, consider the following dynamic factor model:

$$x_{it} = \sum_{j=1}^{\mathcal{J}} \alpha_{ij} f_{jt} + \varepsilon_{it}, \tag{1}$$

[3] See Cullen (1995) for an interesting discussion of contemporary estimates of national income.
[4] Ó Gráda (1994, pp. 379–382) reworks this figure and arrives at £130–40 million for pre-war GNP.

$$f_{jt} = \sum_{k=1}^{K} \beta_{jk} f_{jt-k} + \vartheta_{jt}, \tag{2}$$

where x_{it} is one of $i = 1,\ldots,I$ time series. f_{jt} is one of $j = 1,\ldots,\mathcal{J}$ common factors that are assumed to be independent of each other. The α's are the factor loadings, which gives the relationship of the respective variable to the respective factor. ε_{it} and ϑ_{jt} are independent and normally distributed idiosyncratic error terms.

Two key issues arise relating to identification. First, if there is more than one factor, which factor or combination of factors represents GDP? To return to the example, it is not clear which of the two common factors is related to economic activity and which to interest rates. This problem is usually solved in the business cycle literature by assuming that the first factor, i.e., the factor that accounts for the most variability in the data, represents the business cycle (Breitung and Eickmeier 2006).

Second, the factors are never identified independent of the factor loadings. This implies that the size and sign of the estimated factor(s) can be large or small depending on the assumption imposed on the loadings. Changing the loading assumptions changes the estimates of the factors. This problem is often solved by imposing various (ad hoc) identifying assumptions to normalize the factors such that they can be interpreted as representing the business cycle.

In the second stage, the factors are cumulated into an index, which are then regressed on existing benchmarks of GDP. This stage agnostically identifies which factor or factors are correlated with GDP, but also helps to scale the indices, which are unitless, to the same units as the benchmarks. The identification issues are therefore resolved without resorting to ad hoc assumptions.

The estimates are based on the following steps:

(1) All nominal variables are deflated into real terms.
(2) The first difference of the log of non-stationary variables is taken: $\Delta x_{it} = \ln(X_{it}) - \ln(X_{it-1})$. This transformation is necessary since the factor model requires that the data is stationary.
(3) A principal component (PCA) model is estimated to identify the number of significant factors in the data. Dynamic factor models require that the number of factors to be estimated is specified. Estimating too few factors may cause biased estimates of the factors, while estimating too many quickly reduces the degrees of freedom and the precision of the estimates. The sensitivity of the results to the number of factors included in the dynamic factor model is shown in Section 6.
(4) The dynamic factor model is estimated by maximum likelihood with a Kalman filter. In Section 6, we show that the results are robust to the choice of estimator.
(5) As the model is estimated in log-growth rates, the factors also represent growth rates. To obtain an estimate of the level, an index is constructed by cumulating the respective factor: $\hat{I}_{jt} = \hat{I}_{jt-1} + \hat{f}_{jt}$, where $I_{-1} = 0$. Our estimation of the level using growth rates is similar to the approach of Bai and Ng (2004) who estimate non-stationary common factors using stationary growth rates, before cumulating them into levels.
(6) Alternative combinations of the indices are regressed on the benchmark estimates from Geary and Stark (2015): $\ln(Y_t) = \gamma_0 + \sum_{j=1}^{\mathcal{J}} \gamma_j \hat{I}_{jt} + \omega_t$.
(7) The vector of coefficients of the model that minimizes information criteria is multiplied by the respective annual indices to arrive at annual estimates of GDP: $\ln(\hat{Y}_t) = \hat{\gamma}_0 + \sum_{j=1}^{\mathcal{J}} \hat{\gamma}_j \hat{I}_{jt}$.

It is worth making two points on the methodology at this point. First, the annual estimates of GDP, and growth rates between various points, are not fixed to the benchmarks in

the second-stage regression. The estimates are free to take on any value in any given year. The only restriction imposed is that the average (log) deviation is zero. If the results are close to the benchmarks, then this validates the quality of the benchmarks and our model.

Second, time series are often measured with error, particularly in a historical context. As GDP is the sum of its underlying components, error in their measurement will affect the estimate of GDP, with the bias given by the ratio of the error to the true value of GDP. In a dynamic factor model, the measurement error is likely to be captured by the idiosyncratic component, ε_{it}, not by the common factor, f_{jt}. Therefore, measurement error has a smaller effect on our estimates compared to other approaches.

4. Data

A new balanced data set, constructed from primary and secondary sources, is used to estimate GDP. The baseline model includes 20 time series covering seven categories: macroeconomic, government, agriculture, construction, manufacturing, private consumption, and services (see table 1). The macroeconomic category includes population, currency in the hands of the public, interest rates, Poor Law recipients per capita, stock prices, and wages. The government category includes government revenue. The agriculture category includes grain imports and oxen, pig, and sheep exports. The construction category includes timber imports. The manufacturing category includes butter exports, distilling output, Guinness sales, linen cloth exports, and shipbuilding. The private consumption category includes tobacco consumption per capita. The services category includes property transactions and rail revenue. The sources and transformations involved for each variable are discussed in table A1.[5]

A few variables are measured in nominal terms in the underlying sources, such as currency in the hands of the public, interest rates, stock prices, government revenue, and rail revenue. In the absence of annual GDP estimates, it follows that a GDP deflator is also missing. To construct a deflator we calculate the median inflation rate across existing price indices. For the years up until 1870, Geary and Stark (2004) have constructed two cost of living indices: a Poor Inquiry index and a compromise index. The former is based on expenditure shares derived from official inquiries in the 1830s, while the latter is based on a "best guess at a typical budget for a household of four to six persons of the urban and rural waged labouring class" (Geary and Stark 2004). For the years between 1860 and 1913, Brunt and Cannon (2004) have constructed four cost of living indices: an unadjusted and adjusted series based on 1859 consumption weights and an unadjusted and adjusted series based on 1904 consumption weights. The inflation rates of these indices are plotted in figure 1. The median is preferred over splicing one series from Geary and Stark and another from Brunt and Cannon because it is not clear which of their series should be preferred. The median also has the advantage that it incorporates more information.[6]

All variables are transformed into log first differences except the number of Poor Law recipients per capita and the real interest rate, which are first differenced. In a handful of cases, there are a small amount of missing observations, such as Poor Law recipients per capita (1899), government revenue (1889–1891), oxen exports (1873), and tobacco consumption per capita (1871–1875). In these instances, the gaps have been linearly interpolated.

[5] While the data set captures a large share of economic activity, a number of other series would be useful such as agricultural output before 1850, output of bread and biscuits, clothing production, and migration.

[6] This is also preferred to Kennedy's (2003) index that spans the entire period, as the basket of goods is comparatively light, while some of the prices are interpolated or proxied by their British counterparts.

Table 1. *Estimated factor loadings and variance of idiosyncratic component, 1842–1913*

		Factor 1	Factor 2	Variance of idiosyncratic component
Macroeconomic	Population	0.12	0.35***	0.16***
		(0.08)	(0.07)	(0.04)
	Real currency in the hands of the public	11.78***	3.57*	109.04***
		(1.74)	(2.03)	(21.57)
	Real interest rate	9.10***	−2.44	135.71***
		(1.72)	(1.76)	(25.59)
	Poor Law recipients per capita	0.08	−0.62***	0.37***
		(0.13)	(0.09)	(0.10)
	Real stock prices	10.82***	1.47	27.76***
		(1.16)	(1.70)	(8.01)
	Real wages	3.81***	−0.37	29.71***
		(0.75)	(0.79)	(5.23)
Government	Real government revenue	8.77***	0.70	55.02***
		(1.18)	(1.45)	(10.65)
Agriculture	Grain imports	−19.61***	−9.49**	948.32***
		(4.44)	(4.28)	(170.33)
	Oxen exports	−4.28	−2.30	486.54***
		(2.77)	(2.40)	(81.85)
	Pig exports	2.65	8.73**	797.78***
		(3.88)	(3.45)	(140.24)
	Sheep exports	−8.96***	−1.71	637.40***
		(3.22)	(2.98)	(107.81)
Construction	Timber imports	2.01	3.97**	357.89***
		(2.45)	(2.02)	(60.69)
Manufacturing	Butter exports	1.19	1.12	64.80***
		(1.02)	(0.87)	(10.90)
	Distilling output	4.50***	1.08	123.40***
		(1.44)	(1.33)	(20.94)
	Guinness sales	0.19	0.13	79.86***
		(1.11)	(0.96)	(13.31)
	Linen cloth exports	3.90***	0.22	72.05***
		(1.10)	(1.03)	(12.26)
	Shipbuilding	−7.15	6.20	2359.80***
		(6.14)	(5.03)	(396.62)
Private consumption	Tobacco consumption per capita	0.65	0.63	23.55***
		(0.62)	(0.54)	(3.96)
Services	Property transactions	1.16	−0.03	198.24***
		(1.74)	(1.43)	(33.06)
	Real rail revenue	13.39***	−4.18*	91.12***
		(1.79)	(2.21)	(22.33)
	Factor dynamics	0.06	0.63***	
		(0.13)	(0.12)	

Notes: Standard errors in parentheses. ***Statistically significant at 1 percent level, **statistically significant at 5 percent level, *statistically significant at 10 percent level.

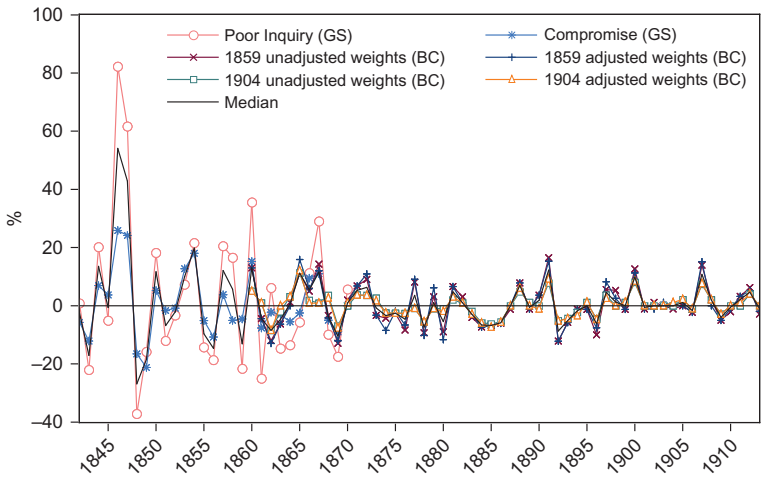

Figure 1. *Comparison of inflation estimates, 1842–1913.*
Notes and sources: BC = Brunt and Cannon (2004), GS = Geary and Stark (2004)

All series are either important components of GDP, on the expenditure, income or output side, or are, in theory, correlated with it. In terms of the components of GDP, the data set covers the output of a number of major industries, such as linen, which "from the eighteenth century to the First World War, […] took centre stage as Ireland's premier industry and primary industrial export" (Bielenberg 2009, p. 177). Textiles and clothing accounted for a third of value added when the first census of production was taken in 1907 (Bielenberg 2008). Other important industrial sectors are also included, such as construction (proxied by timber imports); food, drink, and tobacco; and iron, engineering, and shipbuilding, which together accounted for half of value added in industry. In addition, wages, which were the largest component of factor incomes in the wider United Kingdom in this period (Mitchell 1988), are captured as well.

In terms of correlates of GDP, we have included an index of stock prices, among others, based on the efficient market hypothesis that these prices contain information about economic fundamentals. Hickson and Turner (2008) argue, "as stock-market performance is widely regarded as a bellwether for real economic activity, our indices can serve as a measure of the levels and fluctuations of real economic activity in Ireland during an important period in its economic development." A measure of equity prices was also used in Ritschl *et al.* (2016). Currency in the hands of the public (Kenny and Lennard 2017) is included, based on the logic that monetary aggregates should be related to GDP through the quantity equation, given stable velocity. Bank notes, a large component of this aggregate, have been used in previous studies "as a good barometer of the level of economic activity" for this period in Irish history (Ó Gráda 1994, p. 178).[7]

The benchmark estimates used in step 6 for every tenth year between 1861 and 1911 are calculated as follows. Geary and Stark's (2015) estimates of the Irish share of UK real GDP for these years are multiplied by Feinstein's (Mitchell 1988) corresponding compromise estimate of UK real GDP.

[7] Other examples in Irish economic history include Ollerenshaw (1987, pp. 82–83).

Table 2. *Normalization of indices, 1861–1911*

	Model 1	Model 2	Model 3
Constant	4.374***	4.211***	4.309***
	(0.047)	(0.121)	(0.079)
Factor 1	0.037***		0.028*
	(0.005)		(0.010)
Factor 2		−0.04**	−0.012
		(0.010)	(0.012)
Adjusted R^2	0.923	0.779	0.924
Schwarz information criterion	−25.140	−18.832	−25.122

5. Results

The estimated factor dynamics and factor loadings are shown in table 1. Following initial testing using PCA, two common factors are estimated: factor 1 (f_1) and factor 2 (f_2).[8] Also shown in the table is the variance of the idiosyncratic components. The first factor, f_1, captures a significant positive co-movement between the macroeconomic variables (with the exception of population and Poor Law recipients per capita), government revenue, manufacturing production, such as distilling output and linen cloth exports, and services, as measured by rail revenue, and a significant negative co-movement with grain imports and sheep exports. The second factor, f_2, captures a significant co-movement between population, currency in the hands of the public, Poor Law recipients per capita, grain imports, pig exports, timber imports, and rail revenue.

Having obtained the dynamic factors, we then create an index for each factor and regress them on the six benchmark GDP estimates. These regressions are only performed to normalize the indices and the estimated parameters have no economic interpretation. As the regressions are only based on six observations, one should be careful when interpreting the parameters, standard errors, and significance levels.

Three models are estimated to normalize the indices. The first model includes index 1 ($\hat{I}_1$). The second model includes index 2 ($\hat{I}_2$). The third model includes both indices ($\hat{I}_1$ and $\hat{I}_2$). Based on the results in table 2, the first model is preferred due to better performance in terms of information criteria.

The average (log) deviation between our estimate and the benchmarks of GDP is by construction zero. However, there is no guarantee that the deviations are small for each benchmark year. Nevertheless, the results in table 3 show that the estimates are close to all of the benchmarks. There is virtually no deviation in 1861, 1871, 1901, and 1911, while the largest relative error was −4.0 percent in 1881. This error is relatively small. For example, Feinstein's (Mitchell 1988) income and expenditure estimates of UK nominal GDP at factor cost differ by as much as 25 percent in a single year.

5.1 Irish economic growth

Figure 2 presents annual estimates of real GDP for Ireland between 1842 and 1913.[9] Expressed in constant 1913 prices, the aggregate level is plotted in the top panel, while the bottom panel is shown in per capita terms. The dashed lines are 95 percent confidence

[8] The results of the PCA are shown in table C1.
[9] See table B1 for the underlying annual estimates.

Table 3. *Estimates of real GDP and benchmarks (£ millions), 1861–1911*

	Benchmarks	New estimates	Difference (%)
1861	97.21	98.36	1.18
1871	105.02	105.10	0.08
1881	115.20	110.54	−4.04
1891	113.41	117.18	3.32
1901	125.58	125.03	−0.44
1911	123.51	123.58	0.05

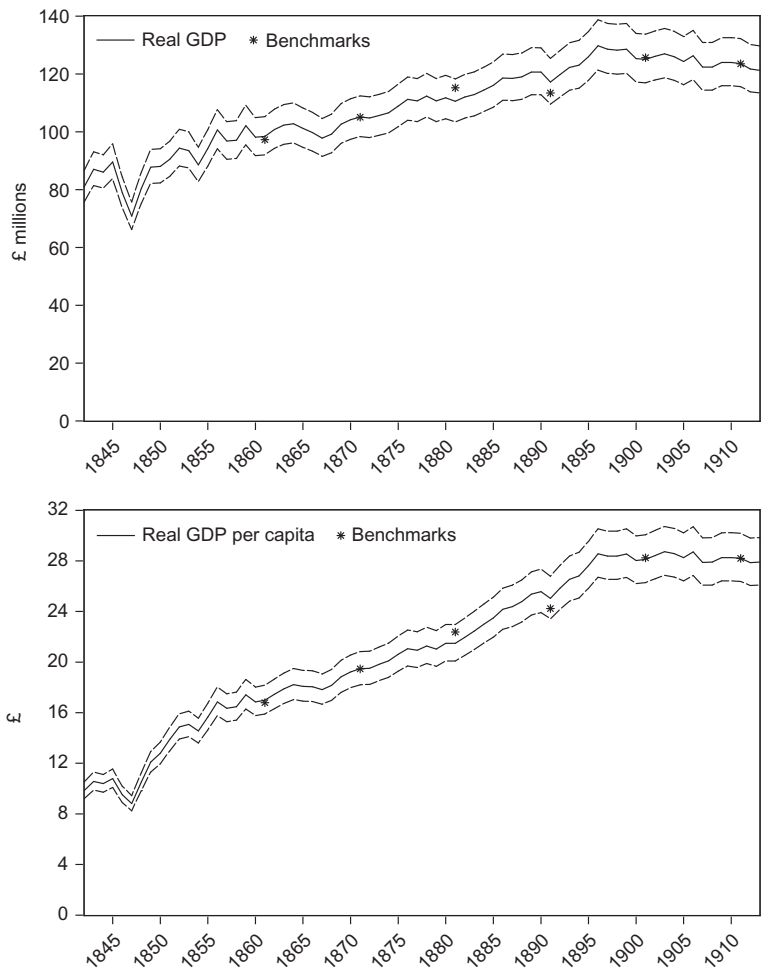

Figure 2. *Estimates of real GDP and real GDP per capita, 1842–1913.*
Note: Dashed lines are 95 percent confidence bands

Table 4. *Average growth of real GDP per capita in Europe (%), 1842–1913*

	Average growth rate
Sweden	1.6
Ireland	1.5
Denmark	1.5
Norway	1.3
France	1.3
Great Britain	1.1
Netherlands	0.8
Italy	0.5
Greece	−0.1
Average	1.1

Source: British data from Thomas and Dimsdale (2017). Other data from Bolt and van Zanden (2014).

intervals, which are based on the standard deviation of the residuals from the second-stage regression. Although there is some deviation between our estimates and the benchmarks, the latter lie within the 95 percent confidence intervals.

The pace of Irish economic growth was impressive between 1842 and 1913. On an aggregate basis, the average rate of growth was 0.6 percent per year, which over the full period saw the size of the economy expand by 50 percent. On a per capita basis, the average rate of growth was 1.5 percent, which meant that living standards almost tripled. The measured increase in living standards is consistent with the literature. Ó Gráda (1994, p. 250) notes that "a whole series of proxies for living standards—wages, consumption, literacy, life-span, height, birth weight, argue for betterment between the Famine and the First World War." Cullen (1972, p. 138) efficiently summarized, "living standards rose" during this time.

As a result of the recent upsurge in the construction of HNAs, data for GDP per capita is available for nine European countries for the years 1842 and 1913. The average growth rate over this interval is displayed in table 4, descending in order from the fastest to slowest growing economies. In an international perspective, the increase in Irish living standards was high. Only in Sweden was per capita GDP growth in Europe greater.

The rapid increase in living standards following the Famine resembles the experience of European countries following the Black Death in the fourteenth century (Pamuk 2007). However, the success of the Irish economy to deliver higher living standards must be balanced by its failure to do so for a growing population, which declined from 8.3 million in 1845 to 4.3 million in 1913 (Mitchell 1988). Boyer *et al.* (1994) calculate that emigration raised per capita income by as much as 25 percent. Part of the increase in living standards is thus due to a falling population.

A striking feature of figure 2 is the slowdown in growth at the tail end of the nineteenth century. From the peak in 1896, output growth was −0.4 percent per year, relative to 0.8 percent after the recovery from the Famine. At the heart of the stagnation may be political uncertainty linked to the growing prospect of Irish independence. Hickson and Turner (2005) argue that "political economy led to an unexpected rise in the real discount rate", while Grossman *et al.* (2014) suggest that it may have also led to capital flight.

5.2 Business cycle fluctuations

Estimates of the Irish business cycle are presented for the first time in figure 3. Business cycles are of interest as they inflict welfare losses on society. The estimates are based on the new series of real GDP and a band pass filter. Specifically, a Maximum Overlap Discrete

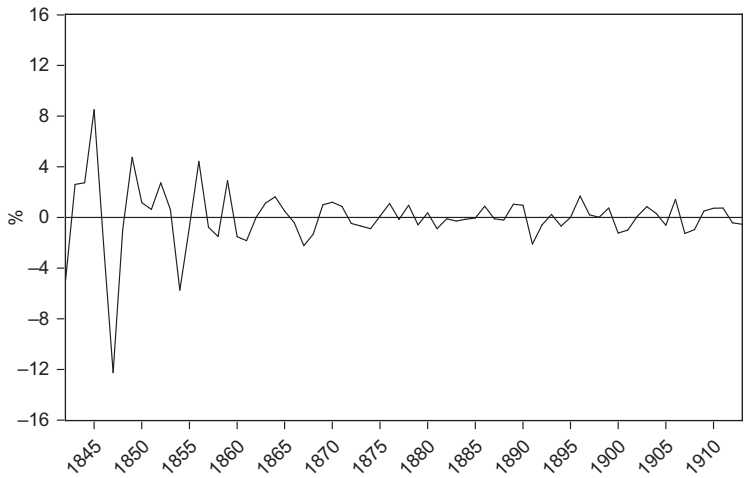

Figure 3. *The business cycle, 1842–1913.*

Wavelet Transform (MODWT) with a Daubechies (4) wavelet filter is used to retain cyclical components lasting 2–8 years.[10] The MODWT combines time and frequency resolution and can therefore estimate the cyclical component of GDP even in the presence of structural breaks, outliers, and other non-recurring events. A chronology of turning points based on the business cycle is shown in table 5.[11]

The major event of the 1840s was, of course, the Great Famine. The macroeconomic consequence of this ecological disaster was severe. From the arrival of the potato blight in the autumn of 1845 to its passing in Black '47 (Ó Gráda 2007), real GDP declined by 21 percent. The lion's share of the decline operated through the business cycle, but there was also a reduction in trend output as well. In a comparative perspective, the output losses in the Great Famine in Ireland were far larger than those in the other major Famines in the history of the British Isles. For example, output declined by little more than 1 percent during the Great European Famine that struck England between 1315 and 1317 (Broadberry *et al.* 2015a, p. 228). This confirms Solar's (1989) view that the Irish Famine was no ordinary subsistence crisis.

The estimates suggest that there was a strong recovery from the Famine. In 1848 and 1849 output grew by 14 percent and 9 percent, respectively. This is perhaps hard to reconcile with the existing narrative, which suggests that 1848 was not a year of recovery but of continued hardship. The crude death rate was still particularly high, although less so than in 1847 (Vaughan and Fitzpatrick 1978; Mitchell 1988). Our approach, like all national accounts, measures market-based economic activity. It is possible that the recovery in non-market activity may have been somewhat different. If this was the case, then there would have also been implications for the distribution of income. In any case, the results show that output had returned to trend in 1849, while the level of GDP recovered in 1851.

[10] For more information about the MODWT, see Percival and Walden (2006) and Andersson (2016).

[11] Note that the results are not sensitive to the filtering method. The correlation between the wavelet and Hodrick-Prescott estimates of the business cycle is 0.99.

Table 5. Chronology of the business cycle, 1842–1913

Peak	Trough	Peak	Trough
1845	1847	1880	1881
1849	1854	1886	1888
1856	1858	1889	1891
1859	1861	1893	1894
1864	1867	1896	1900
1870	1874	1903	1905
1876	1877	1906	1907
1878	1879	1911	

The 1850s were hit by a number of major shocks. After the 1840s it was the most volatile decade of the period, as measured by the standard deviation of the cycle. The first shock came in 1854 when the real value of Irish output fell by 5 percent. This was the largest decline between the Famine and the First World War. The median cost of living index increased by 20 percent, which Lynch and Vaizey (1960, p. 146) associate with the Crimean war. The inflation was not fully compensated for by nominal variables, such as currency, stock prices, interest rates, and railway revenue, so that the real value fell. In addition, the quantity of real variables, such as distilling output and linen cloth exports also declined significantly. The trough was also associated with a bout of migration, with more than 2 percent of the population emigrating (Vaughan and Fitzpatrick 1978; Mitchell 1988). The next shocks were the financial crises of 1856 and 1857. The first of which saw the failure of the Tipperary Bank, while the second was associated with the international crisis. A negative output gap emerged in 1857 and 1858. Lastly, the extreme weather that began in the summer of 1859 and ended in 1864 led to a major agricultural depression (Turner 1996, pp. 30–32). The level of GDP fell by 4 percent between 1859 and 1860, while a negative output gap persisted into 1861.

The outbreak of the American Civil War coincided with the beginning of a short expansionary cycle. The linen industry, in particular, was stimulated by the subsequent cotton Famine across the Atlantic—the value of Irish linen exports increased by 71 percent between 1861 and 1865 (Solar 2005). The trough in 1867 was associated with a sudden 17 percent collapse in the value of agricultural output (Turner 1996, pp. 108, 124). Interestingly, the Fenian Rising, a rebellion organized by the Irish Republican Brotherhood, flared during this depression. The link between economic hard times and the rise of Irish nationalism is a promising area for future research, which is now possible given the new estimates.

Agricultural crisis returned after the poor harvests of 1879–1881 (Ó Gráda 1994, p. 250), leading to a spike in emigration (Vaughan and Fitzpatrick 1978). Yet the economy contracted by just 0.1 percent in this period, which supports Donnelly's (1976) view that this agricultural depression had less macroeconomic significance than that of 1859.

The major macroeconomic events are consigned to the history of the earlier period as opposed to the latter, but there are some further events of interest that are evident in the new series. The failure of the Munster Bank in 1885, the last major bank to do so before 2008 (Ó Gráda 2012), was associated with below-trend output several years before the crisis. Its failure may have had its origin in the weak fundamentals of the time. Interestingly, the international crisis of 1907 emerges as a trough. In response to the crisis, the Bank of Ireland increased its discount rate from 4.5 percent in the spring to 7 percent in the autumn (Hall 1949, p. 389). As monetary policy had large real effects in the United Kingdom in this

period (Lennard 2017), the Bank's response was potentially the source of reduced output as opposed to the panic itself.

There was a moderation of the business cycle after the 1870s. The standard deviation of the cycle fell by nearly three quarters in the period 1880–1913 relative to 1842–1879. A possible cause of the decline in macroeconomic volatility is that agricultural output became much less variable from the 1880s. Grossman *et al.* (2014) find that equity price volatility also declined substantially between the 1880s and the Great War. Previous research has identified a link between macroeconomic volatility and stock-market volatility (Beltratti and Morana 2006).

6. Robustness

In this section, we carry out a number of exercises to gauge the reliability of the new estimates. We first apply the method to Swedish data and compare the results to existing HNAs. Returning to Ireland, we then consider a number of alternative specifications, such as estimating fewer factors, using a state-space model, including agricultural output instead of agricultural proxies, and normalizing with both factors.

6.1 A proof of concept: estimates of Swedish GDP, 1842–1913

We first investigate whether our two-stage methodology works well for an economy with existing HNAs. While there are many possible candidates, we opt for Sweden for two reasons. First, as small, open economies, comparisons between Sweden and Ireland are well established (Kenny 2016). Second, a dynamic factor model has been estimated for the Swedish economy in this period to estimate business cycles (Enflo and Morys 2013). As a result, we include exactly the same data, which constrains us from cherry-picking variables to match the existing estimates. The data set includes 15 variables that cover similar categories, such as macroeconomic, government, agriculture, construction, and manufacturing, but is narrower in that it does not include private consumption or services. Using this data, we re-follow steps 1–7, again using the CPI instead of the GDP deflator in the first step, and using benchmarks of real GDP (Schön and Krantz 2012) in 1861, 1871, 1881, 1891, 1901, and 1911 in step 6.

Figure 4 plots the estimates from the dynamic factor model along with the existing series of Swedish GDP. The figure shows that the model captures the broad contours of economic activity. There is a period between the late 1880s and 1900 when our estimates are consistently higher than the existing HNAs. However, the average deviation is only 3.8 percent. Beyond visual inspection, it is useful to measure how the model captures the short and long-run dynamics. In terms of the short-run, the correlation coefficient in first differences is 0.49, which is statistically significant at the 1 percent significance level. In terms of the long-run, if the two series share similar trends, any difference between the two should be temporary with the implication that the series are cointegrated. An Engel–Granger test of cointegration points to a significant ($p < 0.01$) cointegrating relationship between the estimates from the dynamic factor model and the existing series. Thus, this example is a proof of concept that the two-stage methodology captures both the short and long-run movements in GDP.

6.2 Alternative first- and second-stage regressions

The next step is to test how sensitive the Irish estimates are to alternative first- and second-stage regressions.

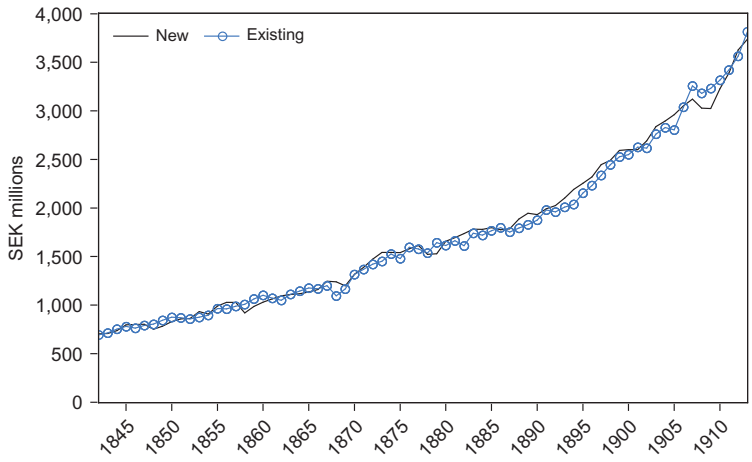

Figure 4. *New and existing estimates of Swedish real GDP, 1842–1913.*

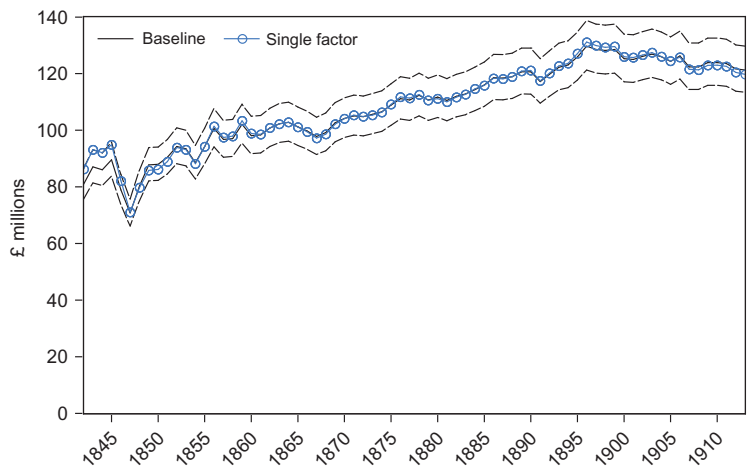

Figure 5. *Sensitivity of estimates of real GDP to number of factors, 1842–1913.*

6.2.1 Number of factors. In the first stage, we estimate a dynamic factor model with the number of factors determined by PCA. As a result, we included two factors in the baseline model. An alternative is to estimate a model assuming only one factor. Figure 5 plots the results from the baseline model and the associated confidence intervals, along with the estimates based on a single factor. Both estimates are similar with a correlation in first differences of 0.99 ($p < 0.01$). The results are, therefore, robust to an alternative number of factors included in the dynamic factor model.

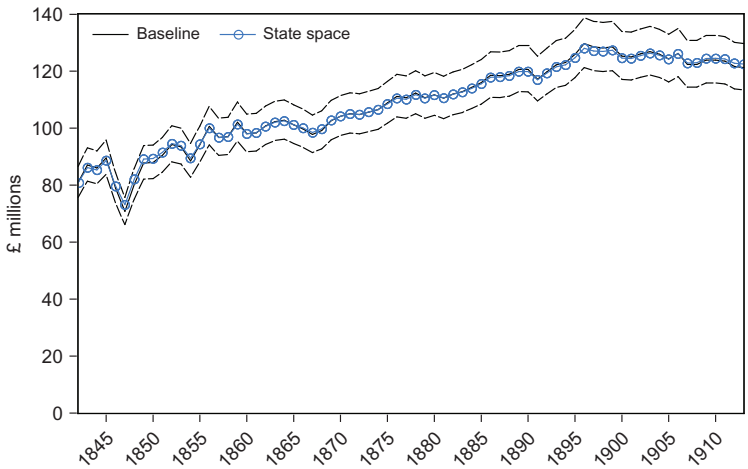

Figure 6. *Sensitivity of estimates of real GDP to econometric method, 1842–1913.*

6.2.2 Econometric method. The results might also be sensitive to the econometric method used in the first-stage regression. The dynamic factor model was used as the baseline as it has become the standard in business cycle applications (Ritschl *et al.* 2016). However, a reasonable alternative is a state-space model, as used in Gerlach and Gerlach-Kristen (2005). Figure 6 shows that the results are not materially sensitive to the choice of econometric method. The state-space estimates lie within the 95 percent confidence interval of those of the dynamic factor model. The correlation between the two in first differences is 1.00 ($p < 0.01$).

6.2.3 Choice of data. The variables included in the first-stage regression are carefully chosen to represent a wide range of economic activity. Agriculture was a major sector of the Irish economy, employing roughly half of the labor force (Geary 1998; Geary and Stark 2002). In the baseline model, four components of agricultural output are included. However, from 1850 the gross output of the aggregate agricultural sector is available, which is a broader indicator than we use in the main specification. Figure 7 shows the results from a model with the volume of agricultural output included in place of the proxies, alongside the baseline estimates. Again, the results are very similar to the baseline with a correlation in first differences of 0.96 ($p < 0.01$) over the common sample.

6.2.4 Normalizing with two factors. In terms of the second-stage regression, only the first factor was used in the normalization. However, it is useful to explore whether using both factors leads to markedly different estimates of GDP. Figure 8 shows that this is not the case. The two estimates are much the same, except that normalizing with both factors suggests a slightly lower level before the Famine and a stronger recovery. Nonetheless, the correlation in first differences is 0.87 ($p < 0.01$).

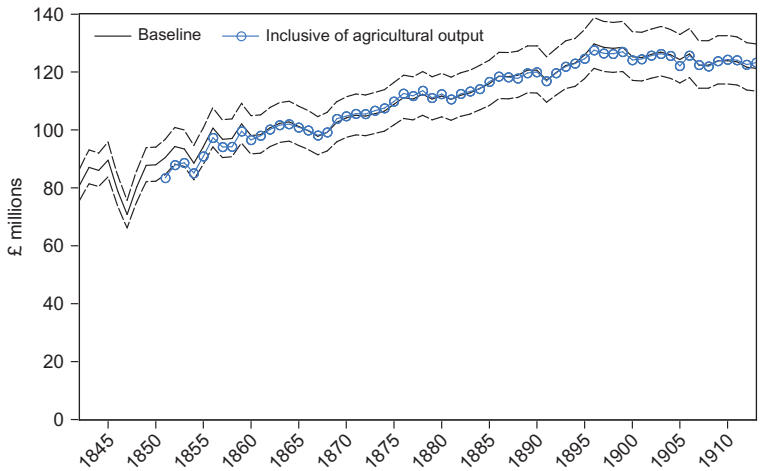

Figure 7. *Sensitivity of estimates of real GDP to inclusion of agricultural output, 1842–1913.*

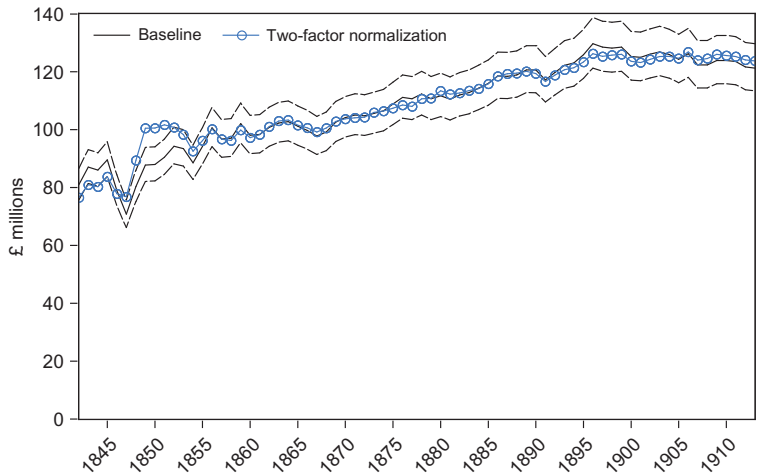

Figure 8. *Sensitivity of estimates of real GDP to two-factor normalization, 1842–1913.*

6.2.5 Summary. Overall, the baseline results are robust to a number of alternative specifications, such as estimating fewer factors, using a state-space model, including agricultural output instead of agricultural proxies, and normalizing with both factors.

7. Conclusion

A major issue in Irish economic history is the lack of historical national accounts prior to the 1930s. The fundamental issue is a lack of data on either the expenditure, income or

output side. This paper introduces an alternative methodology, based on a dynamic factor model, to make use of the available time series evidence. The included series cover the five largest industrial sectors, which together accounted for more than 80 percent of industrial output when the first census was taken in 1907. The agricultural sector was captured by a series of proxies as agricultural output was not available for the full sample. However, its inclusion for a restricted sample has no bearing on the results. The estimates are also robust to a number of other specifications.

The new annual estimates of real GDP point to three major findings. First, living standards improved by 1.5 percent per year between 1842 and 1913. Second, output declined by almost a quarter during the Famine, which is the largest contraction in recorded Irish economic history. Third, economic activity fell from a peak in 1896 to the First World War. The decline was associated with the rising possibility of Irish independence, which has been linked to a rise in the real discount rate and capital flight.

Historical national accounts for the nineteenth century are the holy grail of Irish economic history. While the approach of this paper does not reach those heights by traditional means, it is surely an improvement on focusing on a single time series on blind faith that it is a bellwether of wider economic activity. Even if the "tantalizing dream" (Kennedy 1997) is achieved in the future by standard means, an alternative indicator of economic activity, with well-measured inputs from other sectors such as finance, would be a complement to, as opposed to a substitute for, HNAs.

The approach is potentially useful in other contexts where the construction of HNAs is held back by a lack of data. Benchmarks are available, for example, for colonial India (Broadberry *et al.* 2015b) and for Japan between the eighth and nineteenth centuries (Bassino *et al.* 2017). In combination with annual data that are commonly available, such as wages, prices, trade, and government revenue, it is possible to construct estimates of the level of annual GDP using the two-stage method developed in this paper. This approach may also be valuable for modern developing economies, where existing GDP data is unreliable (Jerven 2013).

Acknowledgements

For help and comments, we are grateful to Anders Ögren, Frank Geary, Gareth Campbell, Jonas Ljungberg, and Seán Kenny. We also thank Kerstin Enflo for providing us with the data for the Swedish dynamic factor model.

Conflict of interest statement. None declared.

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Appendix A

Table A1. *Data and sources*

Variables and units	Sources and notes
Population (number)	Mitchell (1988). Mid year
Real currency in the hands of the public (£)	Nominal series from Kenny and Lennard (2017). Deflated using median cost of living index
Real interest rate (%)	Nominal series from Hall (1949). Weighted annual average of discount rate on 3 month Irish bills. Deflated using median cost of living index
Poor Law relief recipients per capita (number)	Number of indoor recipients from Thom's Irish Almanac (various years). 1899 linearly interpolated due to missing observation. Population from Mitchell (1988)
Real stock prices (1825 = 100)	1840–64: Hickson and Turner (2008), 1865–1913: Grossman *et al.* (2014). Multiplicatively spliced. Year end. Weighted by market capitalization. Deflated using median cost of living index
Real wages (1900 = 100)	Williamson (1995). PPP-adjusted for unskilled labor
Real government revenue (£)	1840–81: House of Commons (1886), 1882–1913: Thom's Irish Almanac (various years). Sum of customs, excise and stamp duties, and income tax revenues. 1889–1891 linearly interpolated due to missing observations. Deflated using median cost of living index
Grain imports (1,000 hundredweight)	Brunt and Cannon (2004)
Oxen exports (100 head)	1840–4: Solar (2006), 1845–1913: Solar (1987). Multiplicatively spliced. 1873 linearly interpolated due to missing observation
Pig exports (100 head)	1840–4: Solar (2006), 1845–1913: Solar (1987). Multiplicatively spliced
Sheep exports (100 head)	1840–4: Solar (2006), 1845–1913: Solar (1987). Multiplicatively spliced
Timber imports (loads)	Bielenberg (2009). Total imports spliced backwards from 1904 using growth rate in imports from foreign

(*Continued*)

Table A1. *Continued*

Variables and units	Sources and notes
Butter exports (hundredweights)	Solar (1990a)
Distilling output (proof gallons)	Bielenberg (2003)
Guinness sales (bulk barrels)	Hughes (2006). Porter and extra stout
Linen cloth exports (1,000 yards)	1840–52: Solar (1990b), 1853–1913: Solar (2005)
Shipbuilding (tonnage)	Bielenberg (2009). Capacity of new ships built
Tobacco consumption per capita (pounds)	Bielenberg and Johnson (1998). On which duty was paid. 1871–5 linearly interpolated due to missing observations
Property transactions (number)	O'Rourke and Polak (1994)
Real rail revenue (£)	Thom's Irish Almanac (various years). Deflated using median cost of living index
Median cost of living index (1913 = 1)	1840–70: Geary and Stark (2004), 1860–1913: Brunt and Cannon (2004)
Agricultural output (1850 = 100)	Turner (1996). Chained Laspeyres quantity index

Appendix B

Table B1. *New estimates of real GDP and real GDP per capita (1913 prices), 1842–1913*

Year	Real GDP (£ millions)	Real GDP per capita (£)	Year	Real GDP (£ millions)	Real GDP per capita (£)
1842	80.96	9.85	1878	112.36	21.27
1843	87.04	10.56	1879	110.70	21.02
1844	86.04	10.39	1880	111.75	21.48
1845	89.55	10.80	1881	110.54	21.48
1846	78.89	9.52	1882	111.97	21.95
1847	70.78	8.82	1883	112.83	22.46
1848	80.38	10.52	1884	114.37	22.99
1849	87.77	12.10	1885	116.02	23.49
1850	87.98	12.79	1886	118.55	24.16
1851	90.46	13.89	1887	118.46	24.39
1852	94.29	14.88	1888	118.95	24.78
1853	93.46	15.08	1889	120.65	25.36
1854	88.51	14.55	1890	120.63	25.57
1855	94.17	15.66	1891	117.18	25.04
1856	100.64	16.85	1892	119.77	25.85
1857	96.77	16.35	1893	122.24	26.53
1858	97.05	16.47	1894	123.04	26.81
1859	102.11	17.42	1895	125.93	27.62
1860	98.09	16.85	1896	129.70	28.56
1861	98.36	16.99	1897	128.52	28.37
1862	100.80	17.45	1898	128.23	28.38
1863	102.29	17.89	1899	128.54	28.55
1864	102.79	18.22	1900	125.26	28.03
1865	101.16	18.08	1901	125.03	28.11

(*Continued*)

Table B1. *Continued*

Year	Real GDP (£ millions)	Real GDP per capita (£)	Year	Real GDP (£ millions)	Real GDP per capita (£)
1866	99.72	18.05	1902	126.09	28.43
1867	97.79	17.82	1903	126.91	28.73
1868	99.20	18.15	1904	125.96	28.58
1869	102.62	18.83	1905	124.31	28.26
1870	104.18	19.22	1906	126.27	28.71
1871	105.10	19.47	1907	122.36	27.88
1872	104.78	19.50	1908	122.35	27.90
1873	105.60	19.82	1909	123.93	28.25
1874	106.52	20.10	1910	123.93	28.26
1875	108.85	20.62	1911	123.58	28.21
1876	111.17	21.06	1912	121.70	27.86
1877	110.65	20.93	1913	121.25	27.90

Appendix C

We use PCA to determine the number of factors to be estimated in the dynamic factor model. It is possible to estimate the PCA either using the covariance matrix or the correlation matrix. The principal components are ranked such that the first component explains the most variation in the data set, the second component explains the second most variation, and so on. Table C1 shows that the first principal component explains 31.8 percent of the variation if the PCA is estimated using the covariance matrix and 23.6 percent if it is estimated using the correlation matrix. The second component explains either 25.3 percent (covariance) or 14.0 percent (correlation). The remaining components account for a smaller share of the variation. The differences in results between the covariance and the correlation-based estimates are explained by some of our variables having a higher variation compared to other variables.

Table C1. Variance explained by principal components (%)

	Covariance	Correlation
PC1	31.8	23.6
PC2	25.3	14.0
PC3	14.6	8.9
PC4	6.8	7.3
PC5	5.3	6.5
PC6	4.1	5.8

The estimation of the dynamic factor model includes up to two factors given the PCA results. We also allow the variance of the idiosyncratic components to vary to account for differences in volatility.

Paper III

Explorations in Economic History 68 (2018) 16–36

Contents lists available at ScienceDirect

Explorations in Economic History

journal homepage: www.elsevier.com/locate/eeh

Did monetary policy matter? Narrative evidence from the classical gold standard

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ARTICLE INFO

JEL classification:
E31
E32
E52
E58
N13

Keywords:
Business cycles
Gold standard
Monetary policy
Narrative identification

ABSTRACT

This paper investigates the causal effects of monetary policy on the British economy during the classical gold standard. Based on the narrative identification approach, I find that following a one percentage point monetary tightening, unemployment rose by 0.9 percentage points, while inflation fell by 3.1 percentage points. In addition, monetary policy shocks accounted for a third of macroeconomic volatility.

1. Introduction

A central question in macroeconomics is how monetary policy affects the economy (Nakamura and Steinsson, 2017). As the anchor of the "most widely used peg in modern financial history" (Mitchener and Weidenmier, 2015), there is a vast literature documenting how monetary policy affected the British economy during the classical gold standard (Aldcroft and Fearon, 1972; Andréadés, 1966; Ford, 1962; Goodhart, 1972; Pesmazoglu, 1951; Sayers, 1976; Tinbergen, 1950). At one end of the scale, Andréadés (1966, p. 316) notes that it had "very injurious effects", while at the other, Sayers (1976, p. 44) argues that it "did not matter".

Despite its historical importance, quantitative estimates are scarce, and those that exist present puzzling results. For example, Jeanne (1995) estimated a structural vector autoregression (SVAR) for the British economy in this period. The results show that a contractionary monetary shock lowered output proxies but *raised* prices - the so-called "price puzzle". A recent review of estimates of the efficacy of monetary policy in modern economies based on this methodology finds that one-third of studies suffer from the same problem (Rusnak et al., 2013).

I address this puzzle by applying the narrative approach, pioneered by Romer and Romer (2004), to measure the causal impact of monetary policy on the British macroeconomy during the classical gold standard. In the first stage, I estimate the central bank's reaction function using information that was available to policymakers in real-time. The residuals from this regression constitute exogenous monetary policy shocks. In the second stage, I use this new measure to estimate the macroeconomic effects of monetary policy. The narrative approach improves on traditional SVARs as the full information set can be controlled for, while in the latter degrees of freedom quickly vanish with the inclusion of additional variables.

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https://doi.org/10.1016/j.eeh.2017.10.001
Received 16 March 2017; Received in revised form 3 October 2017; Accepted 9 October 2017
Available online 12 October 2017
0014-4983/

In response to a one percentage point monetary tightening, I find that unemployment increased by up to 0.9 percentage points, while inflation decreased by up to 3.1 percentage points. The narrative approach therefore solves the price puzzle and, in contrast to previous research (Sayers, 1976), suggests that the macroeconomic effects of monetary policy were large. Existing studies have also downplayed the importance of monetary factors as a source of macroeconomic volatility in this context (Capie and Mills, 1991; Catao and Solomou, 1993). However, I find that monetary policy shocks accounted for as much as 33% of unemployment volatility and 34% of inflation volatility. Monetary policy, therefore, *did* matter in the United Kingdom during the classical gold standard.

My findings add to the short list of estimates of the economic effects of monetary policy using the narrative approach. Romer and Romer (2004) find that a contractionary monetary shock lowered industrial production by a maximum of 4.3% and the price level by up to 5.9% in the US between 1970 and 1996. Similarly, Cloyne and Hürtgen (2016) report peak drops in output and inflation of 0.6% and 1 percentage point respectively in the UK between 1975 and 2007. My results contribute to this literature by applying the Romer and Romer (2004) approach to a historical period and an alternative monetary regime.

An additional contribution relates to the history of the Bank of England's reaction function. Orphanides (2001) argues that the interpretation of historical monetary policy rules hinges on the use of real-time data. There is a long literature that estimates the Bank of England's reaction function during the classical gold standard that includes data that was not available to policymakers and/or excludes important information that was (Davutyan and Parke, 1995; Dutton, 1984; Giovannini, 1986; Morys, 2013; Pippenger, 1984).[1] The first stage of the narrative approach boils down to the estimation of the central bank's reaction function. In light of the Orphanides criticism, a real-time information set for all 1257 monetary policy decisions between 1890 and 1913 is reconstructed from archival sources. This will be a useful resource for future research.

The choice of sample period under investigation (1890–1913) is informed by three considerations. Firstly, earlier vintages of the sources used are inconsistent.[2] Secondly, previous research on the Bank's reaction function during the classical gold standard covers the same years (Davutyan and Parke, 1995; Dutton, 1984; Giovannini, 1986; Morys, 2013; Pippenger, 1984). Thirdly, the targets and actions of the Bank were relatively stable during this period. The Bank "only watched the gold and took the necessary steps automatically" (Giuseppi, 1966, p. 121).

2. Background

2.1. History

In order to understand monetary policy in Britain during the classical gold standard, it is important to grasp the objectives of its conductor, the Bank of England. As Sayers (1976, p. 8) put it, the Bank ran three horses at the same time.

The first horse was the protection of the country's gold reserves. This was in line with the operation of the gold standard, which was legally introduced in the United Kingdom in 1816. In pursuit of this objective, the Bank of England's main instrument was Bank Rate (Goodhart et al., 1994, p. 113): the rate at which it lent to the banking system (Capie and Webber, 1985, p. 305). There is evidence that the Bank also used open market operations and gold devices (Sayers, 1976, pp. 47–53). However, as Eichengreen et al. (1985) argue, Bank Rate "was the most visible and controversial of the Bank's instruments, and as such is the variable most likely, when subjected to detailed analysis, to yield information on the pressures and considerations influencing the formulation of policy."

The second horse was the financing of the government. As the government's banker, the Bank held the public deposits on its books, as well as various government securities (Bank of England Archive, C1/38-61), which brought "prestige rather than income" to Threadneedle Street (Sayers, 1976, p. 17). There is no indication that the Treasury strong-armed the Bank into changing its discount rate as the two "were still at arm's length from each other" (Sayers, 1976, p. 17).

The third horse was the commercial duty to the stockholders. From its establishment by Royal Charter in 1694 until it was nationalized in 1946, the Bank of England was privately owned. While it is true that the Bank's income ebbed and flowed with Bank Rate, the discount rate was not manipulated for this purpose. Instead, to generate income, the Bank affected the volume, as opposed to the price, of discounting. At the time when the Bank was relatively serious about this objective in the late 1890s, Head Office expanded loans to the Stock Exchange, for example, while the branches focused on increasing accounts with local businesses (Sayers, 1976, pp. 19, 21). However, if there was a clash, then the first horse was always the most important (Sayers, 1976, p. 8).

2.2. Theory

According to the macroeconomic trilemma, an economy cannot maintain fixed exchange rates, free capital flows and an independent monetary policy simultaneously (Fleming, 1962; Mundell, 1963).[3] In a world of credibly fixed exchange rates and free capital mobility, such as the classical gold standard, a country's interest rate must follow the interest rate in the base country, which implies

[1] This is also related to existing studies on monetary policy in other countries during the classical gold standard, such as Bazot et al. (2016), Morys (2013) and Reis (2007).

[2] For example, in the 1880s the source used to construct the monetary shocks lists the forward exchange rate with New York as opposed to the spot rate, the exchange rate with Hamburg instead of Berlin and the price of Russian 5% stock in place of French 3%, among other discrepancies. In terms of macroeconomic data, the series used are not available until the 1880s.

[3] A modern variant is the "irreconcilable duo" (Rey, 2015). Given a global financial cycle, the trilemma is reduced to a dilemma, where monetary policy is only possible if the capital account is managed.

sacrificing monetary autonomy (Klein and Shambaugh, 2015). This suggests that there may not have been scope for exogenous variation in monetary policy. However, I argue that such changes may have been possible during the classical gold standard for several reasons.

First, the exchange rate was not rigidly fixed, but fluctuated around the official exchange rate within variable bands, known as the "gold points", which were determined by the costs of shipping gold (Clark, 1984). In the case of gold flows between Britain and the US, the total direct cost was between 0.4 and 0.8% of the nominal value (Officer, 1986). As a result, the $/£ exchange rate fluctuated between 4.84 and 4.91 (Thomas and Dimsdale, 2016). Klein and Shambaugh (2015) find that a degree of exchange-rate flexibility allows for some monetary autonomy. Second, risk premiums were not equal across countries. In terms of country risk, Bordo and Rockoff (1996) find that countries on the gold standard enjoyed lower premiums than those that were not, while Obstfeld and Taylor (2003) show that core countries benefited from smaller premiums relative to the periphery. Third, the United Kingdom *was* the base country during the classical gold standard (Mitchener and Weidenmier, 2015). This suggests that there may have been scope for exogenous changes in Bank Rate during this period.

3. Methodology

3.1. The identification problem

A reasonable first step towards the estimation of the effects of monetary policy might be to regress a macroeconomic variable of interest, x_t, on a measure of monetary policy, i_t:

$$x_t = \beta_0 + \beta_1 i_t + \epsilon_t \tag{1}$$

However, then as now, monetary policy systematically reacted to current macroeconomic conditions, which we might simply model as:

$$i_t = \gamma_0 + \gamma_1 x_t + \varepsilon_t \tag{2}$$

It is clear that there is an issue of reverse causality here, which arises from the fact that monetary policy simultaneously affects macroeconomic outcomes in Eq. (1) while macroeconomic outcomes simultaneously affect monetary policy in Eq. (2). The simple estimation of Eq. (1) will therefore lead to biased estimates of β_1. To see why, recall a variant of the formula for the OLS estimate of β_1:

$$\hat{\beta}_1 = \beta_1 + \frac{Cov(i_t, \epsilon_t)}{Var(i_t)} \tag{3}$$

The parameter $\hat{\beta}_1$ is equal to the true parameter β_1 plus the covariance between the independent variable and the error term. In order for OLS to yield unbiased estimates of $\hat{\beta}_1$, that is $\hat{\beta}_1 = \beta_1$, the covariance between the independent variable and the error term must be zero, i.e. $Cov(i_t, \epsilon_t) = 0$, or the variance of i_t must be explosive. This, of course, is one of the Gauss-Markov assumptions underlying OLS.

This assumption is not met, however, in the case of Eq. (1). Let x_t be a measure of output and assume that the central bank leans against the wind, i.e. $\gamma_1 > 0$. In the case of a positive shock to ϵ_t, a demand shock for example, x_t will rise in Eq. (1), which in turn raises i_t in both Eqs. (1) and (2). Thus, the $Cov(i_t, \epsilon_t) \neq 0$. In fact, $Cov(i_t, \epsilon_t) > 0$. As a result of this positive covariance and the expectation that $\beta_1 < 0$, Eq. (3) implies that $\hat{\beta}_1$ will be downwardly biased towards zero. Therefore, the simple estimation of Eq. (1) will *underestimate* the effects of monetary policy.

3.2. Narrative identification

An interesting solution to the endogeneity problem is the narrative approach developed by Romer and Romer (2004). The procedure involves two stages. In the first stage, the policy instrument, i_t, is regressed on the information set available to the central bank in real-time, Ω_t. Thus, Eq. (2) becomes:

$$i_t = f(\Omega_t) + \varepsilon_t \tag{4}$$

This regression splits the policy instrument i_t into an endogenous component, $f(.)$, that systematically reacts to information relating to the state of the economy, and an exogenous component, ε_t. An important identifying assumption is that the information set itself is not endogenous. It is therefore crucial to use high-frequency, real-time information that does not include the effects of policy changes. In the second stage, the exogenous component, ε_t, is used to consistently estimate the macroeconomic effects of monetary policy.

4. Data

4.1. The timing of monetary policy decisions

During the classical gold standard, the level of Bank Rate was decided at the weekly meeting of the Court of Directors (National Monetary Commission, 1910). This meeting was the historical equivalent of the meetings of the Monetary Policy Committee (MPC) or the Federal Open Market Committee (FOMC). As a first step, the minutes of the Court of Directors are used to record

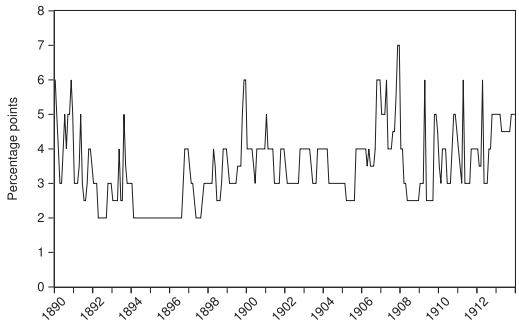

Fig. 1. Bank Rate.
Note: month end.

the dates on which the Court met between 1890 and 1913 (Bank of England Archive, G4/112-136). In general, the Court met each Thursday, although on 13 occasions, typically around Christmas, the Court met earlier in the week. In addition, there were four "Governor's rises", which were emergency increases in Bank Rate made by the Governor outside of the Court of Directors. In total, there were some 1257 monetary policy decisions during this period.

An interesting feature of the classical gold standard is the greater frequency of monetary policy decisions. While the Court of Directors met roughly once a week, the MPC gathered every month (Cloyne and Hürtgen, 2016) and the FOMC every five weeks (Romer and Romer, 2004). As the macroeconomic data used in the second stage regression is monthly, it should be noted that it might be tricky to observe the effects, as weekly shocks may have been offset within the month.

4.2. Bank Rate

The dates of monetary policy decisions are tied with their outcome using archival sources that recorded the prevailing level of Bank Rate at the end of each day (Bank of England Archive, C1/38-61). The final series was checked against Hawtrey (1938, pp. 291–295) and is plotted in Fig. 1.

4.3. Information set

The narrative identification approach requires an accurate, real-time approximation of the policymakers' information set at the time of each monetary policy decision. According to Sayers (1976, p. 30), the "Daily Accounts" were "geared" towards this purpose. An inspection of the sources bears this out. The "Fronts" of these books listed weekly macroeconomic data such as bullion flows, other central banks' rates of discount, sterling exchanges rates, consol prices, wheat prices and bank clearings, among others, while the middle of the books held the Bank's disaggregated balance sheets on a daily basis.[4] In general, stocks were recorded at the close of business on the day before the Court of Directors met and flows appeared in the books as changes since the last meeting. We could think of this source as somewhat comparable to the Federal Reserve's "Greenbooks".

I therefore transcribe these series from the Daily Accounts to produce a new balanced real-time data set for all monetary policy decisions between 1890 and 1913. In doing so, I ensure that the data tied to each meeting was actually available to the Court in real-time. For example, on 21 September 1911, the Daily Accounts show that the Bank of England altered its policy rate on the same day as the Bank of France. In this instance, I turn to contemporary sources to determine whether the Bank was aware of this information. An article in *The Times* (1911) stated that, "the Bank of England rate was yesterday raised from 3 to 4%. The advance was quickly *followed* [my italics] by the raising of the bank rates of France and Austria-Hungary". Therefore, for the Court's meeting on 21 September, I use the Bank of France's policy rate *before* the change. As a result, there should be no simultaneity bias in the first stage regression.

It is worth pointing out some important differences between the Daily Accounts and the sources used by Cloyne and Hürtgen (2016) and Romer and Romer (2004). Firstly, the Daily Accounts are backward looking, while other narrative studies include forecast data. The problem in ignoring forecasts if they were made, either implicitly or explicitly, is omitted variable bias. While macroeconomic forecasting did not spread to the United Kingdom until the 1950s (Hawkins, 2005), it could be that the Court of Directors nevertheless formed expectations. In the interest of robustness, I explore this possibility further in Section 7.1.

[4] See Table A.1 for an example of the "Fronts" in the Daily Accounts.

Secondly, the frequency of the Daily Accounts is higher. The Greenbook forecasts were typically issued six days before an FOMC meeting, while the interval is potentially up to a quarter in Cloyne and Hürtgen (2016). In the Daily Accounts, the data assigned to each meeting relates to the close of business on the previous day.[5] This is optimal as data from the current day would be endogenous, while older data runs the risk of being stale.[6] The danger of stale data is omitted variable bias, as policymakers may look elsewhere for up-to-date information, which could be correlated with the variables in the second stage regression.

Thirdly, the narrative approach does not require that the information set is *exact*, only that it is correlated with the information available to policymakers. For example, the Treasury's information set was not available for the period in which it set British monetary policy to Cloyne and Hürtgen (2016), who instead used forecasts produced by the National Institute of Economic and Social Research on the basis that the two were likely to be highly correlated. However, the accuracy of the Daily Accounts is one of its main strengths. As Sayers (1976, p. 30) notes, it held "exact information, kept up to date".

5. The new measure of monetary shocks

5.1. Specification

The estimates of the Bank of England's reaction function are based on the new data set and the following model:

$$\Delta i_m = \phi_0 + \phi_1 i_{m-1} + \phi_2 \Delta B_m + \phi_3 P_m + \phi_4 \Delta i_m^F + \phi_5 \Delta i_m^G + \phi_6 \Delta e_m^F + \phi_7 \Delta e_m^G + \phi_8 \Delta e_m^{US} + \phi_9 G_m^{NX} + \phi_{10} \Delta Q_m + \phi_{11} \Delta Y_m + \phi_{12} \pi_m + \varepsilon_m \quad (5)$$

where all variables are measured at a decision-by-decision frequency denoted by subscript m. The dependent variable, Δi_m, is the change in Bank Rate (percentage points). In terms of the independent variables, i_{m-1} is the level of Bank Rate at the previous meeting (percentage points), which has been included to capture recent macroeconomic conditions (Cloyne and Hürtgen, 2016) and any tendency toward mean reversion (Romer and Romer, 2004). ΔB_m is the change in the total bullion held by the Bank of England (%), which is measured as the sum of gold and silver coin and bullion in the Banking and Issue departments. P_m is the proportion (%), which is defined as the Banking Department's reserve of notes and coin to the sum of its deposits and post bills. Δi_m^F and Δi_m^G are the change in the minimum rates of discount of the banks of France and Germany respectively (percentage points).[7] Δe_m^F, Δe_m^G and Δe_m^{US} are the changes in the exchange rates in Paris, Berlin and New York (domestic currency per £). G_m^{NX} is net exports of gold coin and bullion (£ millions). ΔQ_m is the rate of consol price inflation (%). ΔY_m is the change in bank clearings (%). π_m is the rate of wheat price inflation (%).

There are a couple of natural questions that might arise about the reaction function. First, can the Bank of England's behaviour in this period be described by a reaction function in the same way as a modern central bank's? A reaction function implies that the policymaker has a target and an instrument with which to hit it. As discussed above, the targets at the time related to convertibility and the main instrument was Bank Rate. There is also a long literature that suggests it is appropriate to model the Bank's behaviour in this way (Davutyan and Parke, 1995; Dutton, 1984; Giovannini, 1986; Morys, 2013; Pippenger, 1984).

Second, are the right variables included in the reaction function? As Aldcroft and Fearon (1972, p. 50) argue, "the Bank of England's policy was dominated largely by the state of its reserves. The Bank's primary objective was to safeguard its gold reserves and the main weapon of control was the Bank Rate." The reaction function covers this base directly, by including both total bullion held and the proportion. The reaction function also deals with this issue indirectly, by including variables that were likely to influence reserves, such as foreign rates of discount. As noted previously, the Bank's other objectives, financing the government and generating income, were not achieved by changing Bank Rate.

Third, should the variables be included in levels, absolute changes or relative changes? The specification is ultimately motivated by the historiography. According to Sayers (1976, p. 30), "the Governors were watching especially the absolute level of the gold held in the Bank and the 'Proportion'". However, Sayers (1976, p. 31) also adds that "changes over the last few days received equal attention." Given the ambiguity, I opt for the relative change in gold and the level of the proportion because this combination maximizes the explanatory power of the model, meaning that more of the Bank's behaviour is explained and that more potentially endogenous variation is stripped out. The other variables are expressed as changes. As Sayers (1976, p. 31) notes, "in deciding whether the absolute levels were adequate, and whether the changes were anything to worry about, the Bank took into account *movements* [my italics] in other items". In the absence of information on whether it was absolute or relative movements that mattered, the choice is again guided by maximizing the explanatory power of the model.[8]

Fourth, are there enough lags in the reaction function? As noted previously, Sayers points out that it was changes over the last few days, as opposed to weeks, that were important. This is confirmed by information criteria as the BIC is minimized with no lags. For the implications of alternative variations of the first stage regression on the baseline results, see Section 7.1.

[5] However, on the 13 occasions that the Court of Directors met on a day other than a Thursday and the four Governor's rises, the macroeconomic data relates to the previous Wednesday.

[6] The use of daily data connects to the high frequency identification literature (HFI). See Kuttner (2001) and Gertler and Karadi (2015) for examples.

[7] On the occasions that a range was given, the minimum was used. This is consistent with the treatment of Bank Rate, which was considered to be the minimum rate of discount. See Bank of England Archive (G15/97) for internal evidence.

[8] Note that all variables in Eq. 5 are ultimately stationary.

Table 1
Determinants of changes in Bank Rate (Δi_m).

Variable	Coefficient	Standard error
Constant (ϕ_0)	0.311***	0.061
Initial Bank Rate (i_{m-1})	−0.037***	0.007
Bullion (ΔB_m)	−0.014***	0.003
Proportion (P_m)	−0.004***	0.001
Change in Bank of France's discount rate (Δi_m^F)	0.056	0.085
Change in Bank of Germany's discount rate (Δi_m^G)	0.135***	0.028
Change in French francs/£ (Δe_m^F)	0.660*	0.349
Change in German marks/£ (Δe_m^G)	1.376***	0.433
Change in US dollars/£ (Δe_m^{US})	3.208***	0.993
Net exports of gold coin and bullion (G_m^{NX})	0.035***	0.010
Consol price inflation (ΔQ_m)	−0.044***	0.011
Change in bank clearings (ΔY_m)	−0.000	0.000
Wheat price inflation (π_m)	0.001	0.003

Notes: */**/*** indicate significance at 10/5/1% level. $R^2 = 0.175$, $F = 21.975$, $N = 1257$. The sample covers all monetary policy decisions between 1890 and 1913.

5.2. Determinants of changes in Bank Rate

The results from the estimation of Eq. (5) are reported in Table 1. The coefficient on the initial level of Bank Rate is negative, as in Romer and Romer (2004) and Cloyne and Hürtgen (2016), and is statistically significant. The sign implies a tendency towards mean reversion as opposed to a consideration of recent macroeconomic conditions. As expected, the coefficients on the Bank's holdings of bullion and the proportion are negative and statistically significant as in Goodhart (1972) and Pippenger (1984), which implies that Bank Rate was increased (decreased) in response to declining (increasing) reserves.

With respect to the discount rates of the banks of France and Germany, the positive coefficients are evidence of "defensive" (Bloomfield, 1959, p. 37) changes in Bank Rate, although the magnitude implies that this was a good deal less than basis point for basis point. A 100 basis point increase in the Bank of Germany's discount rate, for example, was matched by a 13.5 basis point increase in Bank Rate. This result is qualitatively similar, but smaller than that found by Morys (2013). The effect was statistically insignificant for the Bank of France. In addition, Bank Rate positively covaried with the foreign exchanges. These results are also consistent with Morys (2013).

The positive coefficient on the net exports of gold coin and bullion implies that Bank Rate was raised (lowered) in response to an efflux (influx) of gold, as in Jeanne (1995) and Pippenger (1984), which is consistent with the "rules of the game". Bank Rate was also increased (decreased) in response to a decrease (increase) in the price of consols. As the price of bonds is negatively related to the yield, this can be interpreted as a positive association between the long-term market rate of interest and Bank Rate.

The final two rows have a bearing on an enduring debate in economic history: the degree to which the Bank of England ran a countercyclical monetary policy during the classical gold standard (Bloomfield, 1959; Dutton, 1984; Jeanne, 1995). Bank clearings (Klovland, 1998) and the price of wheat (Campbell et al., 2017; Rostow, 1948) are sometimes considered as economic fundamentals in the nineteenth century. Wheat prices, in particular, were an important determinant of workers' real wages (Campbell et al., 2017). It was these variables that the Bank of England monitored on a weekly basis, as opposed to ex-post constructed monthly unemployment or inflation series that are staples of previous research on the reaction function. The statistical insignificance of bank clearings and the price of wheat implies that the Bank of England did not react linearly to observable proxies for economic activity.[9]

5.3. Constructing the new shock series

The inclusion of the information set in Eq. (5) purges the endogenous component of monetary policy changes. As such, the residual is a measure of exogenous monetary policy shocks. However, it is currently measured at a decision-by-decision frequency. In order to transform the residuals into a monthly series, I match the shock with the month in which it occurred. In months with multiple decisions, I sum the shocks, following Romer and Romer (2004) and Cloyne and Hürtgen (2016). The new measure of monetary policy shocks, m_t, is shown in Fig. 2.

An alternative and perhaps more illuminating way to view the shocks is to plot the cumulative sum minus the 36 month moving average of its lagged values, as in Coibion (2012), which yields an indicator of the stance of monetary policy. Fig. 3 plots the stance of monetary policy during the classical gold standard based on this procedure. The intuition runs that zero represents normal monetary policy (Bernanke and Mihov, 1998), while positive (negative) values indicate tight (loose) monetary policy, relative to recent experience.

[9] See Table A.2 for a more nuanced perspective. The Bank reacted asymmetrically to changes in these variables, responding only to increases in bank clearings and wheat prices.

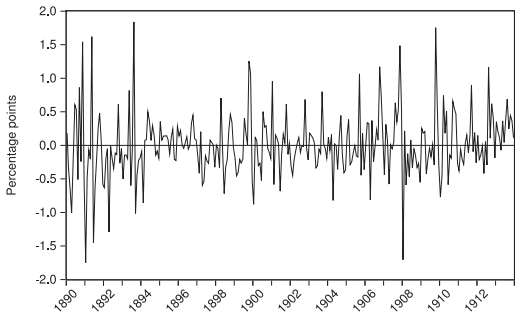

Fig. 2. New measure of monetary policy shocks (m_t).

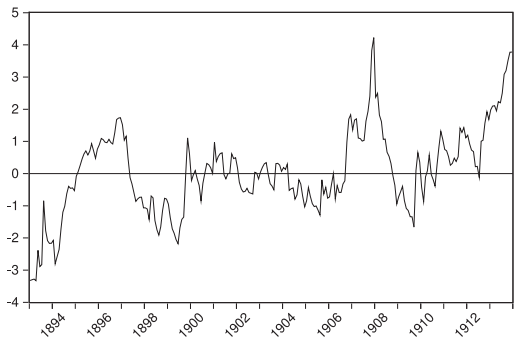

Fig. 3. The stance of monetary policy.

5.4. What are the shocks?

The new series of monetary policy shocks represents deviations in Bank Rate from the Bank of England's *average* response to current macroeconomic conditions. The deviations might have arisen for a number of reasons. One could be linked to the human nature of the Court of Directors. If the mood of the Court was particularly pessimistic, or a pessimistic Director was especially persuasive at a given meeting, then Bank Rate might be changed by more than average, given current macroeconomic conditions. Ogden (1991, p. 334) argues "that many of the Bank of England's actions at this time depended on the personalities that were around." A second could stem from alterations in the Bank of England's targets. In some periods, the Bank may have placed greater emphasis on the French, as opposed to the German, exchange rate, for example. Another could lie in the Bank's preference for discrete changes in Bank Rate of no less than 50 basis points. Of the 129 changes in Bank Rate, 35% resulted in alterations of ± 100 basis points, while the remaining 65% led to changes of ± 50 basis points. As a result, current macroeconomic conditions might have called for an increase in Bank Rate of 25 basis points, but instead the Bank increased by either 50 basis points or none at all. Finally, by construction, the shocks also represent random variation in Bank Rate that are inexplicable.

5.5. Predictability of the shocks

In order to remove any suspicion that the new series of monetary policy innovations might be endogenous, I test to see if the series is predictable from lagged macroeconomic variables, as in Cloyne and Hürtgen (2016) and Coibion (2012). Specifically, I regress the monetary shocks, m_t, on a macroeconomic variable of interest, x_t:

$$m_t = \varphi_0 + \sum_{i=1}^{I} \varphi_i x_{t-i} + \epsilon_t \tag{6}$$

The results from estimating Eq. (6) are shown in Table 2. Alternative specifications are reported, the first with 3 lags (Cloyne and Hürtgen, 2016); the second with 6 lags (Cloyne and Hürtgen, 2016; Coibion, 2012). The macroeconomic variables of interest are the seasonally adjusted unemployment rate, the 12 month wholesale price inflation rate and the 12 month share price inflation rate.

Table 2
Predictability of shocks.

	$I = 3$		$I = 6$	
Independent variable	*F*-statistic	*P*-value	*F*-statistic	*P*-value
Unemployment rate	0.48	0.70	0.85	0.53
Inflation	1.09	0.36	0.89	0.50
Share price inflation	0.86	0.46	0.67	0.67

Notes: The sample runs from January 1890 to February 1912. Share price inflation calculated from Smith and Horne (1934) in Thomas and Dimsdale (2016).

Unemployment and inflation are included as these will be the dependent variables in the second stage analysis. A thorough discussion of these variables is delayed until then. Share price inflation has been included to gauge whether financial markets predicted the shock. New research shows that changes in monetary policy influenced share prices in nineteenth-century Britain (Campbell et al., 2017). Therefore, if financial markets could have predicted the monetary shock, one would expect that share prices would move in anticipation of the shock itself.

In all cases, the large *P*-values indicate that we cannot reject the null hypothesis of exogeneity. As a result, the new series is appropriate to identify the macroeconomic effects of monetary policy.

6. The macroeconomic effects of monetary policy

6.1. Baseline results

The next step is to estimate the macroeconomic effects of the new measure of monetary policy innovations. In line with Cloyne and Hürtgen (2016), the baseline model is a four variable structural VAR with unemployment, inflation, monetary shocks and Bank Rate included.

As in a number of studies on this subject, for example Cloyne and Hürtgen (2016), Coibion (2012), Bernanke et al. (2005) and Romer and Romer (1989), unemployment is included in the model to gauge the real effects of monetary policy. It is preferred over other candidates in this instance, such as GDP or industrial production, simply because the alternatives are not available at a monthly or quarterly frequency. The unemployment series, based on the work of Denman and McDonald (1996) in Thomas and Dimsdale (2016), measures the percentage of trade union members unemployed. It has been seasonally adjusted using a Census X-13 filter. There are, however, two breaks in the series in 1912: the first in March due to a labour dispute (Klovland, 1998, p. 74) and the second in September as a result of the watershed Unemployment Insurance Act of 1911. The sample period for the analysis in Section 5.5 onward therefore ends in February 1912. As Denman and McDonald (1996) point out, a limitation of the series is that, "the coverage of these unemployment rates depended on the rate of unionisation of the workforce in the industries covered, the degree to which unions paid benefits to the unemployed, and the propensity for these unions to submit statistical returns." Nevertheless, even after Boyer and Hatton (2002) correct the series on an *annual* basis for missing industries, short-time working and alternative weights, the correlation between the original and corrected series is high at 0.86.

The measure of prices, based on the work of Sauerbeck in Thomas and Dimsdale (2016), is the 12 month percentage change of the wholesale price index for all commodities. A limitation of the series is that it is an *unweighted* average of 45 commodity prices. However, Sauerbeck weighted the series "implicitly by entering two or more items for particularly important articles" (Klovland, 1993). Klovland evaluated the weighting schemes of alternative indices for the nineteenth century such as that of Gayer et al. (1975), *The Economist* and the Board of Trade with the conclusion that the Sauerbeck index "seems to be the most representative general price index for the period before the First World War."

The measure of monetary shocks is the cumulative sum of shocks, $shock_t = \sum_{i=0}^{I} m_i$, which is conventional (Cloyne and Hürtgen, 2016; Coibion, 2012; Romer and Romer, 2004) as the wider VAR literature is based on the level of the policy rate. Bank Rate is included to measure its response to the monetary innovation, which Cloyne and Hürtgen (2016) and Coibion (2012) show is important for interpreting the magnitude of the shock.

In spite of the evidence supporting the exogeneity of the monetary shocks, a structural VAR is used for three reasons. Firstly, the estimation of a VAR is a belt and braces approach to the endogeneity problem. Secondly, Cloyne and Hürtgen (2016) argue that the inclusion of "lagged dependent variables and controlling for other shocks may yield more precise estimates in short samples." Thirdly, it is in line with, and therefore comparable to, the rest of the narrative literature concerned with the effects of monetary policy (Cloyne and Hürtgen, 2016; Romer and Romer, 2004). In Section 7.4, I consider an alternative econometric approach.

The details of the model are:

$$\boldsymbol{X_t} = \boldsymbol{B(L)X_{t-1}} + \epsilon_t \tag{7}$$

where $\boldsymbol{X_t} = \left[u_t, \pi_t, shock_t, i_t\right]'$ and $\boldsymbol{B(L)}$ is a polynomial lag operator with P lags. The vector of observables ($\boldsymbol{X_t}$) includes the unemployment rate (u_t), the inflation rate (π_t), the cumulated monetary shock ($\boldsymbol{shock_t}$) and Bank Rate (i_t). The remaining aspects of the specification are identical to Cloyne and Hürtgen (2016). In terms of lag selection, I include 24 lags. As to identification, the ordering of the variables follows that in $\boldsymbol{X_t}$. This assumes that the shock does not contemporaneously affect, but is rather affected by,

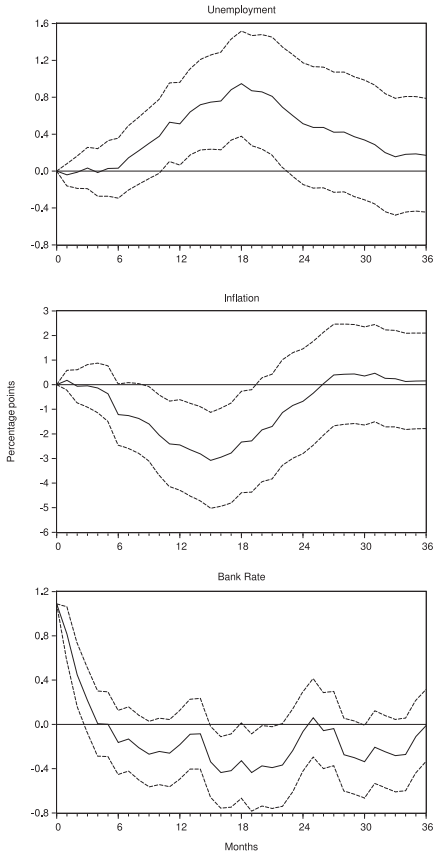

Fig. 4. Response of unemployment, inflation and Bank Rate to a monetary policy shock.
Notes: The solid line is the impulse response to a one percentage point contractionary monetary policy shock with 95% confidence intervals. The sample runs from January 1890 to February 1912.

unemployment and inflation. In Section 7.3, I demonstrate that the baseline results are robust to alternative lag lengths and timing assumptions.

The main results of the paper are shown in Fig. 4. Impulse responses from the baseline VAR are plotted along with 95% bootstrapped confidence intervals based on 2,000 replications, as in Cloyne and Hürtgen (2016). In response to a one percentage point contractionary monetary policy shock, unemployment increased by up to 0.95 percentage points ($t = 3.25$). This was a relatively slow-burning process, with no discernible impact for around 6 months, after which a peak was reached in month 18 and a decay toward zero followed. The effect is statistically significant between months 11 and 22. Similarly, in response to a one percentage point contractionary monetary policy shock, the inflation rate fell by up to 3.08 percentage points ($t = -3.09$). The response of inflation was also somewhat protracted, beginning to decline after the first quarter, peaking at 15 months and then fizzling out. The effect is statistically significant between months 9 and 19. Lastly, in response to a one percentage point contractionary monetary policy shock, Bank Rate increased on impact by 1.09 percentage points. The effect was short-lived, persisting only in the first quarter. The intuition is that there was roughly a one-for-one relationship between the shock and Bank Rate.

6.2. Comparison to the literature

The results from the classical gold standard are within the range spanned by the existing narrative literature. In terms of unemployment, for example, the appendix to Cloyne and Hürtgen (2016) reports a peak effect on the lower end of the scale of 0.1–0.5

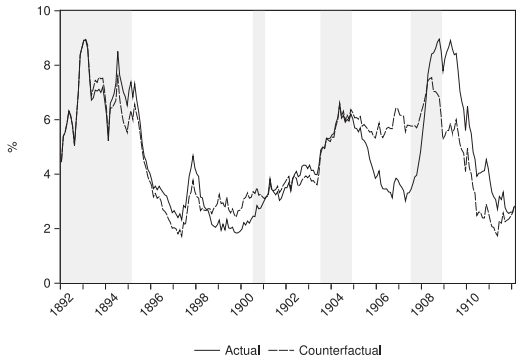

Fig. 5. Historical decomposition.
Notes: The solid (dashed) line is actual (counterfactual) unemployment.

percentage points for the modern UK economy. While Romer and Romer (2004) do not investigate the response of unemployment, Coibion (2012) shows that their shocks raise unemployment by up to 0.9 percentage points in the contemporary American economy. On the higher end of the scale, Romer and Romer (1989) report a maximum effect of 2.1 percentage points for the post-war US economy. The dynamics are also relatively comparable to the existing literature, with an uptick after approximately six months, then gathering speed until a maximum is reached after roughly 18 months.

In terms of inflation, the peak effect also sits centrally in the range of previous estimates. Cloyne and Hürtgen (2016), for example, find that inflation falls by roughly 1 percentage point, while Romer and Romer (2004) estimate that the price level declines by up to 5.9%. The dynamics, however, are somewhat different. In both Cloyne and Hürtgen's (2016) and Romer and Romer's (2004) analyses, prices are sticky around zero for roughly two years before contracting, while inflation began to decline after six months during the classical gold standard. While an outside lag of six months is far from instantaneous, it is a good deal less sluggish than the response for contemporary economies.

Should we be surprised that the macroeconomic effects of monetary policy during the classical gold standard are in the same ballpark as those reported for the post-war period? One reason that we might be is the difference in monetary regime. Given fixed exchange rates, it might be expected that monetary shocks were smaller and less persistent than under the floating regimes of today. The Cloyne and Hürtgen (2016) shocks raise Bank Rate on impact roughly one-for one, persisting for about six months but the same was also true during the classical gold standard. Another reason that we might be surprised is that it implies a degree of consistency in the pricing behaviour of firms between the two periods. However, using macro data, Gordon (1990) finds that prices were equally sticky during both the classical gold standard and post-war periods in the United Kingdom. An interesting extension would be to investigate using micro data whether the frequency of price changes was, in fact, comparable.

6.3. Economic fluctuations

Were monetary shocks an important source of economic fluctuations? This is an interesting question as previous research has suggested that they were not (Capie and Mills, 1991; Catao and Solomou, 1993). The forecast error variance decomposition shows that monetary shocks explain a large fraction of the variance in both unemployment and inflation, accounting for up to 33% of unemployment volatility and 34% of inflation volatility. These numbers are startling given the range of other macroeconomic shocks that affect the economy, such as shocks to credit, energy, fiscal policy, labour supply, technology and uncertainty.[10]

As monetary shocks accounted for a large amount of macroeconomic volatility on average, they may have also been important in particular events of interest in the historiography. One way to investigate this is a historical decomposition. The solid line in Fig. 5 plots the actual path of the real economy, as measured by unemployment, while the dashed line shows the counterfactual had there been no monetary policy shocks. If the counterfactual is less (greater) than the actual series, then the interpretation is that monetary policy shocks raised (lowered) unemployment. The shaded regions are contractionary periods identified by the NBER.

A number of interesting results stand out. In the long recession of 1890–5, policy shocks became increasingly important, raising unemployment by a full percentage point. At the tail end of the expansion that followed, policy shocks were reinforcing, reducing the unemployment rate by up to one percentage point. The stimulus persisted through the 1900–1 depression, which ameliorated the severity of the downturn. In the expansion of 1904–7, policy shocks were crucial. The counterfactual series predicts that unemployment would have remained close to 6% in the absence of policy shocks, while in reality it fell to 3%. The real effects of the 1907 crisis were exacerbated by contractionary policy shocks. In November 1908, the trough of the depression, policy shocks contributed 2.4

[10] See Ramey (2016) for a discussion of a broad range of macroeconomic shocks.

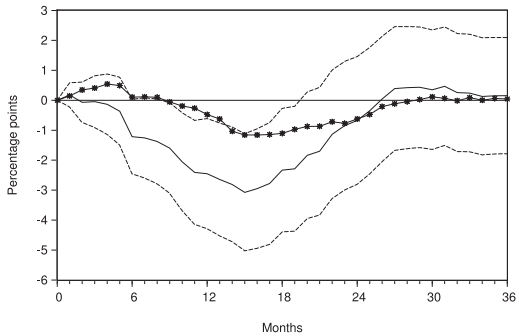

Fig. 6. Response of inflation in a conventional and narrative VAR.
Notes: The solid (starred) line is the baseline (alternative) impulse response to a one percentage point contractionary monetary policy shock with 95% confidence intervals. The sample runs from January 1890 to February 1912.

percentage points, or 470000 workers, to the unemployment rate.[11] This is an interesting finding as previous research has attributed the downturn to a deterioration in international trade (Dimsdale and Hotson, 2014, p. 29). Policy shocks held back the recovery that followed, propping up the unemployment rate by 1.5 percentage points on average.

6.4. The price puzzle

An interesting question is whether a conventional VAR model with unemployment, inflation and Bank Rate identified recursively would deliver the same results as the narrative VAR. As such, I re-estimate Eq. (7), but this time dropping the monetary shock ($shock_t$) from $\boldsymbol{X_t}$ while holding all other aspects constant. The starred lined in Fig. 6 plots the impulse response of inflation to a contractionary shock in Bank Rate while the solid line is the baseline estimate. There are three major implications of this exercise.

Firstly, the conventional VAR produces the price puzzle - the *increase* in inflation following a monetary tightening - peaking at 0.54 percentage points ($t = 1.75$) after four months, then hovering around zero until the fourth quarter. The result joins the 50% of previous studies that run into the price puzzle at the 3 month horizon (Rusnak et al., 2013). In the narrative VAR, on the other hand, inflation declined rapidly and steeply following the monetary shock. Secondly, the efficacy of monetary policy is markedly different between the two models. While the conventional VAR points to a weak peak decline in inflation ($-1.16, t = -1.94$), which is at no point statistically significant at the 5% level, there is a strong and significant drop ($-3.08, t = -3.09$) in the narrative VAR. Thirdly, the two approaches assign different weights to the contribution of monetary policy shocks to inflation volatility. Monetary policy shocks accounted for 12% of inflation volatility in the conventional VAR, but 34% in the narrative VAR. These differences are not explained by diverging Bank Rate paths. In both experiments, Bank Rate increases by roughly 1 percentage point on impact, and declines to zero within six months.

The root cause of the price puzzle and the attenuated response of inflation in the conventional VAR boils down to omitted variable bias. In the conventional VAR, the monetary policy shock is a composite of omitted variables plus the structural shock. If these variables are correlated with inflation then the respective impulse response functions will be biased accordingly. The variables in Eq. (5) are prime suspects. Table 1 shows that changes in the Bank of England's holdings of bullion, for example, were correlated with changes in Bank Rate, while changes in bullion are also likely to have been correlated with inflation.

Aldcroft and Fearon (1972, p. 50) and Bloomfield (1959, pp. 38–39) point out that the omitted variables problem also extends to the case of unemployment. Many variables that entered a central bank's reaction function in this period, such as reserves, covaried with the business cycle. Therefore, in omitting these variables from the conventional VAR model, a covariance is introduced between the monetary policy shock and the measure of the real economy. In dealing with this problem, the peak impact of a monetary policy shock on unemployment is almost 70% larger in the narrative VAR relative to the conventional VAR.

The narrative approach strips out the covariance between the monetary policy shock and the omitted determinants of Bank Rate that lead to biased impulse response functions. In theory, a similar result could have been achieved by including these variables in the conventional VAR. In practice, however, a very large sample is needed as the degrees of freedom would have quickly evaporated given that there were 11 variables in the first stage regression and 24 lags in the second.

6.5. Monetary policy transmission mechanism

Are the effects plausible for Britain during the classical gold standard? To answer this question, I turn to survey data collected by the *The Economist* (1907a; 1907b) in 1907. The survey asked businesses about "the effects of dear money on home trade" - the effect

[11] Calculated using Feinstein's (1972) estimates of the working population.

Table 3
Replies to *The Economist*'s survey on the "Effects of Dear Money on Home Trade".

	Effects	Frequency	%
(1)	Adverse expectations as to future consumption demand	11	15.9
(2)	Adverse expectations as to future investment demand	5	7.2
(3)	Generalized uncertainty	1	1.4
(4)	Significantly higher working capital costs	7	10.1
(5)	Significantly higher fixed capital costs	2	2.9
(6)	Availability of credit reduced	3	4.3
(7)	Reductions in raw material prices as stocks realized owing to higher working capital costs	15	21.7
(8)	Buyers expectations of lower prices reducing raw material demand and prices	3	4.3
(9)	No significant effects	4	5.8
(10)	Not applicable	18	26.1
	Total	69	100

Notes: Reproduced from Moggridge (1972, p. 11). The category "adverse expectations resulting from American crisis", included by Moggridge, has been merged with "not applicable" here as this was another, although not unrelated, issue at the time.

of a monetary tightening on economic activity in today's language. In total, 69 responses were received. Table 3 reports a summary of the responses, based on earlier work by Moggridge (1972).

The results show that more than two-thirds of replies cited a negative impact of some description following a monetary tightening, while just 5.8% responded that there would be no significant effects. Therefore, the VAR results are in line with the views of businesses at the time.

Monetary policy affects the macroeconomy through some or all of the following channels: the interest rate channel, the exchange rate channel, the credit channel and through other asset price effects (Mishkin, 1995). If these mechanisms were underdeveloped or lacking entirely in the British economy during the classical gold standard, then this would be difficult to reconcile with the VAR results. However, the replies to the survey point to a number of classic mechanisms that alleviate such a concern.

The interest rate channel, for example, features strongly. It is through this channel that monetary policy affects investment and consumption via its effect on the real interest rate. In the survey responses, reason (2) explicitly describes a decline in investment, while reasons (4) and (5) implicitly describe a decline in investment. Similarly, adverse expectations of consumption were cited in 15.9% of replies. The implication of reduced investment and consumption is lower aggregate demand, which raises unemployment and lowers prices.

The interest rate channel was particularly well-greased during the classical gold standard. Eichengreen (1992, p. 44) explains:

> By the end of the nineteenth century, the Bank of England's ability to influence market rates was widely acknowledged and increasingly institutionalized. Banks first in London and then throughout the country began to index their loan and overdraft rates to Bank Rate. London banks fixed their deposit rates 1.5 percentage points below Bank Rate. Rates on new loans were indexed to Bank Rate at a higher level, while those on fixtures (long-term loans to the discount market) were similarly indexed at 0.5 percent above the deposit rate.

The indexation of market interest rates to Bank Rate also extended to the rates of other institutions, such as building societies and finance houses (Capie and Webber, 1985, p. 306), and out to longer maturities (Eichengreen, 1987). In line with the survey responses, the Bank of England was able to influence the interest rates upon which a broad spectrum of consumption and investment decisions were made.

In addition, reasons (7) and (8) indicate that the Bank was also able to influence inflation expectations. As consumption and investment decisions are ultimately based on the real interest rate (nominal rate minus inflation expectations), this would have further amplified the interest rate channel.

Reason (6) points to a functional credit channel in the transmission of monetary policy. As Bank Rate was the rate at which the Bank lent to the banking system, a change would affect the quantity of reserves available to commercial banks. Bernanke and Blinder (1992) explain that when the central bank "reduces the volume of reserves, and therefore of loans, spending by customers who depend on bank credit must fall, and therefore so must aggregate demand."

While not explicitly mentioned in the survey results, the movement in exchange rates afforded by the gold points allowed for a limited exchange rate channel. A contractionary monetary shock would have attracted capital from the rest of the world. As a result, the demand for pounds would have increased, leading to an appreciation of the exchange rate. Bazot et al. (2016) study the operation of this mechanism during the classical gold standard, reporting that a one percentage point contractionary Bank Rate shock led to a statistically significant appreciation of the pound relative to the French franc. As such, net exports would have fallen, resulting in a reduction of aggregate demand.

Finally, recent research points to a transmission mechanism through other asset price effects. Campbell et al. (2017) find that Bank Rate was an important determinant of share prices in the nineteenth century. The study shows that a one percentage point increase (decrease) in Bank Rate was contemporaneously associated with a 0.61% fall (rise) in stock returns. The link between Bank Rate and the stock market was also appreciated by contemporaries. On 19 October 1906 Bank Rate was raised from 5 to 6%. *The Economist* (1906) wrote the following day, "the rise in Bank Rate yesterday has electrified all the markets. Not one escaped from the

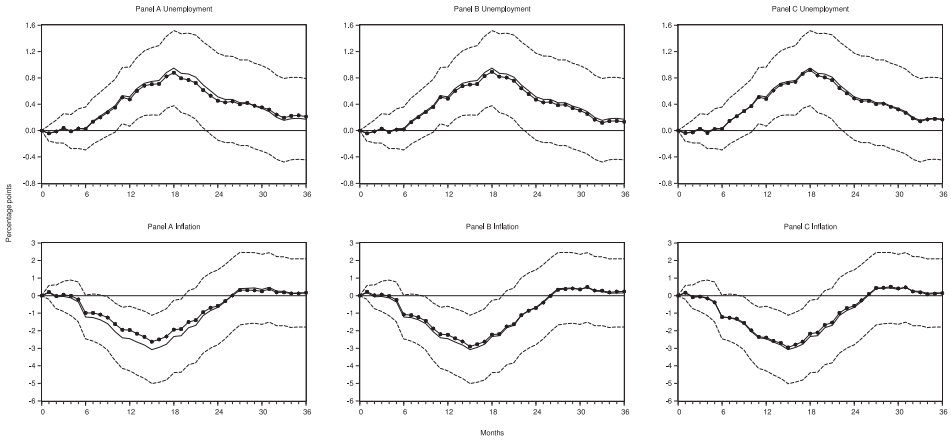

Fig. 7. Robustness to additional variables in first stage regression.
Notes: The solid (starred) line is the baseline (alternative) impulse response to a one percentage point contractionary monetary policy shock with 95% confidence intervals. The sample runs from January 1890 to February 1912.

withering effect of the totally unexpected event [...] the consequence of a high Bank Rate is the imposition of a further check upon general Stock Exchange trade. The man who can get 4.5% from his bankers upon money left with them on deposit sees little object in buying consols or other similar securities which pay 1.25 to 1.5% less."

The link between Bank Rate and asset prices would have amplified the real effects of monetary policy in two ways. Firstly, this would have changed the market value of firms relative to the replacement cost of capital (Tobin's q), which would have altered investment spending. A high q would have stimulated investment as companies could have bought more investment goods for a given issue of equity (Mishkin, 1995). Secondly, in the late nineteenth century, Britain was a "nation of shareholders" (Rutterford et al., 2011). Between 1890 and 1902, 45.1% of individuals owned shares and/or government securities. In addition, these assets made up roughly half of all assets at death. Therefore, Bank Rate would have affected the wealth, and thus consumption, of this large body of individuals.

The Cunliffe Committee (1918), composed of Walter Cunliffe himself (then Governor of the Bank), John Bradbury (Secretary of the Treasury), Arthur Pigou and 11 others, eloquently summarized these very mechanisms in its description of the gold standard before the war:

> the raising of the Bank's discount rate [...] led to a general rise of interest rates and a restriction of credit. New enterprises were therefore postponed and the demand for constructional materials and other capital goods was lessened. The consequent slackening of employment also diminished the demand for consumable goods, while holders of stocks of commodities carried largely with borrowed money, being confronted with an increase of interest charges, if not with actual difficulty in renewing loans, and with the prospect of falling prices, tended to press their goods on a weak market.

7. Robustness

7.1. Extending the first stage regression

In this section, the baseline model is put through a battery of alternative specifications to gauge the robustness of the results. A potential concern is that there are omitted variables in the first stage regression. If this is the case, then the monetary shock will be contaminated, biasing the impulse response functions in the second stage. I address this concern in three ways. Firstly, a number of other variables were consistently reported in the Daily Accounts but were not included in the first stage regression. Bankers' balances, for example, are reported to have been monitored by the Bank (Sayers, 1976, p. 45), but were excluded previously as they were a major component of the proportion. Other variables, such as gold coined by the Royal Mint, net exports of silver bullion, the price of French government bonds, the price of US government bonds, the price of silver and the price of London and North Western Railway consolidated stock - the largest company at the time (Hickson et al., 2011), were also included in the Daily Accounts but excluded in the first stage regression because they had not been cited in the literature as determinants of Bank Rate. Panel A of Fig. 7 plots the results from the baseline VAR (solid line) alongside the results using the residuals from a first stage regression that includes the extra

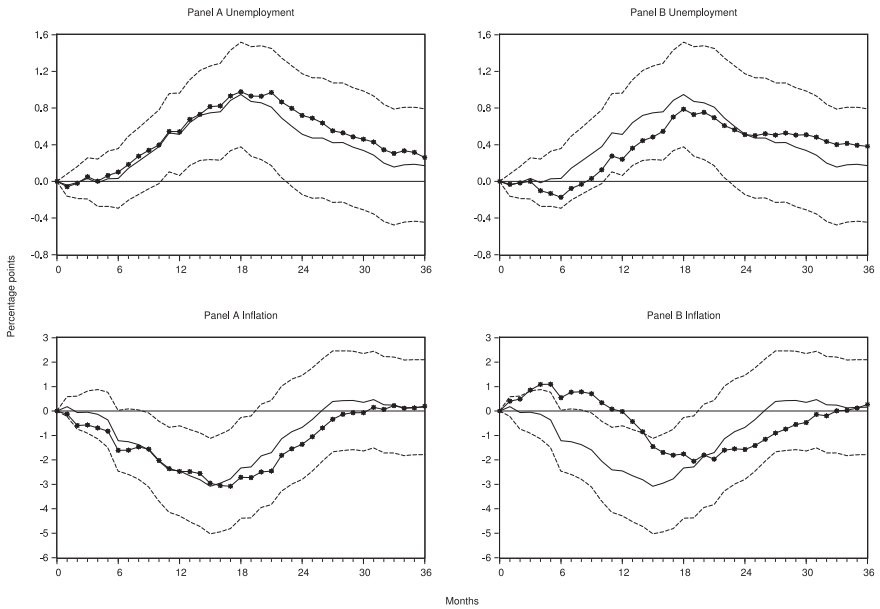

Fig. 8. Robustness to alternative first stage specifications.
Notes: The solid (starred) line is the baseline (alternative) impulse response to a one percentage point contractionary monetary policy shock with 95% confidence intervals. The sample runs from January 1890 to February 1912.

variables (starred line).[12] In the first stage regression, these variables were not statistically significant. As such, it is unsurprising that their inclusion has no discernible effect on the results.

Secondly, although this data was not available to policymakers in real-time, I add unemployment and inflation lagged by one month to the first stage regression. In principal, this is similar to the baseline approach, with the main difference being that the potential covariance between the monetary shock and lagged unemployment and inflation is now purged in the first stage as opposed to the second stage regression. The coefficient on unemployment is not statistically different from zero. While inflation is statistically significant at the 10% level, it is not economically significant. A one percentage point increase in inflation was followed by an increase in Bank Rate of less than 3 basis points. As expected, panel B shows that the peak effects on unemployment $(0.89, t = 3.02)$ and inflation $(-2.90, t = -2.88)$ are virtually unchanged.

Thirdly, other narrative studies of monetary policy have included forecast data in the first stage regression. As noted above, there is no evidence that forecasts were produced in this period. However, it is plausible that policymakers were nonetheless forward looking. One way to approach this issue is to include factors in the first stage regression extracted from a macroeconomic data set. Bernanke and Boivin (2003) show that this approach has comparable forecasting accuracy in terms of unemployment and inflation to the Federal Reserve's Greenbooks. The volume of high-frequency time series available for this period is understandably more modest than that for modern economies. Klovland (1998) collected a number of series to redress the balance, including data on railway freight receipts, deflated bank clearings, the volume of raw materials imported, real non-cotton exports, the volume of raw cotton consumption and real cotton goods exports in order to construct a composite cyclical indicator. This data, retrieved from Thomas and Dimsdale (2016), is transformed into growth rates if non-stationary, from which principal components are calculated for the correlation matrix. Panel C plots the impulse response functions based on the shock from a first stage regression including the first principal component lagged by one month.[13] The maximum response of unemployment $(0.92, t = 3.16)$ and inflation $(-2.95, t = -2.93)$ are practically identical.

The monetary shock might also be contaminated by misspecifications of the first stage regression. One possibility is that the first stage regression included too few lags. After all, it is plausible that the Court of Directors acted on a run of data, rather than the current week's figures alone. Panel A of Fig. 8 reports the results using the residuals from a first stage regression with the number of lags informed by an alternative information criterion. This specification is based on the minimization of the AIC (three lags). The peak

[12] Gold coined by the Royal Mint was not transformed, while growth rates were taken for all other variables to induce stationarity.
[13] The other factors were not statistically significant.

response of unemployment of 0.98 percentage points ($t = 3.50$) is somewhat larger than the baseline, while inflation is unchanged ($-3.08, t = -3.03$).

Another possible source of misspecification is the potential asymmetry of the central bank's reaction function. Although previous narrative studies have not accounted for this, it is plausible, for instance, that holding inflation constant, the central bank might alter the policy rate more strongly to negative output growth than to positive. The same could also be true in a historical context. Davutyan and Parke (1995) find evidence that the Bank of England reacted asymmetrically to a number of variables during this period. For example, there was a significant relationship between changes in Bank Rate and decreases in the Bank's holding of bullion but not between Bank Rate and increases in bullion. With this in mind, I re-estimate Eq. (5) to allow for positive and negative changes of each variable to have a differential impact on Bank Rate. The results of this exercise are reported in Table A.2. Panel B shows that the inclusion of these shocks in the VAR slightly attenuates the effects on the macroeconomy. The peak impact on unemployment falls to 0.79 percentage points ($t = 4.54$), while the inflation effect declines to −2.05 ($t = -2.53$). In the case of inflation, the dynamics are somewhat different, rising initially and then falling slightly later.

7.2. Outliers

A normal concern in time series analysis is the influence of outliers. I therefore set one of the five largest monthly shocks to zero, re-cumulate the shocks and re-estimate the model. The largest shocks, in order of absolute magnitude, came in August 1893 (1.84%), October 1909 (1.75), January 1891 (−1.75), January 1908 (−1.70) and May 1891 (1.62). As can be seen in Fig. 9, the impulse response functions are of a similar magnitude and follow a common path.

7.3. Alternative VAR specifications

In line with Cloyne and Hürtgen (2016), 24 lags were included in the baseline VAR. However, it could be that the results are sensitive to the number of lags included in the model. An agnostic approach as to the correct specification is to refer to information criteria. In a study of the Romer and Romer (2004) shocks, Coibion (2012) uses Monte Carlo simulations to assess the performance of the AIC and BIC. The results show that "the AIC does much better, on average, with only minor underestimates of the correct lag specification." Based on the results from the AIC, panel A of Fig. 10 plots the responses from a model with 29 lags included. The peak response of unemployment ($0.94, t = 2.83$) is basically unchanged but the impact on inflation is somewhat bigger ($-3.39, t = -3.21$).

The measure of monetary shocks was ordered after unemployment and inflation in the original specification, in line with the convention in narrative VARs (Cloyne and Hürtgen, 2016; Coibion, 2012; Romer and Romer, 2004). However, if the shocks are exogenous, as the evidence in Section 5.5 suggests, then the shocks should actually be ordered first. This assumption implies that the shocks are not affected by, but rather affect, unemployment and inflation contemporaneously. Panel B of Fig. 10 presents the results from a VAR with the measure of monetary policy shocks ordered first. It is clear that the results are not materially sensitive to this assumption.

In a financial crisis, the Bank of England might have deviated from its policy norm, such as if it followed Bagehot's rule. As this would have been an endogenous response to current macroeconomic conditions, the monetary shock will be contaminated. If the financial crisis also affected the macroeconomy, then the resulting impulse response functions will be biased. In order to rule out this possibility, I include an exogenous dummy variable in the VAR, which takes the value of one during the financial crises recorded by Reinhart and Rogoff (2011). This chronicles a banking crisis in 1890 and stock market crashes in 1910, 1911 and 1912. Panel C reassuringly shows that controlling for financial panics has no identifiable impact on the results.

7.4. Results from single equations

A possible worry might be that the results are driven by the econometric approach. If the monetary shocks are exogenous, then it is appropriate to include them as regressors in single equations. In line with Cloyne and Hürtgen (2016), I employ Jordà's (2005) local projections method to explore this possibility. The model takes the form:

$$x_{t+h} = \alpha_h + \beta_h m_t + \gamma' \mathbf{z_t} + \epsilon_{t+h} \tag{8}$$

for $h = 0, 1, 2, \ldots$, where x_t is unemployment or inflation, m_t is the new series of monetary policy innovations and $\mathbf{z_t}$ is a vector of control variables that includes 24 lags of unemployment, inflation, the shock and Bank Rate. As Ramey and Zubairy (2017) explain, "the coefficient β_h gives the response of x at time $t + h$ to the shock at time t. Thus, one constructs the impulse responses as a sequence of the β_h's estimated in a series of single regressions for each horizon." The standard errors are Newey–West corrected, with the maximum autocorrelation lag $L = h + 1$, as in Tenreyro and Thwaites (2016).

Fig. 11 plots the impulse responses of unemployment and inflation. The peak response of unemployment ($0.91, t = 3.35$) and inflation ($-2.94, t = -3.84$) is only faintly smaller than the baseline VAR.

In this section, 14 additional variants of the model have been estimated. The results show that the main results are robust to a number of alternative specifications. In terms of unemployment, the smallest peak effect was 0.75 percentage points, while the largest was 1.20. The median peak was 0.92, which is very close to the baseline figure of 0.95. In terms of inflation, the smallest peak effect was −2.05 percentage points, while the largest was −3.44. The median peak was −3.01, which is also very near to the baseline figure of −3.08. Additionally, the peak effect for each variable and variant of the model was significant at the 5% level.

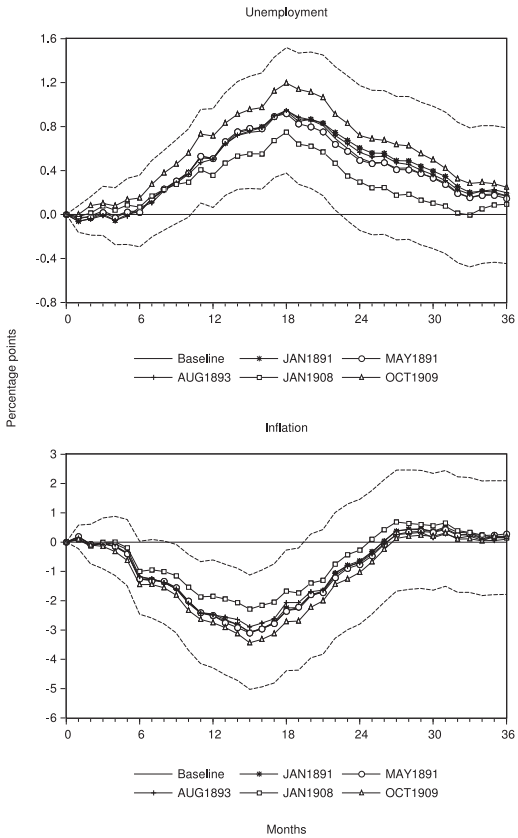

Fig. 9. Robustness to outliers.
Notes: The solid (other) line is the baseline (alternative) impulse response to a one percentage point contractionary monetary policy shock with 95% confidence intervals. The sample runs from January 1890 to February 1912.

8. Extensions

An interesting question is whether positive (contractionary) and negative (expansionary) shocks had the same impact on the macroeconomy. Previous research has shown that hikes have a more powerful impact on real variables than cuts in the modern US economy (Angrist et al., 2017; Tenreyro and Thwaites, 2016). To investigate this possibility, I re-run Eq. (8) but with positive and negative shocks modelled separately:

$$x_{t+h} = \alpha_h + \beta_h^+ \max[0, m_t] + \beta_h^- \min[0, m_t] + \gamma' \mathbf{z_t} + \epsilon_{t+h} \tag{9}$$

The results are reported in Fig. 12, where the first column plots the effect of a tightening, the second a loosening and the third the *P*-value for the test of the null hypothesis that $(\beta_h^+ - \beta_h^-) = 0$. The shocks are scaled to raise Bank Rate by one percentage point on impact to make the comparison fair.

There are a number of interesting, if a little inconclusive, results. Firstly, monetary policy tightenings had a more muted but rapid effect on unemployment, peaking at 0.78 percentage points ($t = 2.90$) after 11 months. A loosening of monetary policy, on the other hand, had a greater but more delayed impact, peaking at 2.24 percentage points ($t = 1.91$) after almost two years. The null hypothesis that $(\beta_h^+ - \beta_h^-) = 0$ can only be rejected at the 5% level at the 7 month horizon. At which point, the response to the tightening was underway, but the reaction to the loosening had not yet begun.

Secondly, positive monetary policy shocks had a more dampened impact on inflation, falling to a low of −1.89 percentage points ($t = -1.98$) after about a year. Negative shocks, however, had a more powerful effect, declining by a maximum of −5.58 ($t = -1.76$)

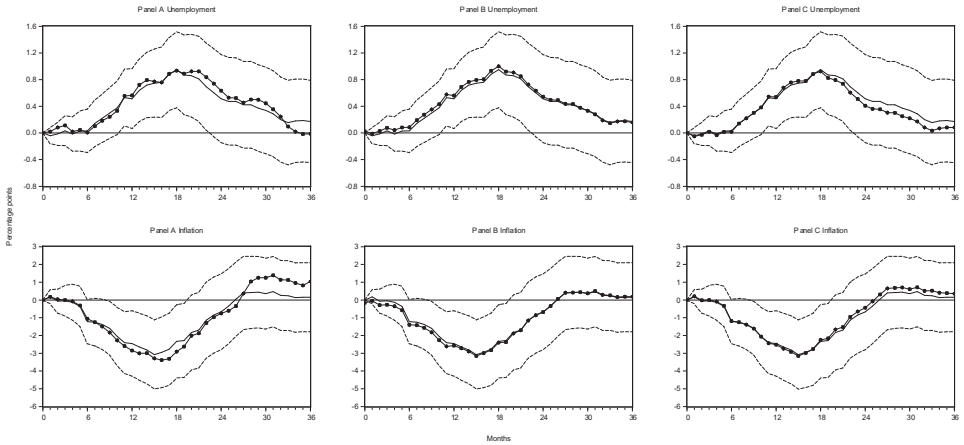

Fig. 10. Robustness to alternative VAR specifications.
Notes: The solid (starred) line is the baseline (alternative) impulse response to a one percentage point contractionary monetary policy shock with 95% confidence intervals. The sample runs from January 1890 to February 1912.

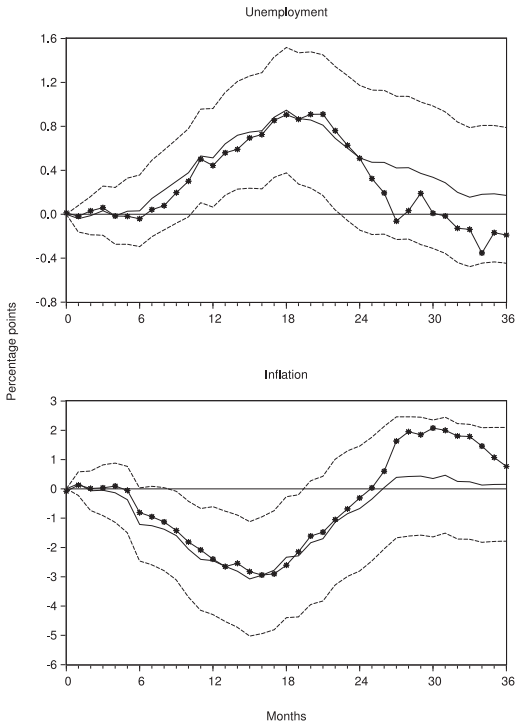

Fig. 11. Robustness to an alternative econometric method.
Notes: The solid (starred) line is the baseline (alternative) impulse response to a one percentage point contractionary monetary policy shock with 95% confidence intervals. The sample runs from January 1890 to February 1912.

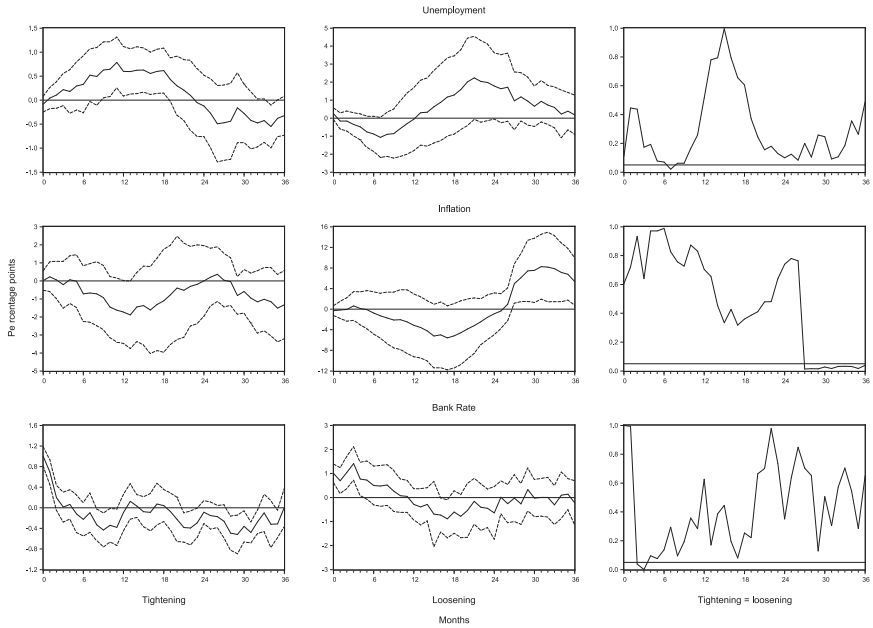

Fig. 12. Response of unemployment, inflation and Bank Rate to positive and negative monetary policy shocks.
Notes: The solid line is the impulse response to a monetary policy shock that raises Bank Rate by 1 percentage point on impact with 95% confidence intervals. The sample runs from January 1890 to February 1912.

after 17 months. Thereafter, inflation overshot in the third year following the loosening of monetary policy, which is a quirk also observed by Tenreyro and Thwaites (2016). However, we cannot reject the null hypothesis that positive and negative shocks were equally powerful, except during the overshooting period.

Thirdly, negative shocks had a more persistent effect on Bank Rate than positive shocks. While both shocks have been scaled to raise Bank Rate by 1 percentage point on impact, negative shocks raised Bank Rate by 0.88 percentage points on average in the first six months, but positive shocks increased Bank Rate by just 0.23 percentage points over this horizon. The non-linearities might therefore be a function of the asymmetric response of Bank Rate to positive and negative shocks.

9. Conclusion

In this paper, I provide new estimates of the causal effects of monetary policy on the British economy during the classical gold standard. However, identifying these effects is challenging because monetary policy is not exogenous. In order to resolve this empirical challenge, I use archival sources to reconstruct the Bank of England's real-time information set for all 1257 monetary policy decisions. In the first stage, I regress the change in Bank Rate on this information set. The residuals from this regression are used to construct an exogenous measure of monetary policy. In the second stage, I include the new series in a VAR to measure the macroeconomic effects of monetary policy.

The first stage regression is the first to use real-time data to estimate the Bank of England's reaction function during the classical gold standard. Orphanides (2001) argues that this is fundamental to the interpretation of historical monetary policy rules. Although the results are generally consistent with earlier studies, an important finding is that the Bank did not react linearly to observable proxies for activity or prices. This implies that the Bank of England did not use its policy rate to manage the economy during the classical gold standard beyond maintaining convertibility.

The new exogenous series of monetary policy is associated with an economically and statistically significant effect on the macroeconomy. Following a one percentage point monetary tightening, unemployment rose by 0.9 percentage points and inflation fell by 3.1 percentage points. This evidence augments the existing literature by resolving the price puzzle and by documenting the large real effects of monetary policy. The results are robust to more than a dozen checks, including different specifications of the first and second stage regressions and controlling for outliers.

The general view is that monetary disturbances were not a major source of economic fluctuations in the United Kingdom (Capie and Mills, 1991; Catao and Solomou, 1993). However, I find that monetary shocks accounted for a large fraction of macroeconomic volatility. In the aftermath of the 1907 crisis, for example, my findings suggest that monetary policy raised unemployment by approximately half a million people.

Narrative estimates of the effects of monetary policy have received considerable attention (Cloyne and Hürtgen, 2016). However, these studies are in short supply. This paper is only the third application of the narrative approach to monetary policy, and the first for a historical context and an alternative monetary regime. My results corroborate the existing findings, suggesting that monetary policy substantially affects the macroeconomy. As the impact of monetary policy ultimately depends on the price setting behaviour of firms (Alvarez et al., 2016), one interesting implication is that, as Gordon (1990) hypothesized, price stickiness may indeed be "timeless and placeless".

Acknowledgements

This work was supported by the Jan Wallander and Tom Hedelius Foundation. For help and comments, I am grateful to Anders Ögren, Arno Hantzsche, Astrid Kander, Charles Goodhart, Fredrik NG Andersson, Gareth Campbell, John Turner, Jonas Ljungberg, Kerstin Enflo, Lars Jonung, Ryland Thomas, Seán Kenny and seminar participants at the Department of Economic History at Lund University.

Appendix

Table A.1
Stylized example of "The Fronts" in the Daily Accounts.

	Total bullion, Bank of England	Rates of discount		Exchanges on London			Price of consols	Average daily clearing for the week	Wheat, average weekly price
		Bank of France	Bank of Germany	Paris. Sight per £	Berlin. Sight per £	New York. Cable transfers			
1 January 1913	31300	4	6	25.17	20.4550	4.8625	$75\frac{1}{4}$	73307	29/10
8 January 1913	33414	4	6	25.18	20.4675	4.8680	$75\frac{1}{8}$	54490	30/5
⋮									
31 December 1913	34983	4	6	25.32	20.5200	4.8620	$71\frac{3}{4}$	69401	31/-

Table A.2
Determinants of changes in Bank Rate (Δi_m).

Variable	Coefficient	Standard error
Constant (ϕ_0)	0.082***	0.027
Initial Bank Rate (i_{m-1})	−0.030***	0.006
Bullion (ΔB_m^+)	−0.004	0.005
Bullion (ΔB_m^-)	−0.023***	0.005
Proportion (ΔP_m^+)	−0.004	0.004
Proportion (ΔP_m^-)	−0.005	0.004
Change in Bank of France's discount rate (Δi_m^{F+})	0.010	0.114
Change in Bank of France's discount rate (Δi_m^{F-})	0.149	0.128
Change in Bank of Germany's discount rate (Δi_m^{G+})	0.188***	0.040
Change in Bank of Germany's discount rate (Δi_m^{G-})	0.049	0.042
Change in French francs/£ (Δe_m^{F+})	1.379**	0.567
Change in French francs/£ (Δe_m^{F-})	−0.306	0.614
Change in German marks/£ (Δe_m^{G+})	−0.297	0.723
Change in German marks/£ (Δe_m^{G-})	3.655***	0.780
Change in US dollars/£ (Δe_m^{US+})	2.639	1.611
Change in US dollars/£ (Δe_m^{US-})	2.466	1.718
Net exports of gold coin and bullion (G_m^{NX+})	0.070***	0.016
Net exports of gold coin and bullion (G_m^{NX-})	0.006	0.017
Consol price inflation (ΔQ_m^+)	−0.036*	0.019
Consol price inflation (ΔQ_m^-)	−0.059***	0.019
Change in bank clearings (ΔY_m^+)	−0.001*	0.000
Change in bank clearings (ΔY_m^-)	0.001	0.001
Wheat price inflation (π_m^+)	0.010**	0.005
Wheat price inflation (π_m^-)	−0.008	0.005

Notes: */**/*** indicate significance at 10/5/1% level. $R^2 = 0.197$, $F = 13.172$, $N = 1257$. The sample covers all monetary policy decisions between 1890 and 1913.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at 10.1016/j.eeh.2017.10.001.

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Paper IV

Uncertainty and the Great Slump[*]

JASON LENNARD

This paper investigates the impact of economic policy uncertainty on the macroeconomy of interwar Britain. A new index of economic policy uncertainty constructed from contemporary newspapers indicates that this was a period of great anxiety. Time series evidence suggests that this uncertainty reduced output, raised unemployment and contributed to macroeconomic volatility.

"Business can flourish with tariffs. Business can flourish without tariffs. Business cannot flourish where there is uncertainty."[1]

The interwar period holds a number of unwanted records in British economic history. Unemployment in the 1930s was higher than at any point since records began in 1855.[2] The volatility of output growth was greater than under any macroeconomic regime of the past three centuries.[3] No recession since the early 1700s has been as deep as that of the early 1920s.[4] What caused this instability?

Textbook answers to this question identify four main factors. The first factor is the reduction in hours worked after the First World War, which led to an increase in the natural rate of unemployment (Broadberry 1986). The second is the behavior of the nominal and real exchange rate, which had both short- and long-run effects (Solomou 1996). The third is the decline of the old staple industries (Richardson 1965). Textiles, iron and steel, and shipbuilding, which Britain had invested heavily in, suffered from weak demand and oversupply (Eichengreen 2006). The final factor is the constraint on stabilization policy. Monetary policy was curbed by the commitment to the interwar gold standard, while fiscal policy was limited by the balanced budget orthodoxy of the time.

[*] Department of Economic History, Lund University and National Institute of Economic and Social Research. For help and comments, I thank Anders Ögren, Arno Hantzsche, Fredrik NG Andersson, Gabriel Mathy, Gareth Campbell, John Turner, Kerstin Enflo, Martin Weale, Nicholas Bloom, Scott Baker, Seán Kenny and Steven Davis.

[1] Stanley Baldwin, Leader of the Opposition (British Parliamentary Papers, vol. 236).

[2] Figures in this paragraph are calculated from data in Thomas and Dimsdale (2017).

[3] Volatility measured using sample standard deviation. Chronology of regimes based on Benati (2006).

[4] Based on the year-on-year percentage change in output.

Yet contemporaries were concerned with another issue. Businessmen, journalists and politicians frequently held uncertainty over economic policy accountable for the slump. In 1930, for example, the Labour government faced a vote of no confidence on this issue. Winston Churchill appealed to the House of Commons, "the charge that we make against the Chancellor of the Exchequer is that, without due cause, he has created uncertainty which has been harmful to trade and employment" (British Parliamentary Papers, vol. 236). Ultimately, the noes had it by a majority of 73 and the Government avoided defeat. The role of uncertainty has since been relegated to a footnote in the economic history of interwar Britain.

A possible explanation for why the impact of uncertainty has not been investigated further in this context is measurement. As a nebulous concept, uncertainty is difficult to quantify. Scott R. Baker et al. (2016) and Michelle Alexopoulos and Jon Cohen (2015) address this challenge by constructing indices based on the frequency of articles in a sample of newspapers relating to economic policy uncertainty. Vector autoregressions (VAR) show that these measures have been associated with lower output and higher unemployment and volatility in the United States.

This paper revisits the old uncertainty hypothesis using a new index of economic policy uncertainty constructed from the archives of the *Daily Mail*, *The Guardian* and *The Times*. The index confirms that the interwar period was indeed a time of heightened uncertainty. Local projections show that a major uncertainty shock, such as that associated with the break from the gold standard in 1931, reduced output by 2.8 percent, raised unemployment by 2.0 percentage points and accounted for a fifth of macroeconomic volatility.

The local projections model does not identify whether uncertainty had a *causal* impact on the economy. In order to investigate this issue, I propose a novel identification approach. The first step isolates significant spikes in policy uncertainty, defined as episodes in which the de-trended uncertainty index rose significantly above the mean. The second studies the narrative record to disentangle whether these episodes were endogenous or exogenous. The final step uses the series of exogenous uncertainty spikes in a local projections model. These causal estimates also support the hypothesis that uncertainty mattered.

The interwar period has substantial relevance for today. First, as was the case following the 2010 and 2017 elections, a hung parliament resulted from the general election in 1929. Second, as in 2017, there were snap general elections in 1923 and 1931. Third, in the same way that unconventional policy measures were implemented in response to the Great Recession, policymakers introduced a range of new fiscal and monetary policies to fight the

Great War and the Great Slump. Fourth, as the issue of trade barriers has emerged in the wake of Brexit, tariffs were implemented in Europe and the United States in the interwar period. Britain also turned inwards, promoting a policy of imperial preference. Fifth, as with the Scottish independence referendum in 2014, there was the issue of Irish independence in the interwar period. Sixth, in both periods, the threat of war loomed.

PREVIOUS LITERATURE

The literature on uncertainty has mushroomed in recent years.[5] The best empirical estimates are based on narrative measures of uncertainty. Alexopoulos and Cohen (2015) construct indices based on the relative frequency of articles in the *New York Times* relating to general economic and economic policy uncertainty. The impact of an uncertainty shock such as that of 9/11 caused a 2 percent decline in output and a 1 percent reduction in employment, according to a VAR model estimated for monthly U.S. data between 1985 and 2007. Moreover, uncertainty shocks accounted for roughly one-fifth to one-half of macroeconomic volatility.

Baker et al. (2016) build on this measure in a number of ways. First, the sample of U.S. newspapers is increased to 10. The resulting index is highly correlated (0.58) with the VIX, which is an alternative measure of uncertainty based on the implied volatility of S&P500 index options. Based on a VAR model applied to monthly U.S. data between 1985 and 2014, a shock equal to the change in economic policy uncertainty during the recent financial crisis led to peak declines in industrial production and employment of 1.1 and 0.35 percent respectively. Second, the sample is extended to 12 major economies. A panel VAR estimated over the same sample period indicates similar, although marginally smaller, peak effects.

The economic effects of policy uncertainty have also been investigated in historical contexts. Gabriel Mathy (2017), like Alexopoulos and Cohen (2015), constructs a measure of uncertainty based on articles in the *New York Times* for the U.S. during the Great Depression. A VAR model indicates that uncertainty accounted for a substantial share of the deep decline in industrial production. Based on qualitative evidence and the variability of stock markets, Christina D. Romer (1990) argues that the hangover of uncertainty from the Great Crash was a key factor in the propagation of the Great Depression. Mathy and Nicolas L. Ziebarth

[5] See Bloom (2014) for a comprehensive review.

(2017) study political uncertainty in Louisiana during the 1920s and 1930s using both stock return volatility and newspapers, finding no impact of uncertainty on employment.

The theoretical literature is ambiguous on the sign of uncertainty's impact on the macroeconomy (Bloom 2014). On one hand, uncertainty increases the option value of postponing decisions that are costly to reverse. As a result, firms delay investment (Bernanke 1983) and households hold back on durable consumption (Bertola et al. 2005), which leads to lower output and employment (Mathy and Ziebarth 2017). On the other hand, uncertainty can generate growth. As uncertainty increases the spread of possible outcomes, bigger prizes for winners are potentially available, which can in turn stimulate investment in certain circumstances (Bloom 2014). This "growth options" effect was appreciated in interwar Britain. At the ordinary general meeting of Courtaulds, Limited, the Chairman noted that "uncertainty has room for hopes as well as for misgivings" (*The Guardian*, 10 March 1933, p. 16).

MEASURING ECONOMIC POLICY UNCERTAINTY

Measuring uncertainty over economic policy is challenging as it is not directly observable. In order to overcome this challenge, Baker et al. (2016) develop an index based on the number of articles about economic policy uncertainty relative to all articles in a sample of newspapers in a given time period. An article is identified as relating to economic policy uncertainty if it contains an economic, policy *and* uncertainty related term. Once the relative frequency of these articles has been calculated for each newspaper, it is normalized to have unit standard deviation. The normalized newspaper-specific series are then averaged to give an aggregate index, which is scaled to have a mean of 100.

Baker et al. (2016) construct indices for 12 modern economies, including the United Kingdom from 1997. Based on *The Times* and the *Financial Times*, the economic terms are "economic" or "economy". The policy terms include "spending", "policy", "deficit", "budget", "tax", "regulation" or "Bank of England". The uncertainty terms are "uncertain" or "uncertainty". Equivalent terms were originally selected for the United States to minimize the sum of false positive and negatives and adapted for the United Kingdom. Baker et al. (2016) also include historical indices for the United States and United Kingdom in an online appendix. Based on *The Guardian* and *The Times*, the historical index for Britain runs from 1900 to 2010 and expands the economic term set to include "business", "industry",

"commerce" or "commercial" and adds "war" or "tariff" to the policy terms. However, the impact of this index on the macroeconomy has not been analyzed.

I construct a new index of economic policy uncertainty for interwar Britain. This builds on Baker et al. (2016) in a few important ways. First, the sample of newspapers includes the *Daily Mail* as well as the *The Guardian* and *The Times*. Like these papers, the *Mail* also covered economic and financial news, but unlike these papers it had a significant readership. In the interwar period, the *Daily Mail* was "not only the largest selling daily newspaper in Great Britain but in the world" (Jeffery and McClelland 1987, p. 28). Second, I expand the policy term set to include "Bank Rate" and "duty". These terms were commonplace in interwar Britain. The first described the main instrument of monetary policy; the second referred to a tariff. I also include close variants of the economic, policy and uncertainty terms, such as "duties".

The new EPU index is shown in Figure 1. The interpretation is that larger (smaller) values are associated with greater (lesser) economic policy uncertainty. What causes these fluctuations in uncertainty? While a detailed narrative account of every major spike in policy uncertainty is given in the Appendix, it is important to introduce some of the main causes.

The first cause of uncertainty was events overseas. As war loomed in Europe, events such as the Munich Agreement and the Spanish Civil War were associated with rising uncertainty. International politics, such as elections in Germany and the United States, also induced anxiety.

The second cause was, unsurprisingly, domestic politics. Events such as the snap general elections of 1923 and 1931, the ordinary elections of 1924, 1929, 1931, and 1935 and the hung parliament of 1929 were often associated with increases in uncertainty.

The other major cause of uncertainty was stabilization policy. In terms of fiscal policy, the spring budget was often associated with rising uncertainty. As changes to fiscal policy were usually announced on budget day, uncertainty naturally built in advance. Relatedly, a number of emergency policies were implemented during and just after the Great War such as the 1915 McKenna Duty and the 1921 Safeguarding of Industries Act. These policies insulated domestic industries producing goods like cars, certain textiles and products essential to national security from foreign competition.[6] At various times during the interwar period, there were bouts of uncertainty over whether these extraordinary measures were to be lifted in a return to Britain's pre-war policy of free trade.

[6] See de Bromhead et al. (2017) for a primer on British interwar trade policy.

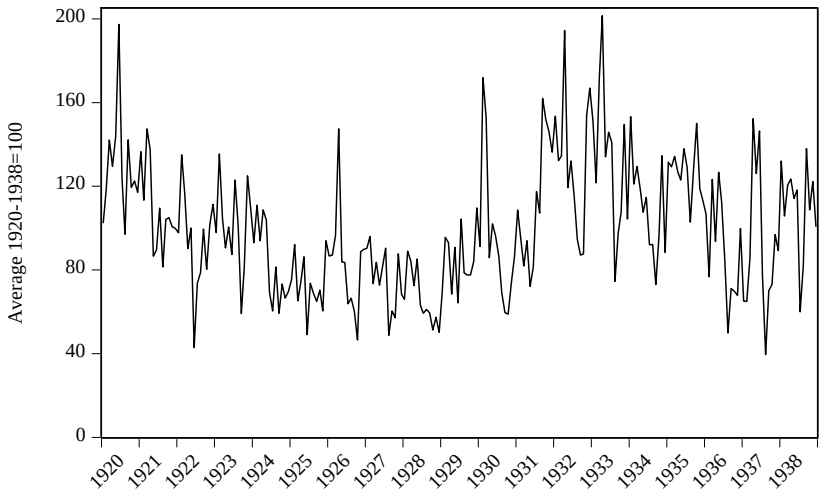


FIGURE 1

NEW ECONOMIC POLICY UNCERTAINTY INDEX FOR THE UNITED KINGDOM

Source: Author's calculations. The data is available at policyuncertainty.com/interwar_uk.

In terms of monetary policy, the major cause of anxiety related to the gold standard. In April 1925 the United Kingdom returned to the gold standard at the pre-war parity of £3.85 per ounce. The return was not associated with an immediate change in EPU, which is not surprising as the intention to do so had been announced as early as November 1919 (Solomou 1996, p. 93). However, EPU was almost a third lower on average during the interwar gold standard, relative to the periods before and after. Uncertainty returned as the interwar gold standard was abandoned in September 1931, "a policy that was surely unanticipated" as "the National Government was elected to maintain the parity" (Broadberry 1986, p. 115).

THE MACROECONOMIC EFFECTS OF ECONOMIC POLICY UNCERTAINTY

Data and Specification

To measure the macroeconomic effects of economic policy uncertainty I estimate a local projections (Jordà 2005) model. This model has a number of advantages over a VAR. One advantage is that it is more robust to misspecification. Another is that it is highly flexible, which will be exploited in a later section. Specifically, I estimate the following model:

$$y_{t+h} - y_{t-1} = \alpha^h + \sum_{j=1}^{11} \gamma_j^h D_{jt} + \delta^h t_t + \beta^h EPU_t + \sum_{k=1}^{N} \varphi_k^h EPU_{t-k} + \sum_{k=0}^{N} \theta_k^h y_{t-k} + e_{t+h} \quad (1)$$

where y is a measure of economic activity (natural logarithm of real GDP or unemployment rate), the D_j's are monthly dummies, t is a linear time trend and EPU is the new economic policy uncertainty index. The impact of economic policy uncertainty on economic activity at horizon h is given by β^h.

At horizon 0, equation 1 regresses the change in economic activity on the contemporaneous values of output and policy uncertainty. As the contemporaneous change is the dependent variable and the contemporaneous level of output is included as an independent variable, the coefficients on output and policy uncertainty are 1 and 0 respectively. At horizons beyond 0, variation in uncertainty that is orthogonal to output contemporaneously, has room to have a non-zero effect. This is equivalent to a Cholesky decomposition with output ordered first and uncertainty second, which assumes that output affects uncertainty within the period, but not vice versa. Baker et al. (2016) and Alexopoulos and Cohen (2015) order uncertainty first, which is likely to overestimate the effect. In a subsequent section, I directly tackle the identification challenge.

The sources and definitions for the data used in the model are given in Table 1. James Mitchell et al. (2012) calculate monthly estimates of real GDP by allocating the annual total (Sefton and Weale 1995) across the months of the year based on movements in a common factor, which itself is a function of up to 14 indicators of economic activity collected by *The Economist* at the time. As a result, the components of expenditure are not available at a monthly frequency, which might have otherwise been useful to understand the mechanism through which uncertainty influenced the macroeconomy. This monthly GDP series has been used previously in econometric work, such as by Nicholas Crafts and Terence C. Mills (2015;

2013). Except for the debt, expenditure and revenue of the government, which I collected from contemporary issues of *The Economist*, the remaining data is from secondary sources.

TABLE 1

DATA SOURCES

Variable	Source	Description
EPU index	See text	Average 1920-38 = 100
Real GDP at factor cost	Mitchell et al. (2012) table 1b	£ millions at 1938 prices
Unemployment	Capie and Collins (1983) table 4.4	Percent
Control Variables		
Bank Rate	Thomas and Dimsdale (2017)	Percent. End month
M0	Capie and Webber (1985) table I.1	£ millions. End month
Real government debt, expenditure and revenue	*The Economist* (various dates). Collected for month t from the first issue of month $t + 1$	£ millions at 1924 prices. Deflated by the retail price index
Yield on consols	Capie and Webber (1985) table III.10	Percent. End month
Real exports	Capie and Collins (1983) table 5.8	£ millions at 1924 prices. Deflated by the retail price index
Real wages	Capie and Collins (1983) tables 4.1 and 4.2	Deflated by the retail price index
Retail price index	Capie and Collins (1983) table 2.13	Average 1924 = 100
Share price index	Thomas and Dimsdale (2017)	Average 1920-38 = 100. Spliced monthly index weighted by market capitalization
$/£ exchange rate	Thomas and Dimsdale (2017)	

Baseline Results

Turning to the main results of the paper, Figure 2 plots the impulse response of output and economic policy uncertainty to an economic policy uncertainty shock, where y, in this case, is the natural logarithm of real GDP and N, the number of lags, is set to 1. Baker et al. (2016) scale the uncertainty shock equal to the change in the EPU index during the recent financial crisis, which was 90 points (a 90 percent increase on the sample average, in other words). I have scaled the shock to 55 points (a 55 percent increase on the sample average), which is equal to the increase in September 1931 when Britain abandoned the gold standard. The change in uncertainty around this event was big but not exceptionally so, ranking as the sixth largest increase. The shaded areas represent 68 and 95 percent confidence intervals based on Newey-West (1987) standard errors, where the maximum autocorrelation lag is set to $h + 1$ (Tenreyro and Thwaites 2016).

Panel A illustrates the impulse response of the economic policy uncertainty index to an innovation to itself, which is estimated using equation 1 where y is replaced by EPU. It shows that shocks persisted for roughly a year, which could be due to the fact that an episode of heightened uncertainty lived long in the memory (at least in the minds of journalists) or that events that induce uncertainty follow each other.

Panel B shows that this economic policy uncertainty shock had an economically and statistically significant effect on output, declining by a maximum of 2.8 percent ($t = -2.6$) after a year and returning sluggishly towards zero thereafter. The effect is statistically significant at the 5 percent level between months 1 and 17. These estimates are in the same ballpark as those reported in the literature. Following a major uncertainty shock, Baker et al. (2016) document a peak drop of 1.1 percent in industrial production, while Alexopoulos and Cohen (2015) and Mathy (2017) find a 2 and 5 percent decline respectively.

A key channel through which policy uncertainty affects the economy is employment. As unemployment was a chronic problem of the interwar period, I also investigate whether policy uncertainty was a factor. Figure 3 plots the impulse response of unemployment to an economic policy uncertainty shock, where y, in this case, is the percentage of insured workers unemployed. Following a major policy uncertainty shock, such as the break from the gold standard, unemployment increased rapidly, peaking at 2.0 percentage points ($t = 2.5$) after a year and slowly subsiding after. The effect is statistically significant at the 5 percent level between months 7 and 15. Note that the estimated unemployment effect is larger and more precise if output is included as a control. This effect therefore works over and above Okun's Law.

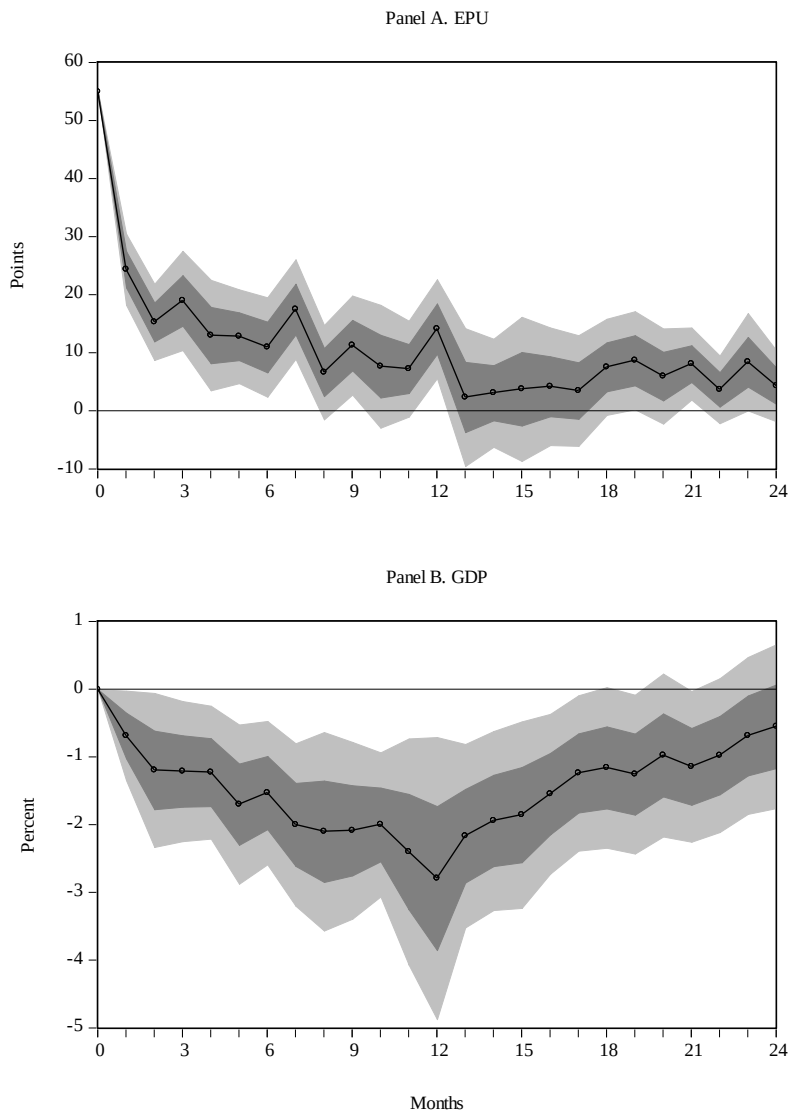


FIGURE 2

RESPONSE OF EPU AND GDP TO AN EPU SHOCK

Source: Author's calculations.

A standout feature of the interwar period relative to other macroeconomic epochs in British history was the volatility of the business cycle (Solomou 1996). A variance

decomposition can speak to this issue. Yuriy Gorodnichenko and Byoungchan Lee (2017) propose an R^2 approach to variance decomposition with local projections. This involves regressing the residuals for each horizon from equation 1, e_{t+h}, on EPU from time t to $t+h$, excluding a constant:

$$e_{t+h} = \psi_0^h EPU_t + \cdots + \psi_h^h EPU_{t+h} + u_{t+h} \tag{2}$$

where the variance decomposition at each horizon is given by the R^2. The results show that economic policy uncertainty explained 20 percent of the variance in output, which implies that uncertainty has been an underappreciated cause of the macroeconomic volatility of the interwar period.

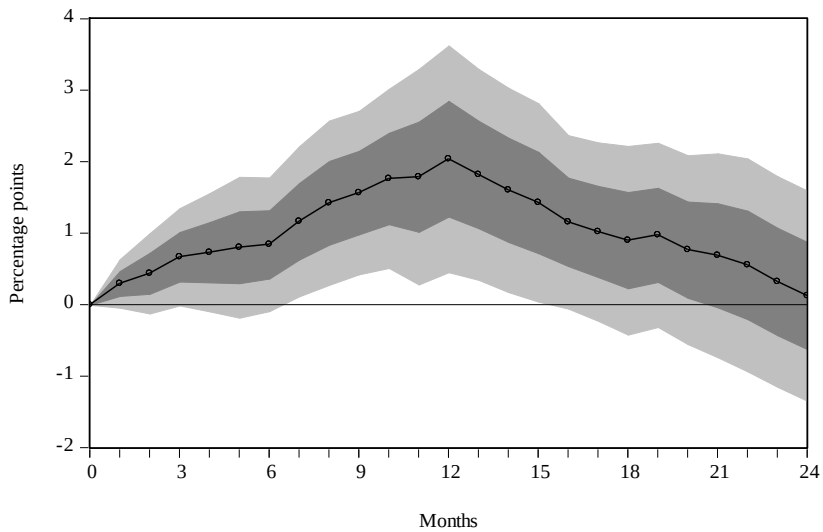


FIGURE 3

RESPONSE OF UNEMPLOYMENT TO AN EPU SHOCK

Source: Author's calculations.

Identification

A major empirical challenge in the uncertainty literature is identification. Because uncertainty is not exogenous, correlations between uncertainty and output may not identify the effect of uncertainty. To find out how serious the issue of reverse causality is, I develop a novel three-step identification approach. The first step isolates major economic policy uncertainty shocks. The second disentangles whether these major uncertainty shocks were exogenous or endogenous by studying contemporary newspapers. The third regresses real GDP on the interaction of the EPU index and the series of major exogenous shocks.

Focusing on major shocks is related to a long literature in empirical macroeconomics, such as the studies by Valerie A. Ramey and Matthew D. Shapiro (1998) and Christina D. Romer and David H. Romer (1989) on fiscal and monetary policy respectively. In the context of uncertainty, Bloom (2009) identifies a major shock as that in which a de-trended measure of uncertainty rises significantly above the mean and suggests that such shocks are "arguably exogenous".

In the first step, I follow Bloom's approach by de-trending the natural logarithm of the new EPU index using a Hodrick-Prescott (1997) filter set according to the Ravn-Uhlig (2002) rule ($\lambda = 129600$). Identifying a major shock as those events that are 1.65 standard deviations above the mean, which is the one-tailed, 5 percent significance level, there were nine major shocks, beginning in June 1920, April 1926, February 1930, September 1931, April 1932, December 1932, March 1933, April 1937 and June 1937. The results of this exercise are shown in Appendix Figure 1.

In the second step, instead of assuming that these events are exogenous just because they are large, I read contemporary newspapers to understand what caused these spikes in uncertainty. This narrative approach is also related to a literature in empirical macroeconomics that uses historical documents to disentangle causality, such as James Cloyne (2013) and Romer and Romer (2010) on tax changes and Seán Kenny et al. (2017) and Andrew J. Jalil (2015) on banking crises.[7]

In order to be concrete, consider the following simple model of the determinants of output:

$$\Delta y_t = \alpha + \beta shock_t + e_t \tag{3}$$

[7] Mathy (2016) also studies the historical record to understand the causes of jumps in U.S. uncertainty, but in terms of banking crises, monetary policy, war, etc., whereas my goal is to understand whether spikes in uncertainty were caused by endogenous or exogenous factors.

where y is a measure of output and $shock$ is the series of major episodes identified in the first step. I define an exogenous episode as one that satisfies $E(e_t|shock_t) = 0$. In other words, an exogenous episode is one that is not correlated with an output shock. Based on contemporary newspapers, such as the *Daily Mail*, *The Economist*, *Financial Times* and *The Times*, I classify April 1926 and September 1931 as endogenous and June 1920, February 1930, April 1932, December 1932, March 1933, April 1937 and June 1937 as exogenous. The Appendix contains a detailed narrative account of each episode.

As an example of an episode that I classify as endogenous, the narrative record suggests that the spike in policy uncertainty in September 1931 was a consequence of abandoning the gold standard, which in turn was a response to the state of the economy. As an example of an exogenous episode, the rise of uncertainty in June 1920 stemmed from a rumor in a national newspaper. The *Sunday Express* (wrongly) reported that the government had abandoned the war wealth tax, which stoked uncertainty as to whether this was true.

From this information, I then construct a dummy variable, $shock^x$, that is 1 in the first month of an exogenous shock and 0 otherwise. Armed with the new series of exogenous shocks, in the third step I estimate the following model:

$$y_{t+h} - y_{t-1} = \alpha^h + \sum_{j=1}^{11} \gamma_j^h D_{jt} + \delta^h t_t + \beta^h (EPU_t \cdot shock_t^x) + \sum_{k=1}^{N} \varphi_k^h EPU_{t-k} + \sum_{k=1}^{N} \theta_k^h y_{t-k} + e_{t+h} \quad (4)$$

where I interact EPU_t with $shock_t^x$. The interaction term takes the value of the policy uncertainty index in exogenous months and is zero otherwise. I have also excluded the contemporaneous output term in this specification, which assumes that the interaction term is contemporaneously exogenous.

It is worth pointing out that $shock_t^x$ could be used as an instrument for EPU_t. In terms of relevance, this instrument is likely to be highly correlated with EPU since it is constructed from EPU itself. In terms of exogeneity, the instrument is uncorrelated with output shocks by construction. However, this would scale each episode equally, as would

using using $shock_t^x$ in place of EPU_t. The interaction term retains information on the severity of the uncertainty shocks.

The results are presented in Figure 4. The response has been scaled to raise the EPU index on impact by 55 points, so that it can be compared to the baseline results. The economic impact of policy uncertainty is slightly smaller in this model. Following a major uncertainty shock, real GDP declined by up to 1.7 percent ($t = -2.0$) after 11 months. The effect is statistically significant between months 9 and 12.

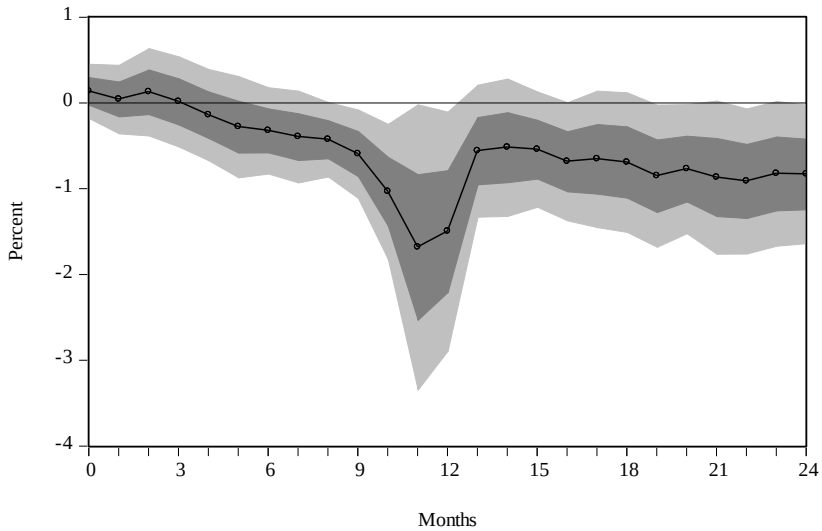


FIGURE 4

CAUSAL RESPONSE OF GDP TO AN EPU SHOCK

Source: Author's calculations.

An advantage of focusing on large, plausibly exogenous variation is that the causal effect can be identified. However, excluding all other information reduces the variation and therefore the precision of the estimates. It is for this reason that I prefer to use this approach not as the baseline but as an extension to gauge the sensitivity of the results to the endogeneity problem. Nevertheless, these results reinforce the hypothesis that policy uncertainty mattered during the Great Slump.

Qualitative Evidence

In this section I analyze qualitative evidence relating to the macroeconomic effects of economic policy uncertainty in interwar Britain. The first type of evidence I consider are economic reports in contemporary newspapers, based on the logic that these reflect the views of informed observers. This evidence is supportive of the uncertainty hypothesis.

On the Safeguarding Act, for example, *The Guardian* (20 December 1924, p. 13) noted that "industry can adapt itself to any stable and calculable condition, even the condition of a regular tariff; the one condition fatal to enterprise and trade recovery is uncertainty. The Government's proposal is a proposal to introduce such uncertainty." In relation to the possibility of a general election, Winston Churchill observed that "the uncertainty is bad from every point of view. It hangs like a cloud over the trade of the country" (*The Times*, 19 March 1930, p. 20). In a letter to the editor of *The Times* (5 July 1932, p. 10), signed by the economics departments of the universities of Oxford (including James Meade) and Cambridge (including John Maynard Keynes), the government was urged to "explicitly declare its policy in advance. A definite pronouncement of this kind should remove all fears of uncontrolled inflation - fears which arise primarily from a sense of uncertainty." *The Economist* (30 January 1932, p. 1) summarized that, "business this year has been overshadowed by the economic and political uncertainty at home and abroad."

Uncertainty's depressive effect on employment was also widely recognized. In the winter of 1920, the *Daily Mail* (30 December 1920, p. 4) observed that "among the main causes of unemployment at the present moment […] is uncertainty in the business world", which was associated with the Excess Profits Duty. In the same newspaper a decade later, Sir William Morris, founder of Morris Motors Limited, attacked the incumbent government on the same issue (*Daily Mail*, 29 August 1930, p. 8):

> No business could be run on the lines on which we try to run England. Whoever heard in the board room of a successful commercial house the counterpart of such childish bickerings and pettifogging personal pin-prickings as those to which we have been treated of late in our supposedly austere and deep-thinking House of Parliament? […] This is the position we find ourselves in to-day, floundering in a sea of uncertainty […] the result being colossal unemployment.

While *The Times* (12 March 1930, p. 15) noted:

> There are manufacturers unable to do their usual amount of trade because of an expectation, or a bare possibility, that Government policy may interfere with their markets and affect the price of their products. Commercial uncertainty is contagious, and uncertainty soon intensifies the depression of which the increase of unemployment is a measure. Enterprise languishes in a period of political uncertainty.

The qualitative evidence also sheds light on some of the mechanisms through which uncertainty affects the macroeconomy. The *Mail* (7 June 1920, p. 2) observed that "surely the uncertainty as to taxation has had much to do with the lessened popularity of industrial investments", which is one of the key mechanisms highlighted in the modern theoretical literature. Similarly, on the National Government's financial proposals in 1931, the paper (7 September 1931, p. 3) noted that "uncertainty as to these has played havoc with the stock markets of late." Depressed stock prices could be associated with lower consumption through wealth effects.

At the microeconomic level, Sir William Letts, chairman and managing director of Willys Overland Crossley, a car manufacturer, told shareholders at the annual general meeting (*The Guardian*, 25 February 1930, p. 6):

> I do not wish to introduce politics or thrust my opinion upon a body of shareholders, but I think it is only right that attention should be directed to what has been and is really hindering our business – the uncertainty regarding the McKenna duties. I believe that no sensible Chancellor of the Exchequer would take these duties off, but uncertainty exists, it is crippling business and holding back activity and energy in our great industry. We rely upon the buying public, and if they are led to believe that prices will be reduced if the duties come off, naturally they prefer to wait and see what happens. The result is that our manufacturing programmes are held up and unemployment in our industry is being increased. All this could be checked if the powers that be would make a definite statement without delay.

Similarly, "no one in the motor industry can go ahead and lay plans in advance for large and economical production if there is complete uncertainty as to whether the McKenna duties will be maintained" (*Daily Mail*, 13 November 1929, p. 12). The McKenna duties not only affected the car industry but others too: "motorcar manufacturers and piano manufacturers […] could not believe that any British administration would be so enslaved by financial

pedantry as to keep our industries in disastrous uncertainty, which is absolutely destructive of business" (*Daily Mail*, 16 April 1924, p. 8).

Tariff anxieties also hung over the textile industry. To a chorus of "hear, hear", the chairman of the Fine Cotton Spinners' and Doublers' Association recounted at the annual general meeting in 1930 that "uncertainty which existed throughout the year as to whether the government intended to repeal the Safeguarding and McKenna duties […] undoubtedly gravely affected [the] particular trade as well as the general trade of the country" (*The Guardian*, 28 May 1930, p. 14). In dress goods, it was expected that business "held up because of uncertainty as to a tariff will now go to the French instead of being placed here" (*Daily Mail*, 14 December 1923, p. 5). There was also uncertainty over duties on artificial silk, if the "duties are to be imposed, we would prefer to have them at once rather than have any unnecessary prolongation of the present uncertainty. It is not only stopping the weaving of the artificial silk but also of the cotton which would have gone to build up the fabric in which the artificial silk is used" (*The Guardian*, 20 June 1925, p. 13). This uncertainty continued in the rayon industry for at least a decade, "retarding every branch of the trade from the producer to the shopkeeper" (*The Guardian*, 10 December 1935, p. 7).

Murmurings of amendments to the Great Charter of Electricity also sparked damaging uncertainty. At the ordinary general meeting of the British Electric Traction Company it was "hoped that the Government will announce at an early date its abandonment of this policy, for it is undoubtedly true that further uncertainty has a serious deterrent effect on enterprise in this important key industry" (*Financial Times*, 3 July 1920, p. 2).

In summary, the qualitative evidence is also supportive of the uncertainty hypothesis. According to contemporaries, policy uncertainty hit a number of industries from cars to textiles. The impact of policy uncertainty on consumption and investment was also recognized, dragging down employment and output.

ROBUSTNESS

Alternative Specifications

A number of calls had to be made to estimate the model. The first was the type of model itself. Baker et al. (2016) and Alexopoulos and Cohen (2015) model uncertainty's impact on the economy using a VAR. I therefore estimate a simple bivariate VAR including the natural logarithm of real GDP and the new index of policy uncertainty. The VAR also

includes a linear trend and seasonal dummies as exogenous variables. The model includes a single lag and is identified using a Cholesky decomposition, which assumes that output affects policy uncertainty contemporaneously but that policy uncertainty does not affect output within the period. Figure 5 plots the impulse response function from the VAR and the associated confidence intervals following a major uncertainty shock. As is common, the impulse responses from the VAR are smoother than those generated using local projections. The peak drop is 1.1 percent ($t = -3.1$) and all responses between months 1 and 16 are statistically significant at the 5 percent level.

The second call was the number of lags to include. I therefore re-run equation 1, but adding additional lags. Figure 6 plots the impulse response function where $N = 3$, as in Baker et al. (2016), and $N = 6$, as in Alexopoulos and Cohen (2015), alongside the baseline and the associated confidence intervals. Including 3 lags leads to virtually identical results - the peak drop was 2.7 percent ($t = -2.6$) after a year. Including 6 lags results in slightly smaller responses, peaking at -1.6 percent ($t = -2.4$).

In summary, reasonable variations of the original specification do not materially alter the results.

Controlling for Other Variables

The baseline model included lags of output and policy uncertainty as controls. However, if there were other determinants of output growth that were also correlated with economic policy uncertainty, then the impulse responses will be biased. As the number of variables that can be controlled for at the same time is constrained in short samples, I rotate in one control at a time into the model:

$$y_{t+h} - y_{t-1} = \alpha^h + \sum_{j=1}^{11} \gamma_j^h D_{jt} + \delta^h t_t + \beta^h EPU_t + \sum_{k=1}^{N} \varphi_k^h EPU_{t-k} + \sum_{k=0}^{N} \theta_k^h y_{t-k} + \sum_{k=1}^{N} \psi_k^h z_{t-k} + e_{t+h} \quad (5)$$

where z is a control variable of interest. Table 2 presents the peak effects from these models.

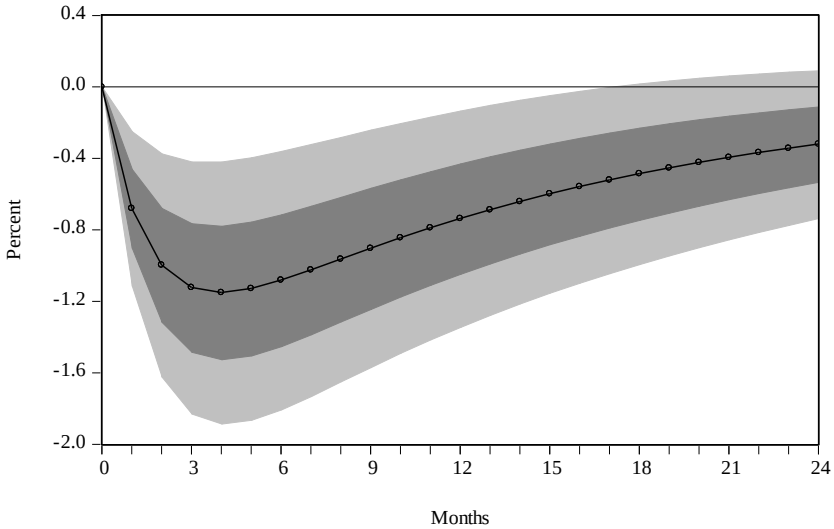


FIGURE 5

SENSITIVITY TO AN ALTERNATIVE MODEL

Source: Author's calculations.

The first set of control variables relate to fiscal policy. To make sure that all bases are covered, the natural logarithm of real government debt, expenditure and revenue are each included as controls. The second set of controls relates to monetary policy, such as Bank Rate and the monetary base. I also include the yield on consols, which arguably reflects both fiscal and monetary policy. The third set of controls relates to the general macroeconomy, such as the natural logarithms of real exports, real wages, retail price index and share prices and the level of the $/£ exchange rate. The inclusion of these variables has little impact on the size or precision of the estimated responses.

In order to gauge the sensitivity of the baseline results to alternative specifications, 14 additional models have been estimated, which address issues relating to the specification and omitted variables. The smallest peak effect was -1.1 percent ($t = -3.1$), while the largest was -2.9 percent ($t = -2.8$). The median peak was -2.7 percent, which is only a fraction less than the baseline estimate. In each and every case, the peak impact was statistically significant at the 5 percent level. The depressive impact of uncertainty on the British interwar economy is therefore a robust result.

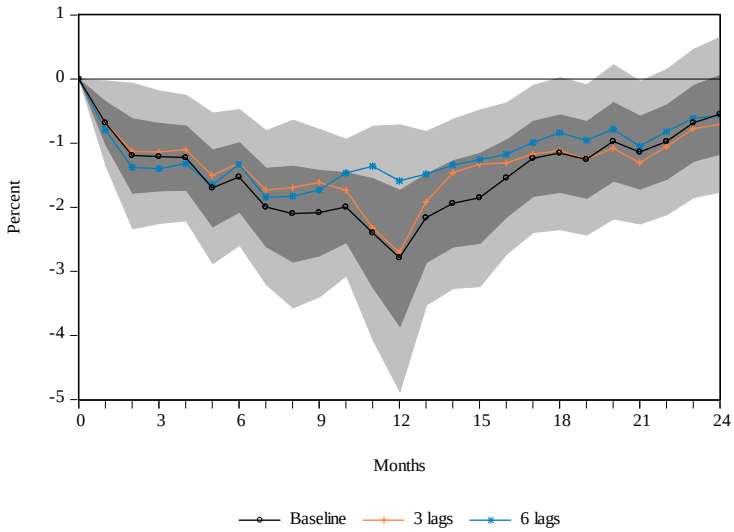


FIGURE 6

SENSITIVITY TO ALTERNATIVE LAG LENGTHS

Source: Author's calculations.

CONCLUSION

A new index shows that there were significant fluctuations in economic policy uncertainty during the interwar period, due to familiar anxieties over hung parliaments, tariffs and the rewinding of unconventional fiscal and monetary policies, among others. It was also a time of major macroeconomic problems. However, previous studies of interwar Britain have not linked these issues together. This paper argued that the two may well have been related.

Time series evidence revealed a number of findings of interest to economic historians. First, the impact of a major uncertainty shock, such as the break from the interwar gold standard, caused a 2.8 percent drop in output and a 2.0 percentage point spike in unemployment. Second, the great variability of output was a standout feature of the interwar period. Uncertainty accounted for a fifth of this volatility. These findings are robust to a wide range of robustness exercises.

The results of this paper might also be of interest to economists. The sign and size of the elasticities of output and unemployment to uncertainty shocks are in line with both Baker

et al. (2016) and Alexopoulos and Cohen (2015). Moreover, the results of the variance decomposition indicate that uncertainty shocks are an important, although not complete, explanation for economic fluctuations, which is also consistent with previous research.

TABLE 2

PEAK EFFECTS IN MODELS WITH ADDITIONAL VARIABLES

Control variable	Peak effect (Percent)
Real government debt	−2.7 (−2.7)
Real government expenditure	−2.7 (−2.7)
Real government revenue	−2.8 (−2.8)
Bank Rate	−2.7 (−2.6)
M0	−2.9 (−2.8)
Yield on consols	−2.8 (−2.8)
Real exports	−2.5 (−2.5)
Real wages	−2.6 (−2.6)
Retail price index	−2.7 (−2.7)
Share price index	−2.4 (−2.2)
$/£ exchange rate	−2.2 (−2.3)

Note: t-statistics in parentheses.

As correlation is not necessarily causation, I developed a three-step identification method. The first step isolates major shocks, the second disentangles whether these shocks were exogenous or endogenous and the third uses the exogenous major shocks in a single equation regression. This approach could be extended beyond uncertainty to measure the causal impact of other shocks such as those to government spending, credit and oil.

A century on from the great anxiety of the interwar period, uncertainty is back, ballooning by almost three-quarters in the 18 months since the EU referendum compared to the previous year and a half (Baker et al. 2016). History is never a perfect guide to future events, but unless the relationship between economic policy uncertainty and the macroeconomy has weakened significantly over time, the economic consequences of events such as Brexit are likely to be bleak.

NARRATIVE APPENDIX

This Appendix documents the causes of major spikes in policy uncertainty during the interwar period using the narrative record. The major uncertainty shocks, identified as those episodes that are 1.65 standard deviations above the mean of the de-trended (ln) EPU index, are highlighted with vertical lines in Appendix Figure 1.

June 1920 (Exogenous, X)

The EPU index increased by 37 percent in June 1920. There were both domestic and international reasons for this spike in uncertainty. On the home front, there was great anxiety over the war wealth levy. According to *The Economist* (5 June 1920, pp. 1241-2), the public did not know whether this levy had been abandoned or not:

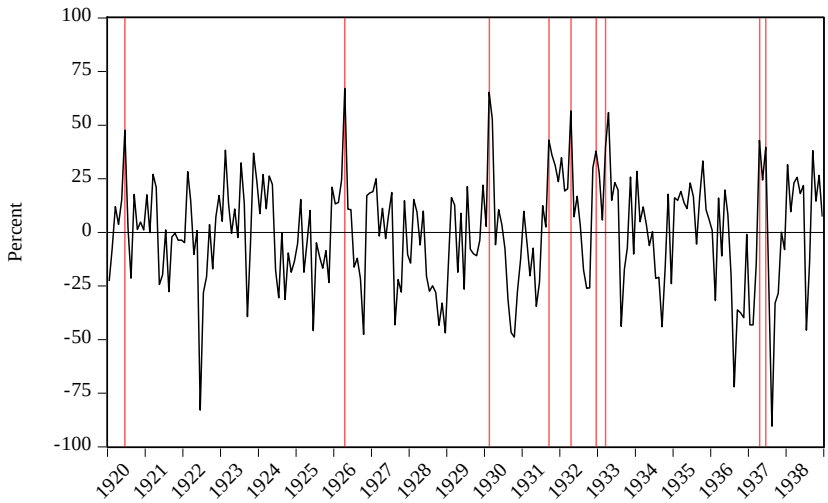
> At home uncertainty concerning the government's action with regard to the war wealth tax is still the chief preoccupation of the business world. It was definitely stated by a Sunday paper last Sunday that the tax had been abandoned. This apparently was not correct, although it seems to have been true that opinion in the Cabinet has been growing against it with considerable force, and it seems likely that the statement of the Sunday Express may turn out to be wrong only in being made a week or so too early.

In addition, there were anxieties related to Irish independence, such as several debates in the House of Commons and riots in Londonderry (*The Economist*, various dates).

There was also a great deal of international political turmoil, such as the German federal elections and the resignation of the Italian cabinet (*The Economist*, various dates). In America, uncertainty was unusually high over the Republican and Democratic presidential nominations (*The Times*, 4 June 1920, p. 16):

> With the opening of the first great national political Conventions less than a week distant, most experienced observers, including even those responsible for the workings of party organization machinery, hesitate to predict who will be the ultimate choice either of Republicans or Democrats. Never before in the history of the country has Convention time loomed so near without at least some candidate in one party in a more or less commanding position, and never before has the outcome in both major parties been fraught with such uncertainty at so late a date.

Given that uncertainty peaked because of a communication mishap and international events, I classify this episode as exogenous (X).



APPENDIX FIGURE 1

DE-TRENDED ECONOMIC POLICY UNCERTAINTY INDEX FOR THE UNITED KINGDOM

Source: Author's calculations.

April 1926 (Endogenous, N)

The EPU index increased by 53 percent in April 1926. One cause was the looming general strike. Although the strike did not come into force until May, news of growing tension was reported in April. *The Times* (10 April 1926, p. 17; 30 April 1926, p. 25), for instance, wrote of "the uncertainty of the coal trade trouble" and of the "baffling uncertainties regarding the coal crisis". Another cause was Winston Churchill's second budget as Chancellor. This was expected to be less "spectacular" than his first (*The Economist*, 1 May 1926, p. 867), but uncertainty remained over whether taxes would be cut.

As there had long been a budget in April or early May, and that these events naturally stoked uncertainty, there is a case for classifying this episode as exogenous. However, the

general strike was very much an endogenous response to current macroeconomic conditions. The strikes were a result of coal mine owners reducing wages and increasing hours in the face of the deflation associated with the return to the gold standard (Eichengreen and Temin 2000). On balance, I classify this episode as endogenous (N).

February 1930 (Exogenous, X)

The EPU index increased by 89 percent in February 1930. As the budget loomed on 14 April, there was significant uncertainty over whether the Chancellor, Philip Snowden, would alter the McKenna Duties or the Safeguarding of Industries Act. *The Financial Times* (4 February 1930, p. 6; 7 February 1930, p. 7) noted several times that the stock market was affected by "Budget uncertainties." Sir Walter Raine, President of the Association of British Chambers of Commerce went to HM Treasury to plead to the Chancellor (*The Times*, 28 February 1930, p. 16):

> Can you see your way to make an immediate statement with regard to the McKenna Duties and the Safeguarding Duties? […] There is a precedent for what I am suggesting on behalf of industry in the fact that one of your predecessors, Sir Austen Chamberlain, made a declaration in advance of his Budget, in regard to excess profits duties. The situation is much more serious than it was then, and if you can see your way to do something now to cause this uncertainty to be dissipated, you will help trade: whereas if we have to wait until April 14, I am afraid that the damage, so far as this year's trade is concerned, will be very serious.

As there was always a budget in the spring, and that the budget involved the unveiling of changes to fiscal policy that were secret up until that point, policy uncertainty naturally increased at this time. As this uncertainty was seasonal, I classify this episode as exogenous (X).

September 1931 (Endogenous, N)

The EPU index increased by 51 percent in September 1931. The month was blighted by a series of major events. First, there was the *second* budget of 1931 as well as the increasing likelihood of an early general election. *The Mail* (9 September 1931, p. 2) wrote

that, "there is, as is only natural, uncertainty pending to-morrow's Budget announcement. […] But if the folly of a general election next month is persisted in, then we shall have a further period of paralysing uncertainty." *The Economist* (19 September 1931, p. 525) noted that there was "growing talk of an early General Election in this country", while the *Financial Times* (21 September 1931, p. 5) observed that there was "uncertainty regarding the date of the General Election."

Another major event was Britain's departure from the gold standard. *The Economist* (26 September 1931, p. 547) wrote that "it is safe to predict that Monday, September 21, 1931, will become a historic date; the suspension of the gold standard in Great Britain on that day, after the six years of painful effort which followed this country's return to gold in 1925, marks the definite end of an epoch in the world's financial and economic development." However, according to contemporaries, the uncertainty did not stem from the period leading up to the break from gold but the period after. *The Times* (28 September 1931, p. 20) noted that "there remained, however, immense uncertainties arising out of Britain's action in suspending gold redemption", while according to *The Economist* (26 September 1931, p. 572), "the week's events, in short, showed that professional and private investors were uncertain of the extent of possible development under the new currency regime."

While budgets and elections and the associated uncertainty occur at regular intervals, the budget and election of 1931, along with the break from gold, arose out of the extraordinary macroeconomic conditions of the time. As a result, I classify this episode as endogenous (N).

April 1932 (Exogenous, X)

The EPU index increased by 45 percent in April 1932. Policy inertia on multiple fronts came to a head at this time. The lead article in *The Economist* was titled "Wanted - A Policy" (30 April 1932, p. 951). According to the article, the "world was in doubt as to our monetary policy", while there was also uncertainty over the "vital question of war debts and reparations", which had "been put off again and again."

The main source of uncertainty though was Neville Chamberlain's first budget, which was to be announced on 19 April. According to the *Daily Mail* (18 April 1932, p. 10), "the country is anxiously waiting for a full declaration of future tariff policy […] Industry cannot plan ahead if it is left in ignorance and uncertainty." The *Financial Times* (20 April 1932, p. 1) again referred to "budget uncertainties". *The Times* (18 April 1932, p. 13) observed that

"this uncertainty applies, it is true, more especially to the Revenue Estimates; for until the outcome of the Lausanne meeting and of the Ottawa Conference is known it will hardly be possible to do much more than guess the yield of many sources of income. Meanwhile on the expenditure side too there must remain an element of uncertainty so long as the world problem of government indebtedness remains unsolved."

As uncertainty was associated with the timing of the budget, which was usually set exogenously, and that the question marks over the budget related to international factors, I classify this episode as exogenous (X).

December 1932 (Exogenous, X)

The EPU index increased by 8 percent in December 1932. "A period of uneasy suspense" hung over the month as a result of the war debts due to the United States (*The Economist*, 3 December 1932, p. 1015). The British, French and other European governments had asked the United States to reconsider the payments. According to *The Economist* (17 December 1932, p. 1136), "uncertainty as to the debt outcome has acted as a drag on all markets, and has probably to some extent injured trade in general". After a month of negotiations, Britain agreed to conditionally pay.

As this uncertainty arose from the inevitable maturity of existing debts, it is unlikely to be caused by domestic economic conditions. Given that this event was anticipated far in advance, it is surprising that it is associated with uncertainty. However, the uncertainty arises from the fact that the United States was between Republican and Democratic governments as Franklin D. Roosevelt had been elected the month before, while Herbert Hoover was still in office, and there were potential divisions on the subject of debt forgiveness. As a result, I classify this episode as exogenous (X).

March 1933 (Exogenous, X)

The EPU index increased by 41 percent in March 1933.[8] This spike in uncertainty was also related to the spring budget. Neville Chamberlain delivered a "half-and-half" budget on 25 April 1933 (*The Economist*, 29 April 1933, p. 891). Against a backdrop of "naughty advocates of deliberate unbalancing" of the budget and bold policy overseas which lifted

[8] Mathy (2016) finds a major jump in U.S. uncertainty in March 1933, relating to the exit from the gold standard.

expectations, the Chancellor was "inhibited by innate conservative caution." Thus, "those who would prefer to see evidence of determination to create revenue-yielding income must once again suffer disappointment."

Another recurring source of uncertainty was the war debts, which were once again soon due. The *Financial Times* (23 March 1933, p. 7) summarized:

> Conflicting stories are in circulation here regarding the war debt instalment due on 15th June and the future of the Liberty bonds. According to the cabled reports from London and elsewhere, widely published here in the past few days, it is evident that the foreign correspondents are as much in the dark as those here at home, and are largely guessing at the position. They have based their stories on a few known facts, plus a little "information" gleaned in talks with officials at Washington – other than Mr. Roosevelt – who are also merely guessing. It is no secret that preliminary talks have been held between Government officials here and in London regarding war debts and the next payment due in June.

As uncertainty coincided once again with the historic convention of a spring budget and the maturity of debt issued more than a decade before, I classify this episode as exogenous (X).

April 1937 (Exogenous, X)

The EPU index increased by 77 percent in April 1937. This rise in policy uncertainty was again related to the Chancellor's annual budget, which was delivered on 20 April. The *Financial Times* (20 April 1937, p. 1) again pointed out the "budget uncertainty". The *Daily Mail* (21 April 1937, p. 2) observed that "news of the additional defence contribution, which came as a surprise, caused uncertainty", while the *Financial Times* (24 April 1937, p. 10) wrote that there was uncertainty "resulting from the profits tax proposals."

There was also uncertainty over American policy. Roosevelt too delivered a budget message in April 1937 (*The Economist*, 26 April 1937, p. 1). However, according to *The Times* (19 April 1937, p. 21), there was also "uncertainty over the Government's gold policy". Hartley Withers wrote in the *Illustrated London News* (17 April 1937, p. 680) that there was a "rumour to the effect that the American Government proposed to reduce its price for gold. It was, in the first place, a timely reminder that a new and particularly incalculable

uncertainty has been introduced in the field of business fluctuations since the arrangements of the money market were taken over by Governments." *The Mail* (24 April 1937, p. 2) described this as the "short-lived but damaging gold scare."

As the spike in uncertainty was associated with a budget, the date of which was determined irrespective of current macroeconomic conditions, as well as international events, I classify this episode as exogenous (X).

June 1937 (Exogenous, X)

The EPU index increased by 16 percent in June 1937. There were two major sources of uncertainty at this time. The first was "European political uncertainties" (*The Times*, 24 June 1937, p. 26). The case for intervention in the Spanish civil war was debated in the House of Commons on 15 June (*The Times*, 26 June 1937, p. 8). According to one Member of Parliament:

> In Italy today there was considerable anxiety with regard to the policy of this country. It was said they were not afraid of an attack from this country while the present Government was in power, but if, on the completion of the rearmament programme, a Social Government were in office there might be war. That was the sort of feeling in the world that was causing great disturbance.

The second was the so-called "gold scare" (Jaremski and Mathy forthcoming). *The Economist* (26 June 1937, p. 18) wrote of "uncertainties regarding the future of gold", while the *Mail* (12 June 1937, p. 2) also wrote about "gold uncertainty".

Given the seemingly international nature of this uncertainty, I classify this episode as exogenous (X).

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Paper V

The Macroeconomic Effects of Banking Crises: Evidence from the United Kingdom, 1750-1938[*]

By SEÁN KENNY, JASON LENNARD AND JOHN D. TURNER

This paper investigates the macroeconomic effects of banking crises in the United Kingdom between 1750 and 1938. We construct a new annual time series measuring the fraction of the banking system hit by suspensions and failures. Using the narrative record to identify crises caused by plausibly exogenous factors, we find that the macroeconomic effects of banking crises are highly non-linear. A 1 percentage point increase in the proportion of banks suffering suspensions and failures raises economic activity by up to 2.9 per cent when the failure ratio is low, but reduces output by a maximum of 3.8 per cent when the failure ratio is high. (JEL: E32, E44, G21, N13, N14, N23, N24)

The distant memory of banking crises and the Great Moderation meant that from the 1980s the economics profession became less concerned about banking crises and economic downturns. This temporary amnesia dissipated when the 2008 Global Financial Crisis reignited the interest of the profession in the banking crises of the past and their economic consequences. This paper attempts to further this renewed interest by assessing the macroeconomic effects of banking crises in the UK over the period 1750 to 1938.

However, there are at least three difficulties researchers face if they want to investigate the effects of past banking crises on the economy. First, banking crises are very difficult events to define, identify and measure. As a result, there is little correspondence between existing indices of banking crises for the UK. As an illustrative example, over the period 1870 to 1914, Schularick and Taylor (2012) identify a banking crisis in 1873 and 1890, Reinhart and Rogoff (2009a) and Grossman (2010) classify crises in 1878, 1890 and 1914 and Turner (2014) identifies a nonmajor crisis in 1878. According to Bordo and Meissner (2016), this "classification uncertainty" results in a potentially wide range of estimates of output losses. Thus, this classification uncertainty not only influences our understanding of

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the incidence of banking crises, but it introduces measurement error into estimates of the effect of banking crises on the macroeconomy. A major motivation of this paper, therefore, is to chronicle carefully the incidence of British banking crises using a new quantitative approach which uses bank failure data. Using annual failure data has the major advantage that we can generate a continuous measure of banking (in)stability, which produces much more variation than a binary definition.

The second difficulty faced by researchers is how to model the effect of banking crises. Is output a linear or nonlinear function of banking crises? The vast majority of previous research has implicitly taken a stand on this issue. Studies that use a continuous variable, such as Campbell et al. (2016) and Romer and Romer (2017, 2018), assume that the macroeconomic effects are linear. Whereas studies that use a discrete variable, such as Reinhart and Rogoff (2009b) and Jalil (2015), implicitly assume that the macroeconomic effects of banking crises are nonlinear. In this paper, while we use a continuous variable, we model the relationship between this variable and output as non-linear so as not to generate biased impulse response functions. The intuition behind our approach is that bank failures up to a certain point may actually have a positive effect upon output because inefficient and potentially system-destabilizing banks are removed. In other words, some destruction of banks may be creative and therefore beneficial for economic growth. However, beyond a certain point, bank failures may reach a level that there are spillover effects for healthy banks that induce a credit crunch and a contraction in the money supply.

The final difficulty which researchers must overcome is to disentangle the causal effect to determine whether banking crises affect the macroeconomy or vice versa. We utilize a narrative methodology to distinguish between righthand tail events which contemporaries attributed to economic shocks and those which were identified as being caused by other factors. This narrative approach has been used by Jalil (2015) in the case of US banking panics and by Cloyne (2013), Ramey (2011), Ramey and Zubairy (2018), and Romer and Romer (2004, 2010) in studies of fiscal and monetary policy.

Although a study of the macroeconomic effects of banking crises in the United Kingdom between the Industrial Revolution and Second World War is important in its own right, there is an additional motivation for focusing on this setting. Whereas today distressed banks are often bailed out by authorities, this was not the case historically. This is important as bailouts would tend to bias the estimates of the economic effects of failures for two reasons. First, there would be a selection bias as the sample would only contain banks that were left to fail, which may have been deemed by authorities to be economically

insignificant. Second, bailouts could be correlated with both failures and output if, for example, the authorities implement credit rationing in bailed out banks. The estimated effects of banking crises would be upwardly biased in the first example, but downwardly biased in the second. In focusing on the era before "too big to fail", history offers an ideal laboratory to estimate unbiasedly the macroeconomic effects of banking crises.

The first thing we do is construct, for each year from 1750 to 1938, the population of banks in the UK and ascertain which banks exited the population because of liquidation, suspension, or failure. We then use the paid-up capital of each bank in the population and those exiting the population to calculate a capital-weighted bank failure series. We then take this new series for the UK and use a local projections model to understand the relationship between our series and output.

In our baseline model, we find that a nonlinear specification best fits our data. We also find that at low levels of bank failures, additional bank failures boost output and that at high levels of failures, additional bank failures have a negative effect on output. The break-even failure rate is 1.7 per cent, with failures above this level having a detrimental effect on output, while failures below this level have a positive impact on output. We also find in our baseline results that output losses are more persistent over time as the bank failure rate rises.

The next step we take in the paper is to use a narrative approach to identify exogenous and endogenous banking crises. We use primary sources to help us understand the perceptions of contemporaries as regards the nature of righthand tail events (95^{th} percentile and above) in our bank failure series. Our evidence suggests that the crises of 1772, 1825-6, 1857 and 1866 were exogenous, whilst those of 1815-16, 1821, 1841 and 1930 were endogenous. Using this identification strategy, we find that the effects of crises on output are generally stronger than our baseline findings, with greater creative destruction at low levels of bank failures and bigger output losses at high levels of bank failures.

The final step we take in the paper is to subject our findings to a series of robustness checks. To begin with, we ensure that our results are not being driven by how we define and construct our new indicator of banking crises. First, we exclude London-based banks which operated in the UK's colonies. This robustness check makes little qualitative difference to our findings. Second, in order to check that the breadth as well the reach of banking failures produced qualitatively similar results, we used an unweighted failure-rate indicator. Because the weighted and unweighted indictors are so closely correlated, it is unsurprising that using an unweighted indicator has a negligible effect on our baseline results. We also ensure that our results are robust to different lag lengths, an alternative timing assumption and the

inclusion of control variables. We find that regardless of the specification we use, the macroeconomic effects of bank failures appear to be nonlinear, where a cluster of bank failures at low levels is associated with large, sustained gains in output, while the failure of the same cluster at high levels is followed by large and persistent losses.

This paper augments the literature on the effects of banking crises on the real economy (Bernanke, 1983; da Rocha and Solomou, 2015; Dell'Ariccia et al., 2008; Demirgüç-Kunt et al., 2006; Friedman and Schwartz, 1963; Grossman, 1993; Hoggarth et al., 2002; Jalil, 2015; Laeven, 2011; Laeven and Valencia, 2010). Our contribution is twofold. First, we go back much further than any previous study to examine the effect of banking crises on the real economy. Second, we use a continuous measure of banking crises and model the nonlinear effects of banking crises upon the real economy.

Our paper is structured as follows. Section I develops and discusses our new UK banking crisis series. Section II takes this new series and examines the effect of UK banking crises on the real economy. Section III subjects our baseline results to a series of robustness checks. Section IV contains a brief conclusion.

I. The New UK Banking Crisis Series

A. *Issues of Definition*

Defining banking crises is challenging. The standard way in the literature of assessing whether a banking crisis has occurred is to use a qualitative approach and read the secondary literature relating to the historical development of the banking system concerned. Scholars have a definition in mind when they read the secondary literature looking for crises. For example, Reinhart and Rogoff (2009a, p.10) define a banking crisis as being made manifest by one of two events: (1) bank runs that lead to closure, merging or government takeover of one or more financial institutions or (2) the closure, merging, takeover, or government assistance of an important financial institution or group of institutions.

This approach is problematic for a number of reasons. First, this definition implies that a bank failure in and of itself constitutes a banking crisis. However, as will soon become clear, multiple bank failures were part and parcel of a normal year in British banking history. In addition, failures may make the banking system more stable by removing imprudent banks (Calomiris and Kahn, 1991). Indeed, such may have been the case in the UK in the nineteenth system (Baker and Collins, 1999). Second, including institutions which are not commercial

banks (e.g., investment banks) in the definition of banking crises is unhelpful in an historical context, because they were not involved in either the money supply (via deposits) or credit intermediation (Turner, 2014). Third, while it is possible to quantify the importance of a financial institution, previous chronologies have tended to approach this question in a subjective, ad hoc fashion. These issues of definition help to explain the classification uncertainty inherent in previous chronologies.

An alternative approach is Jalil (2015), who defines a banking crisis as a cluster of 3 bank runs and suspensions. While this is a clearer, data-driven approach, there are also several issues. First, it assumes that there is a discontinuity at 3 bank failures. Second, it does not account for the importance or size of the banks in question. This may have been less of an issue in American history, where branch banking was prohibited, but there was large variation in the size of British banks. Third, it does not account for the size of the banking system. In the United Kingdom, for example, the population of banks fluctuated between less than 100 to nearly 1,000 between the Industrial Revolution and the Second World War.

According to both of these approaches, a defining characteristic of a banking crisis is a reduction in the capacity of the banking system, either due to suspensions or failures (Diamond and Dybvig, 1983). However, a disadvantage of both of these approaches is that it reduces rich and varied histories into a binary variable. This discards information on the severity and the persistence of crises. As a result, recent approaches have attempted to construct continuous measures. One example of a continuous approach is Romer and Romer (2017, 2018), who develop a new measure of financial distress for 24 countries between 1967 and 2012 along a scale from 0 to 15 based on their reading of the *OECD Economic Outlook*. While this deals with many of the issues of earlier approaches, it is unavoidably subjective and requires the consistent reporting of financial conditions across time and space.

Another continuous approach is that of Turner (2014), who uses bank share prices as an indicator of UK banking stability. Although this overcomes the drawbacks with the qualitative and discrete approaches to defining banking crises, it is only of use after 1826, when there are banks listed on stock exchanges. In addition, this indicator ignores non-listed partnership banks, who were in the majority until the 1850s and who were still playing a role until the early twentieth century.

In this paper, we construct a new measure of banking distress based on the proportion of the commercial banking system that suspends or fails each year, where each bank in the population is weighted by its paid-up capital. This is in the spirit of more qualitative approaches that stress the importance of suspensions and failures as defining characteristics

of crises, but has the advantage of continuous measures since information on the severity of crises can be exploited. A continuous measure also enables us to capture the effect of bank failures on the economy even when there is not necessarily a banking crisis (Ramirez and Shively, 2012). Bank failures have been shown to magnify economic distress through a variety of channels – direct wealth effects (Friedman and Schwartz, 1963), the costly liquidation of economically viable projects (Diamond and Dybvig, 1983), rendering deposits illiquid (Anari et al., 2005), destroying customer relationships and related information advantages (Bernanke, 1983; Mishkin, 1991), and a credit crunch (Bernanke, 1983).

B. *Construction of Series*

The two primary data objectives were (1) to determine the total population of banks that existed in the UK each year over the period 1750 to 1938 and (2) to identify those exits from the population which were the direct result of failure or suspension.

A number of sources were drawn upon to construct the new series. Following the work of Bond (2016), whose study focused on the British banking population between 1790 and 1982, the *Bankers' Almanac* was the principal reference which formed the basis of our series. The *Almanac*, first published in 1845, was an annual volume, which, among other things, listed all joint-stock and private banks registered in the UK.

This data was later collated in *Almanac* registers, which included them amongst all registered international banks, ordering them alphabetically. It was therefore first necessary to separate all individual UK banks from the global list provided in the *Almanac* (2009). This source was examined for all banks that were listed as having resided in the "UK," "Ireland" and "Northern Ireland" over the entire period.[1] Every bank which existed in Ireland during the period 1800-1921 is included in the population, while the Northern Irish banks remain in the sample from 1922.

The *Almanac* (2009) provides the name of each bank, its date of establishment and closure, as well as the type of closure. In theory, such a source alone should prove sufficient to construct the required population and failure series, provided a reliable closing stock existed which would represent those banks that did not experience an event (and therefore

[1] Although listings were also reported for both the Channel Islands and the Isle of Man, they are excluded on the grounds that they are crown dependencies and have never formed part of the United Kingdom.

would never appear in the source). However, it became apparent that the source needed to be complemented with additional information to construct a complete series.[2]

One shortcoming of the *Almanac* was that a number of listings contained no entries for start or end dates. We overcome these omissions by using Barrow (1975), Checkland (1975), Dawes and Ward-Perkins (2001), Gilbart (1860), Hall (1949), O'Kelly (1959) and Price (1890). Not only were these supplementary sources used to correct for omissions, they were also employed to crosscheck all existing entries in the *Almanac*.

This crosschecking process was crucial in eliminating significant duplication in the *Almanac*. The issue involved the erroneous recording as separate banks of the same bank with multiple variations on the name and partnership changes where new names appeared on the same banking business. However, perhaps the most common form of duplication were where banks that had changed the name of partnership on more than one occasion maintained the original date of the first partnership as their date of establishment. In such an instance, every new name change would erroneously represent a newly-added bank with a date of establishment recorded at the earliest point in time of the original partnership's existence.

After the data was treated in the manner described, the next step was to identify failures from the new population. The *Almanac* provides an array of events, such as "failed", "suspended payment", "bankrupt", "name changed", "acquired" and "merged". In order to separate failures from other types of event, we classify a failure as an event that reduces banking capacity. While other events, such as mergers, reduce the number of banks, the capacity of the banking system is unchanged. Where evidence exists in the supplementary sources that a difficulty had preceded a takeover or merger, a failure is deemed to have occurred.

The new series which results from all the above procedures are based upon the collection of the lifespans of almost 2,500 banks which existed in the UK between 1750 and 1938.[3]

Because we want our measure of banking stability to capture the depth of banking crises and to reflect the relative size of banks that fail, we weight our failure rate using each bank's paid-up capital. This involved the collection of data from primary and secondary sources. These sources are discussed in Appendix 1. For partnership banks, an average was calculated for the eighteenth, nineteenth and twentieth centuries based on a sample of balance

[2] In our treatment of the data, we closely mirror the methods employed by Bond (2016).
[3] The closing stock of our bank population in 1938 is taken from the *Bankers' Almanac* volume of 1939.

sheets. These averages were centered, so that the observation for the eighteenth century was centered on 1750, the observation for the nineteenth century was centered on 1850, and so on, with the gaps being linearly interpolated. For joint-stock banks, the paid-up capital was obtained from the editions of the *Bankers' Almanac* every fifth year and linearly interpolated between. Because banks changed their paid-up capital infrequently, there was ultimately little need for interpolation. In cases where the earliest observation for paid-up capital was prior to the publication of the first *Bankers' Almanac* in 1845, we collect capital at the date of establishment from sources listed in Appendix 1. If this was not possible, the earliest recorded growth rate of paid-up capital for that bank is cast backwards. In the rare event that banks had no recorded capital, they take on the average of the other joint stock banks for that year.

C. *The New Series*

The new chronology of banking crises is shown in Figure 1. How does this new series compare to previous chronologies such as those of Reinhart and Rogoff (2009), Schularick and Taylor (2012) and Turner (2014)? The answer to this question is important for at least two reasons. First, it helps us see the extent to which our series agrees with the extant chronologies. Second, it may shed some light on crises which have previously been under or over-emphasized in the historiography of UK banking crises. In order to compare with extant chronologies, we will focus our attention on the righthand tail of the distribution (95^{th} percentile) in Figure 1. From Figure 1, we identify eight major tail events – 1772, 1815-16, 1821, 1825-6, 1841, 1857, 1866, and 1930. Three things are worthy of brief comment.

Firstly, four of the major tail events in our series – 1815-16, 1825-26, 1857, 1866 have been defined by the extant series as banking crises. However, 1772, 1821, 1841 and 1930 have not appeared in previous chronologies. Notably, 1772, 1821 and 1930 are between the 95^{th} and 97^{th} percentile in Figure 1.

1772 does not appear in extant series because most of them do not stretch back that far. But 1772 has been viewed as a banking crisis which was centered upon Scotland in the historiography of British banking (Goodspeed, 2016). 1821 does not appear in extant series or the historiography, possibly because it has been overshadowed by the substantial crisis of 1825-26. Although previous studies have not identified 1841 as having a banking crisis, they have highlighted the difficulties experienced by the banking system in 1837-9 (Reinhart and

Rogoff, 2009a; Turner, 2014). Notably, Bordo et al. (2003) in their index of UK financial conditions classify 1841 as a year characterized by severe distress.

1930 is at the 95th percentile in the series. However, previous chronologies do not identify a banking crisis in this year or during the Great Depression. Indeed, the majority opinion among banking historians is that the UK did not have a banking crisis during the Great Depression (Billings and Capie, 2011; Grossman, 1994). However, Bernanke and James (1991), in their study of international crises in the interwar period, classify the UK as having a banking crisis in 1931.

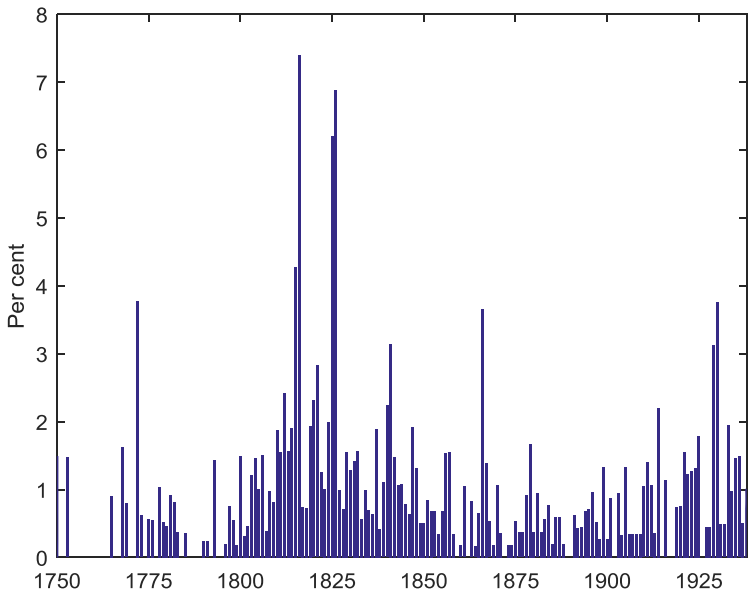

Figure 1. *Annual Weighted Bank Failure Ratio, 1750-1938*

Secondly, there are a number of episodes that have been extensively covered in the extant literature but were not associated with a critical mass of bank failures, e.g., 1810, 1837, 1847, 1873, 1878, 1890, and 1914. On average, only 1.2 per cent of banks failed in these years.

Thirdly, our new series suggests that righthand tail events were much less common than in the United States (Jalil, 2015). In addition, after 1866, only one year (1930) is above the 95th percentile. Why did the frequency of such tail events decrease after 1866? After 1866

and by the time Walter Bagehot had published *Lombard Street* in 1873, it was commonly accepted that the Bank of England would act as a lender of last resort during a crisis. In addition, by this date, the structure of the UK banking system had moved from one dominated by small unit banks to one increasingly dominated by large branched banks (Capie, 2014; Capie and Rodrik-Bali, 1982; Goodhart, 1988; Turner, 2014). It is therefore noteworthy that the incidence of righthand tail events is much greater in the period 1750-1866 than afterwards.

II. The Macroeconomic Effects of Banking Crises

A. *Data and Specification*

In order to investigate how banking crises affect the economy, we estimate a local projections model (Jordà, 2005), which has been used by da Rocha and Solomou (2015) and Romer and Romer (2017, 2018) in recent studies of banking crises. This model is not only robust to misspecification but is also highly flexible. Specifically, we estimate two models for horizons of 0 to 5 years. The first is a local linear projections model:

$$y_{t+h} = \alpha_h + \beta_h F_t + \sum_{k=1}^{2} \delta_{h,k} F_{t-k} + \sum_{k=1}^{2} \theta_{h,k} y_{t-k} + u_{t+h} \quad (1)$$

where y_{t+h} is a macroeconomic variable of interest and F_t is the *weighted* failure ratio. In addition, two years of lags of y and F are included as controls as per Romer and Romer (2017, 2018). In terms of identification, this setup assumes that banking crises affect output contemporaneously, but that output does not affect banking crises within the period (da Rocha and Solomou, 2015; Romer and Romer, 2017, 2018).

The impulse response of y_{t+h} to a unit shock to F_t at horizon h is given by β_h. In terms of inference, the standard errors are heteroskedasticity and autocorrelation consistent (Newey and West, 1987).

The second model we estimate is a local nonlinear projections model:

$$y_{t+h} = \alpha_h + \beta_h F_t + \gamma_h F_t^2 + \sum_{k=1}^{2} \delta_{h,k} F_{t-k} + \sum_{k=1}^{2} \theta_{h,k} y_{t-k} + u_{t+h} \tag{2}$$

where F_t^2 is the weighted failure ratio squared. In the interest of parsimony, nonlinearities are restricted to F_t as in Jordà (2005). The impulse response of y_{t+h} to a unit shock to F_t at horizon h is given by:

$$\begin{aligned} &\{\beta_h(F_t + 1) + \gamma_h(F_t + 1)^2\} - \{\beta_h F_t + \gamma_h F_t^2\} \\ &= \beta_h + \gamma_h(2F_t + 1) \end{aligned} \tag{3}$$

As the impulse response depends on F_t, there is therefore a different response for every value of F_t. In terms of inference, the standard error is given by:

$$\{\Sigma_{11} + 2(2F_t + 1)\Sigma_{12} + (2F_t + 1)^2 \Sigma_{22}\}^{0.5} \tag{4}$$

where Σ_{ij} is the element in the ith row and jth column of the heteroskedasticity and autocorrelation consistent variance-covariance matrix of β_h and γ_h.

The sources and definitions of the data used in the paper are given in Table 1.

B. *Baseline Results*

Table 2 presents the results from estimating equations (1) and (2), where y_{t+h} is the natural logarithm of real GDP at factor cost. The linear model suggests that output is a negative function of bank failures as $\beta_h < 0$ for horizons of less than 4 years. The nonlinear model, however, suggests that output is a positive but decreasing function of bank failures as $\beta_h > 0$ and $\gamma_h < 0$ for all horizons.

In order to distinguish between the two models, some formal criteria are needed. A standard test is that the nonlinear term is nonzero ($\gamma_h \neq 0$). As can be seen, all of the γ_h coefficients are statistically significant, which is clear evidence that the macroeconomic effects of banking crises are nonlinear. In addition, the adjusted R^2 is larger at every horizon

for the nonlinear model by an average of 2.7 percentage points, suggesting that a nonlinear specification fits the data better. We also experimented with a local cubic projections model, but none of the coefficients on the failure ratio cubed were statistically significant.

Table 1. *Data Sources*

Variable	Source	Description
Failure ratio	See text	Per cent. 1750-1938
Real GDP at factor cost	Thomas and Dimsdale (2017)	£ millions. 1750-1938
Agricultural, industrial and services output	Broadberry et al. (2015) and Feinstein (1972)	1750=100. 1750-1913
GDP deflator	Thomas and Dimsdale (2017)	1750=100. 1750-1938
Credit spread	Campbell et al. (2016)	Per cent. Corporate-government bond spread. 1860-1938
Equity prices	Thomas and Dimsdale (2017)	1750=100. 1750-1938
Broad money supply	Capie and Webber (1985) and Palma (2018)	£ millions. 1750-1938
Bank Rate	Thomas and Dimsdale (2017)	Per cent. End year. 1750-1938
Government revenue	Thomas and Dimsdale (2017)	£ millions. Calendar year. 1750-1938
Government spending	Thomas and Dimsdale (2017)	£ millions. Calendar year. 1750-1938
Consol yield	Thomas and Dimsdale (2017)	Per cent. Annual average. 1750-1938

Figure 2 plots the relationship between output and the failure rate at various horizons based on the nonlinear model. The x-axis plots the failure ratio, the y-axis plots the horizon and the z-axis plots GDP. The colors represent the level of statistical significance of each point estimate, where darker colors represent lower p-values. In terms of the interpretation, the shock is a 1 percentage point change in the failure ratio evaluated at different levels of the failure ratio.

Table 2. *The Impact of Banking Crises on Real GDP*

	Equation 1	Equation 2	
h	β_h	β_h	γ_h
0	-0.38	0.58	-0.21**
	(0.33)	(0.56)	(0.08)
1	-0.60**	0.58	-0.26*
	(0.30)	(0.80)	(0.14)
2	-0.26	1.31	-0.34*
	(0.32)	(1.11)	(0.20)
3	-0.34	2.20*	-0.55**
	(0.37)	(1.24)	(0.22)
4	0.20	3.00**	-0.60**
	(0.52)	(1.47)	(0.24)
5	0.84	3.41**	-0.55**
	(0.46)	(1.34)	(0.23)

Notes: Standard errors in parentheses. $*$, $**$ and $***$ indicate statistical significance at 10, 5 and 1 per cent level.

There are three major results. First, a 1 percentage point increase in bank failures at low levels *boosts* output as β_h dominates in equation (3). For example, an increase in the failure ratio from 0 to 1 per cent raises output by 2.9 per cent after 5 years ($t = 2.5$). That low levels of bank failures are growth enhancing could be explained by a number of mechanisms. One is that some minor weeding of weak and potentially risky institutions improves the stability of the banking system (Calomiris and Kahn, 1991; Baker and Collins, 1999), which in turn stimulates long-run growth. Another mechanism is that bank failures, up to a point, foster Schumpeterian creative destruction, where relatively inefficient intermediators of credit are replaced by more efficient ones (Schumpeter, 1942).

The second major result is that a 1 percentage point increase in bank failures at high levels has an increasingly negative impact on output as γ_h weighs more heavily. For example, an increase in the failure ratio from 2 to 3 per cent reduces output by a maximum of 0.7 per cent ($t = -2.4$), while an increase from 3 to 4 per cent lowers output by up to 1.6 per cent ($t = -2.4$). The peak impact, for an increase in the failure ratio from 5 to 6 per cent, is 3.8 per cent ($t = -2.9$).

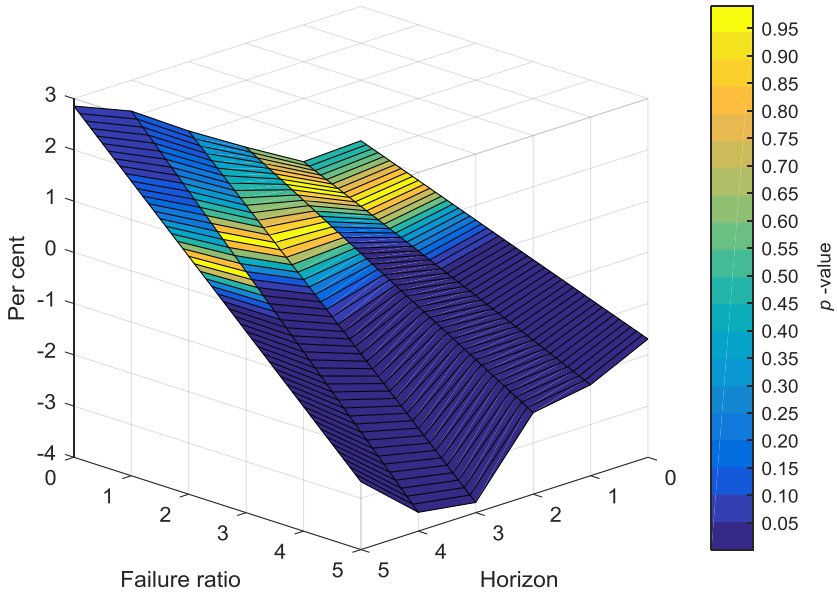

Figure 2. *The Effect of Bank Failures on Real GDP*

Notes: The figure shows the response of real GDP to a 1 per cent impulse in the failure ratio based on equation (2). The sample period is 1750 to 1938.

The third result is that the output losses become more persistent as the failure ratio rises. For example, an increase in the failure ratio from 2 to 3 per cent has no economic impact statistically different from zero beyond a year, while increases from 3 to 4 per cent and from 4 to 5 per cent lead to output losses statistically different from zero after 4 and 5 years, respectively.

As the macroeconomic effects of banking crises are positive for low levels of the failure ratio, but negative for high levels, there must be a failure ratio at which the economic costs are precisely zero. Using equation (3), it is possible to calculate what we call the *break-even failure rate*:

$$BEFR_h = \frac{-\beta_h}{2\gamma_h} - 0.5 \tag{5}$$

Based on the estimates from Table 2, the turning point is approximately 0.9 per cent for $h = 0$, 0.6 per cent for $h = 1$ and so on. The threshold at which the cumulative output loss is zero is given by:

$$BEFR = \frac{-\sum_{h=0}^{5} \beta_h}{2\sum_{h=0}^{5} \gamma_h} - 0.5 \quad (6)$$

Plugging in the estimates from Table 2 suggests that the turning point is roughly 1.7 per cent. In other words, an increase in the failure ratio from 1.7 to 2.7 per cent has no impact on economic activity after 5 years.

The results have interesting policy implications. From the narrow perspective of stabilizing output, the results suggest that if the failure ratio is below the break-even point at the horizon relevant to policymakers, and a bank or group of banks representing 1 per cent of the system is on the verge collapse, then policymakers should let them fail. This would increase economic growth through creative destruction. However, if the failure ratio is above the break-even point, then policymakers should intervene to prevent output losses.

The positive impact of low levels of bank failures was not lost on contemporaries. In terms of a stability channel, in 1878, a year when the failure ratio was below break-even, one newspaper reported that "in many of the cases the failures will be of public advantage, as tending to clear the commercial world of concerns which have lived on wild speculation and foolish ventures" (*Dundee Evening Telegraph*, 4 October 1878).

In terms of a creative destruction channel, in 1843, another year when the failure ratio was below break-even, the *Stamford Mercury* (3 February 1843) described a system of zombie banks in which "favourite old [private] Banks … stopped without any run or pressure and in almost every instance for years previous to their stoppage they existed only in name, although to the very last the public thought them as safe and as strong as any of the old banks which yet remain standing." The commentator elaborated that instead of issuing credit, "every penny is spent in maintaining appearances, lest the public suspicion should be aroused." Thus, these zombie banks that ultimately failed were inefficient with high operating expenses relative to interest income.

Contemporaries were also painfully aware of the impact of bank failures at times of widespread collapse. Following the closure of a bank during the 1815 crisis, for example, the *Hampshire Chronicle* (27 November 1815) noted that "this failure has led principally to a

determination to shorten the number of hands employed there, and lower the wages of others. Upwards of 5000 men have been put out of employ; and a disturbed and riotous populace has become insubordinate in consequence." As the crisis entered its second year, the *Morning Chronicle* (19 July 1816) explained:

> We continue to receive the most distressing accounts of the state of business at Sunderland. The failure of Cooke and Co. has paralysed everything. Nearly the whole of the ship carpenters have been discharged, and several vessels have come round from Sunderland to Newcastle to load coals, which they cannot now procure at Sunderland. Credit is completely destroyed, for since the failure of the bank not a single bill has been paid. Never, perhaps, in any place before were the ruinous effects of a sudden deprivation of capital so strikingly exemplified. How to avert the total ruination of the town will be a consideration of the greatest difficulty.

Contemporaries had a similar view of the 1825-6 crisis. The *Sussex Advertiser* (20 February 1826) wrote that "the mass of misery caused to the working class by the failure of a bank was incalculable." The *Hull Advertiser and Exchange Gazette* (16 December 1825) added:

> On Saturday and Monday a run of some magnitude was made upon the different banks in that place [Leeds]; and such was the panic for a time, that the most foolish occurrences were asserted to have taken place – cash transactions were deemed injudicious – the wages of a great number of work-people were left unpaid – and the business of shopkeepers was proceeded in with tardiness and doubt.

In the crisis of 1841, the *Hampshire Telegraph* (29 November 1841) noted that since the failure of a local bank, "a general gloom has pervaded the City of Chichester, from the ruin it has inflicted on many."

C. *Other Outcome Variables*

Our results show that bank failures have nonlinear effects on economic activity. However, as yet, we know little about how bank failures translate into these wider macroeconomic effects. We therefore investigate the transmission of crises along a number of dimensions. In order to do so, we re-estimate equation (2), where y_{t+h} is an outcome variable of interest.

A large body of literature documents the impact of banking crises on monetary and financial variables such as credit spreads (Krishnamurthy and Muir, 2017), equity prices

(Reinhart and Rogoff, 2009b) and the broad money supply (Friedman and Schwartz, 1963). The response of these variables to bank failures and suspensions is shown in Figure 3.

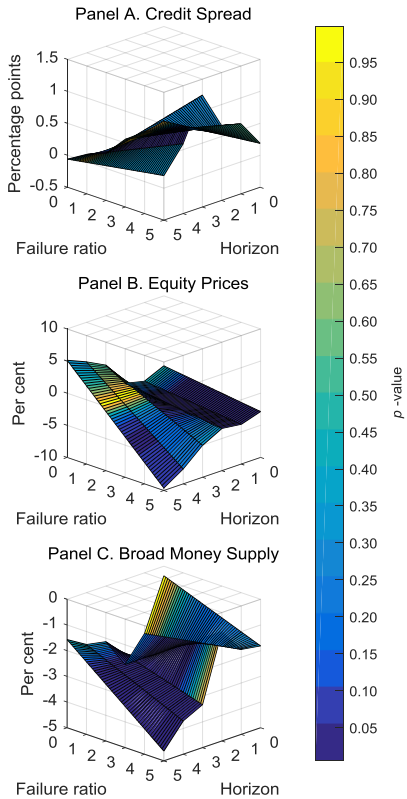

Figure 3. *The Effect of Bank Failures on the Credit Spread, Equity Prices and Broad Money Supply*

Notes: The panels show the response of the respective outcome variable to a 1 per cent impulse in the failure ratio based on equation (2). The sample period is 1860 to 1938 for Panel A. The sample period is 1750 to 1938 for panels B and C.

The top panel shows the results for the credit spread, which is measured as the difference between corporate and government bond yields. In response to a 1 percentage point shock to the failure ratio, credit spreads rise for failure ratios above the break-even rate of 0.5 per cent, peaking at 125 basis points ($t = 2.8$) after 3 years for an increase in the

failure ratio from 5 to 6 per cent. Thus, high levels of bank failures have a large and long-lasting impact on credit spreads, which has been shown to have significant predictive power for economic activity (Gilchrist and Zakrajšek, 2012). Interestingly, an increase in the failure ratio from 0 to 1 per cent is associated with a 17 basis point ($t = -2.1$) decline in the credit spread after 3 years, which could be indicative of a creative destruction channel, as credit is intermediated more efficiently by those banks that survive.

The middle panel shows the response of the natural logarithm of equity prices. In response to a 1 percentage point shock to the failure ratio, the cumulative response is negative above the break-even rate of 0.8 per cent, dropping by up to 9.6 per cent ($t = -1.9$) after 5 years for an increase in the failure ratio from 5 to 6 per cent. An obvious channel through which large declines in equity prices might affect the macroeconomy is through a wealth effect.

The bottom panel shows the response of the natural logarithm of the broad money supply. In response to a 1 percentage point shock to the failure ratio, the cumulative response is negative for all failure ratios. The peak effect is for an increase in the failure ratio from 5 to 6 per cent, which is associated with a fall in the broad money supply of 4.6 per cent ($t = -2.5$) after 5 years. There are several reasons why the broad money supply might fall during a crisis, such as through the loss of deposits in failed banks or through a rise in the currency-deposit ratio, which typically increases during panics (James, 1984; Mishkin, 1991).

Another mechanism through which banking crises might be transmitted to the economy is through sectors. We therefore investigate the response of the output of the agriculture, industry and services sectors. As the sectoral data has gaps during the First World War, we truncate the sample for all variables to 1750-1913. Figure 4 plots the results from these models.

Panels A, B and C show that banking crises affect the agriculture, industry and services sectors in much the same way, exhibiting both an increase in economic activity at low levels of bank failures and a reduction at higher levels. Agricultural output, for example, rises by as much as 2.3 per cent ($t = 2.0$) for an increase in the failure ratio from 0 to 1 per cent, but falls by up 4.5 per cent ($t = -5.0$) for an increase from 5 to 6 per cent. Industrial output increases by up to 3.4 per cent ($t = 2.7$) and decreases by a maximum of 1.7 per cent ($t = -1.7$) for the same failure ratios. Services output peaks at 2.1 per cent ($t = 2.1$) and troughs at -3.9 per cent ($t = -2.6$), again for an increase in the failure ratio from 0 to 1 per cent and

from 5 to 6 per cent, respectively. Thus, the macroeconomic effects of banking crises are not driven by a single idiosyncratic sector but are felt broadly throughout the economy.

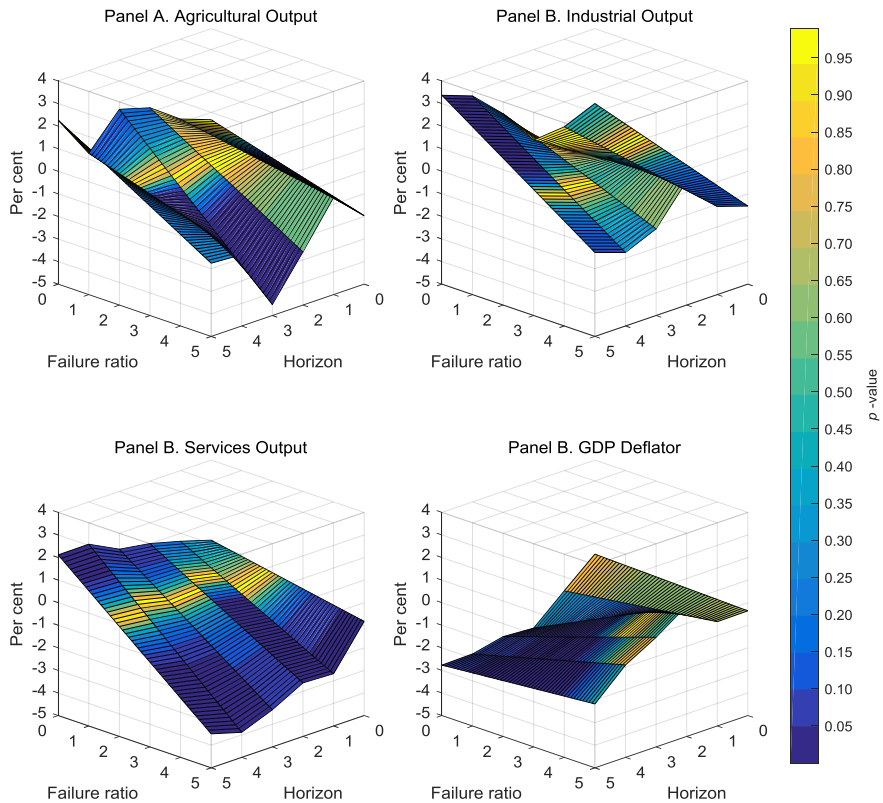

Figure 4. *The Effect of Bank Failures on Agricultural Output, Industrial Output, Services Output and the GDP Deflator*

Notes: The panels show the response of the respective outcome variable to a 1 per cent impulse in the failure ratio based on equation (2). The sample period is 1750 to 1913.

Panel D plots the response of the GDP deflator to bank failures and suspensions. Interestingly, bank failures lower prices for virtually all levels of the failure ratio, declining by up to 2.8 per cent ($t = -1.5$) for a change in the failure ratio from 0 to 1 per cent. Note, however, that while the peak drop is not statistically significant at conventional levels, large swathes of the impulse response function are. Taken together with the baseline results for

output, the implication is that bank failures, when there are many others, lower output and prices, which is consistent with the conventional view of banking crises as a demand shock. However, bank failures at a time when there are few others raise output but lower prices, which is more consistent with a supply shock. This is also suggestive of a creative destruction channel, where low levels of bank failures improve the supply side of the economy through more efficient credit intermediation.

D. *Identification*

Identifying the causal effect of banking crises is challenging as it is not only plausible that banking crises affect the economy but also that the economy affects banking crises. In general, previous studies have only indirectly addressed this challenge by assuming that the contemporaneous correlation runs only from banking crises to the economy (da Rocha and Solomou, 2015; Romer and Romer, 2017, 2018). A direct solution in the context of time series has been the narrative approach, which has recently been applied to tax multipliers (Cloyne, 2013; Romer and Romer, 2010), government spending multipliers (Ramey, 2011; Ramey and Zubairy, 2018) and monetary policy (Cloyne and Hürtgen, 2016; Lennard, 2018; Romer and Romer, 2004), but can be traced back to the seminal contribution of Friedman and Schwartz (1963).

In this spirit, we apply the narrative approach, which was pioneered in the case of historical banking crises in the United States by Jalil (2015). The intuition is to use contemporary accounts to disentangle exogenous crises, i.e., those that were not related to output shocks, from endogenous crises, i.e., those that were related to such shocks. This approach assumes that informed contemporaries could accurately identify the cause of a crisis.

In order to make the discussion more concrete, consider the following model:

$$y_t = \alpha + \beta F_t + u_t \tag{7}$$

To consistently estimate β it is necessary that $Cov(F_t, u_t) = 0$. However, it is plausible that banking crises are not only a function of idiosyncratic shocks (x_t), but also the shocks that make up u_t:

$$F_t = x_t + f(u_t) \tag{8}$$

If this is the case, simply using F_t will lead to inconsistent estimates of β as equation (8) shows that $Cov(F_t, u_t) \neq 0$. However, isolating those crises in F_t that are determined by exogenous factors will lead to consistent estimates of β.

Exogenous crises are therefore those that are not correlated with output shocks. This type of crisis might unfold for several reasons. First, a number of historical crises have been associated with bubbles (Reinhart and Rogoff, 2009a, pp. 158-62), where asset prices appear to have been detached from fundamentals (Garber, 2000; Kindleberger and Aliber, 2011). Second, certain changes in bank regulation might trigger a crisis, yet would not affect the macroeconomy other than through the crisis itself. Third, the failure of a particular institution for idiosyncratic reasons such as fraud might lead to a systemic crisis but would not be a function of the state of the economy.

To construct an exogenous series, the starting point is to identify a discrete number of events to study. Narrowing our focus to major events helps us to plausibly identify a cluster of bank failures as endogenous or exogenous, which would otherwise be challenging since reporting may be slim for minor events. Our focus on major spikes in our failure rate series is related to the approach of seminal narrative studies such as Ramey and Shapiro (1998) and Romer and Romer (1989). We identify a crisis as an event from the righthand tail of the distribution, or, in other words, as years in which the weighted failure ratio is above 2.4 per cent, which is the 95th percentile.[4] This qualifies 1772, 1815-6, 1821, 1825-6, 1841 1857, 1866 and 1930 as crises.

The next step is to classify which of the crises were exogenous using the narrative record. Specifically, we study a range of primary sources, such as newspapers, parliamentary enquires and bank records. For the sake of robustness, we also cross-reference the reports of contemporaries with the existing historiography. Appendix 2 details the sources and evidence used to construct the exogenous series.

The results show that half of the eight crises were exogenous: 1772, 1825-6, 1857 and 1866, while the other half were endogenous: 1815-6, 1821, 1841 and 1930. The exogenous crises mainly stemmed from poor risk management, while the endogenous crises were largely due to recessions. The fact that half of the crises prior to the Second World War were

[4] This is also 1.65 standard deviations above the mean, which is the one tailed, 5 per cent significance level.

exogenous challenges Aldcroft and Fearon's (1972, p. 95) argument that "the great financial crises of this era occur, almost without exception, after the downturn of the cycle."

The next step is to use the new exogenous series as an instrumental variable. However, this is complicated slightly by the fact that we have both the failure ratio and the failure ratio squared as endogenous variables. Following Wooldridge (2010, pp. 262-71), we first estimate a reduced form for the failure ratio:

$$F_t = \alpha + \beta CRISIS_t^X + \sum_{k=1}^{2} \delta_k F_{t-k} + \sum_{k=1}^{2} \theta_k y_{t-k} + u_t \tag{9}$$

where $CRISIS_t^X$ is a dummy variable that is 1 in the first year of an exogenous crisis and zero otherwise. We then re-estimate equation (2) using the fitted values and squared fitted values from (9), $\hat{F}_t$ and $\hat{F}_t^2$, as instruments for F_t and F_t^2.

Figure 5 shows the *causal* impact of banking crises on the macroeconomy. The profile is strikingly similar to the baseline, which follows from the fact that β_h remains positive while γ_h is still negative at all horizons. However, the effects are generally stronger with greater creative destruction at low levels of bank failures and larger output losses at high levels of bank failures. For example, following an increase in the failure ratio from 0 to 1 per cent, the IV model suggests that output increases by up to 3.8 per cent ($t = 1.7$), while the baseline model points to a peak of 2.9 per cent ($t = 2.5$). Similarly, following an increase in the failure ratio from 5 to 6 per cent, the IV model peaks at -6.5 per cent ($t = -2.2$), while the baseline model drops by up to 3.8 per cent ($t = -2.9$). The slightly lighter coloring of Figure 5 relative to Figure 2 implies that the impulse response functions are estimated with less precision. Nevertheless, the IV estimates support our baseline findings.

III. Robustness

In this section, we put the baseline model through the mill, assessing the sensitivity of the results to alternative definitions of the failure ratio, to a variety of model specifications and to the addition of control variables.

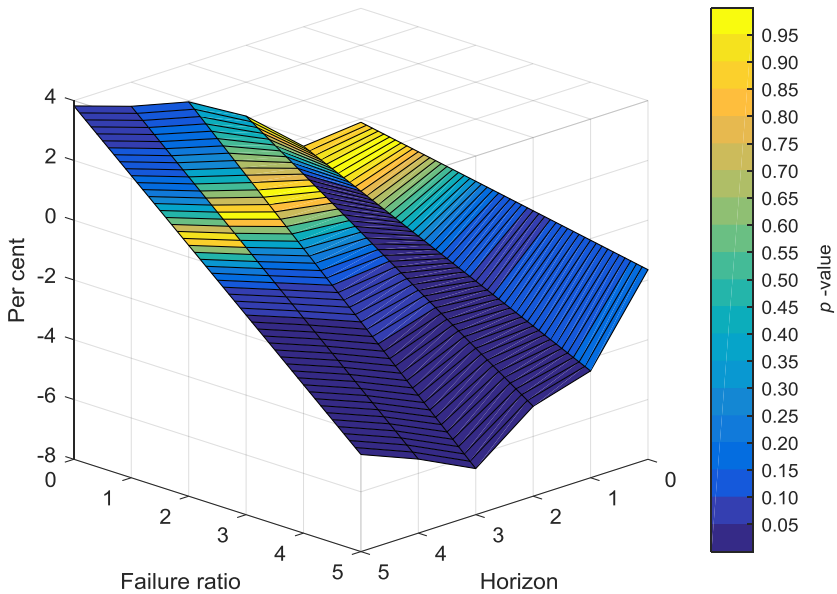

Figure 5. *The Causal Effect of Bank Failures on Real GDP*

Notes: The panels show the response of real GDP to a 1 per cent impulse in the failure ratio based on IV estimation of equation (2). The sample period is 1750 to 1938.

A. *The Failure Ratio*

There are alternative ways to construct the failure ratio. One is an indicator that excludes foreign and colonial banks. These institutions, which flourished in the nineteenth century, were registered as companies in the United Kingdom, but conducted most of their business elsewhere (Turner, 2014, pp. 51-2). If there are episodes in the sample that are driven by these institutions, the results are likely to be biased towards zero as these events are unlikely to impact the domestic economy. In order to identify foreign and colonial banks in the sample, we turn to annual editions of the *Bankers' Almanac* and the Banking Supplement of *The Economist*, which listed these institutions separately.

The series of bank failures, inclusive and exclusive of foreign and colonial banks are very similar, with a correlation coefficient of 0.99. Panel A of Figure 6 plots the response of output to a 1 percentage point increase in the failure ratio exclusive of foreign and colonial banks. In terms of the maximum, minimum and break-even rate, the results are similar if a

little softer than those from the baseline model. The maximum response of output is 2.5 per cent ($t = 2.5$), the minimum response is -3.5 per cent ($t = -2.8$), and the break-even failure rate is 1.6 per cent.

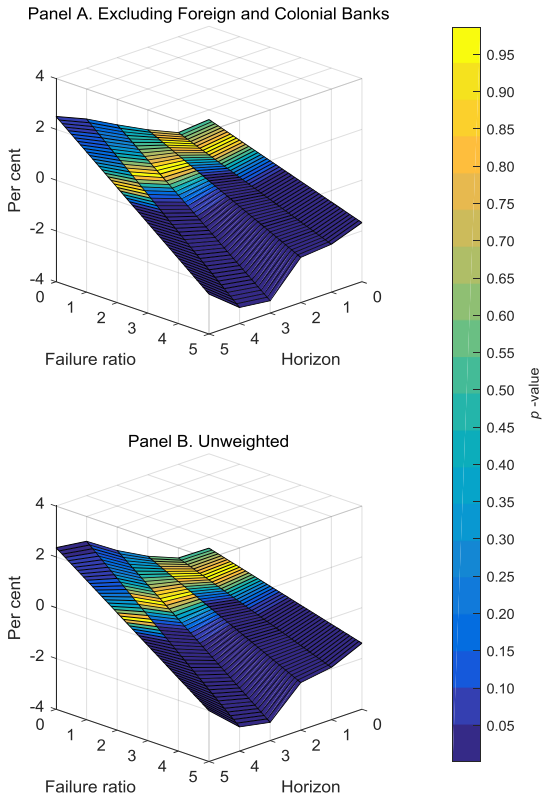

Figure 6. *The Effect of Bank Failures on Real GDP: Alternative Failure Ratios*
Notes: The figure shows the response of real GDP to a 1 per cent impulse in alternative failure ratios based on equation (2). The sample period is 1750 to 1938.

A second alternative is an unweighted failure ratio, which is simply the number of bank failures divided by the number of banks in the population. An unweighted measure might better capture the breadth of a crisis, but may not accurately capture the depth. Nevertheless, the weighted and unweighted series are highly correlated ($r = 0.96$). Panel B of Figure 6 shows that the results are not particularly sensitive to whether we use the weighted or

unweighted failure ratio, with a maximum response of output of 2.4 per cent ($t = 2.5$), a minimum of -3.3 per cent ($t = -3.2$) and a break-even rate of 1.7 per cent.

B. *Model Specification*

The results may be sensitive to the specification of the model. One possibility is the number of lags of F and y included. Panel A of Figure 7 shows the results from a model with 1 lag of F and y included, while Panel B shows the results from a model with 3 lags of each included. Reducing the lag length indicates a similar degree of creative destruction at low levels of bank failures, but points to bigger output losses at high levels of bank failures, as the minimum response rises to -4.5 per cent ($t = -3.8$). Increasing the lag length slightly reduces the extent of creative destruction as the maximum response falls to 2.4 per cent ($t = 2.2$), but the minimum response is unchanged.

Another possibility is that the results are sensitive to the timing assumption. In the baseline model, we followed the standard practice in the literature and assumed that crises affect but are not affected by output contemporaneously. While the IV estimates suggest that the baseline results are, if anything, a lower bound on the causal estimates, we reverse the timing assumptions as a belt and braces approach to the endogeneity problem. We therefore estimate a close variant of equation 2:

$$y_{t+h} = \alpha_h + \beta_h F_t + \gamma_h F_t^2 + \sum_{k=1}^{2} \delta_{h,k} F_{t-k} + \sum_{k=0}^{2} \theta_{h,k} y_{t-k} + u_{t+h} \quad (10)$$

where the sole difference is that the contemporaneous value of y is included as a control, which assumes that output affects, but is not affected by, crises within the period. Panel C of Figure 7 points to slightly weaker results, as the peak degree of creative destruction falls to 2.6 per cent ($t = 2.3$) and the maximum economic cost falls to -2.5 per cent ($t = -2.5$). The narrative analysis suggests that the truth probably lies somewhere between the baseline and alternative timing assumptions, as half of the major events were exogenous, while the other half were endogenous. Nevertheless, in both specifications, the conclusion remains that bank failures at high and low levels have statistically significant effects on economic activity.

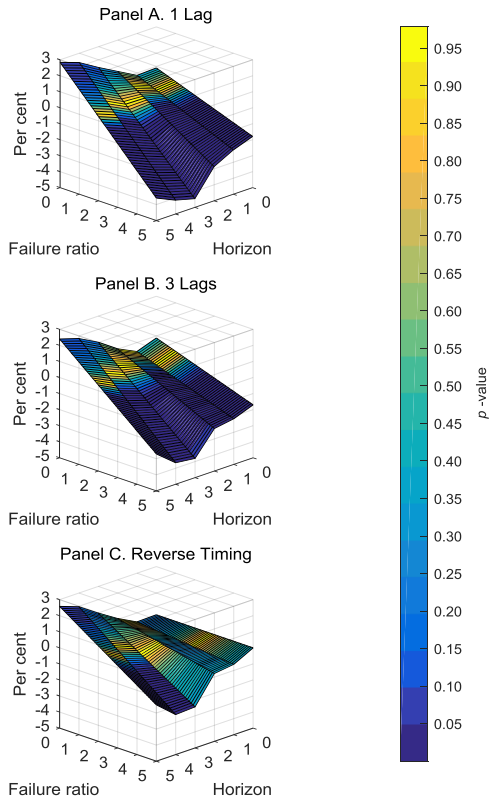

Figure 7. *The Effect of Bank Failures on Real GDP: Alternative Lag Lengths*

Notes: The figure shows the response of real GDP to a 1 per cent impulse in the failure ratio based on a variation of equation (2). The sample period is 1750 to 1938.

C. *Control Variables*

There are several factors that could be correlated with bank failures and output. If this is the case, then omitting these factors will lead to inconsistent impulse response functions (Stock and Watson, 2001). While the original specification was intended to be simple, we now extend the model to include a range of control variables. We therefore rotate in a series of control variables of interest, z_t, into equation (11):

$$y_{t+h} = \alpha_h + \beta_h F_t + \gamma_h F_t^2 + \sum_{k=1}^{2} \delta_{h,k} F_{t-k} + \sum_{k=1}^{2} \theta_{h,k} y_{t-k} + \sum_{k=1}^{2} \varphi_{h,k} z_{t-k} + u_{t+h} \quad (11)$$

The first set of control variables relate to stabilization policy. Monetary and fiscal policy are potential candidates to be both correlated with bank failures and output. According to Dimsdale and Hotson (2014, p. 32), the Bank of England and HM Treasury were to blame for the crisis of 1825-6, while economic policy, even in the nineteenth century, had large macroeconomic effects (Lennard, 2018). The measure of monetary policy is Bank Rate, the rate at which the Bank of England lent to the banking system. Fiscal policy is captured by the natural logarithms of government revenue and spending. We also include the yield on consols, which reflects both monetary and fiscal policy. The next set of controls are general macroeconomic variables: the natural logarithms of the GDP deflator and equity prices. It is reasonable to assume that these variables might be important. A wave of bank failures might well follow an asset price crash, for example, while a fall in asset prices might reduce output through wealth effects.

Figure 8 presents the results from these models. Adding controls has mixed results. Controlling for consol yields or equity prices points to stronger results, with greater creative destruction for low levels of the failure ratio and larger economic costs for high levels. Controlling for Bank Rate, government revenue, government spending or the GDP deflator, on the other hand, indicates greater creative destruction at low levels of bank failures but lower output losses at high levels, which suggests that economic policy ameliorated the severity of downturns following major bouts of bank failures.

In order to gauge the robustness of the results, 11 additional variants of the model were estimated, such as excluding foreign and colonial banks, using an unweighted failure ratio, varying the number of lags of F and y, reversing the timing assumption and controlling for a range of potentially confounding factors. The estimated minimum response ranged from -2.5 to -4.5 per cent, the maximum response varied between 2.4 and 3.7 per cent and the break-even failure rate fluctuated between 1.5 and 2.3 per cent. Irrespective of the specification, the macroeconomic effects of bank failures appear to be nonlinear, where a cluster of bank failures at low levels leads to large, sustained gains in output, while the failure of the same cluster at high levels is associated with large and persistent losses.

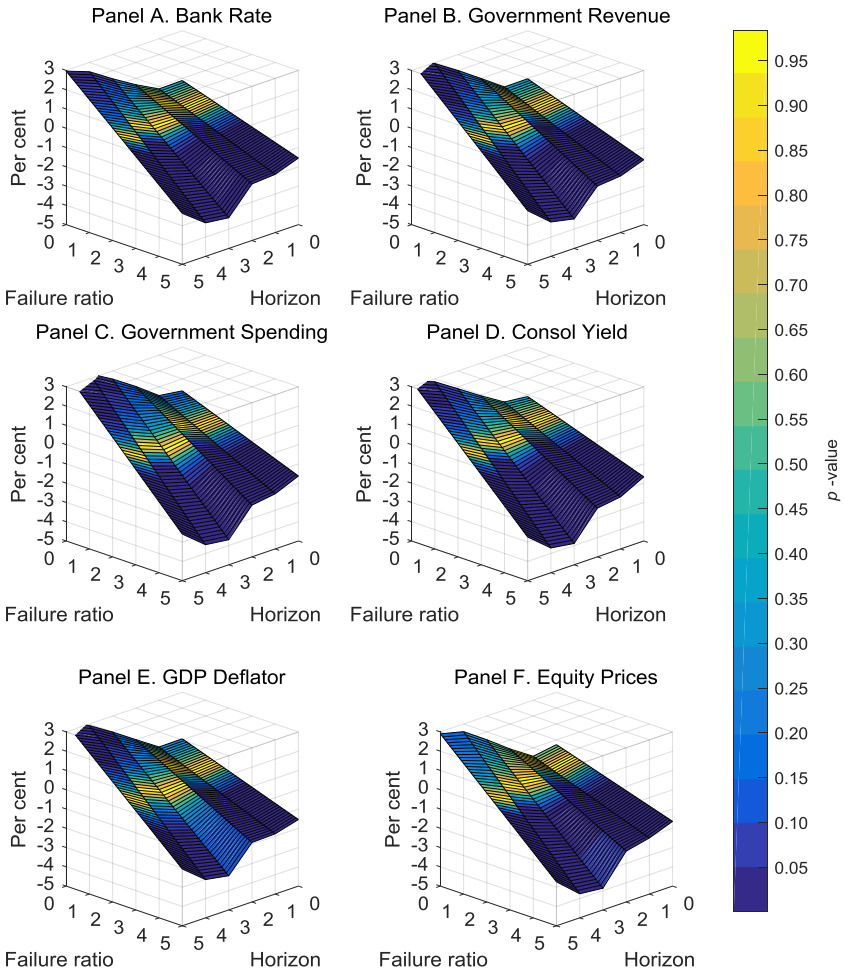

Figure 8. *The Effect of Bank Failures on Real GDP: Additional Control Variables*

Notes: The panels show the response of real GDP to a 1 per cent impulse in alternative failure ratios based on equation (11). The sample period is 1750 to 1938.

IV. Conclusions

Using a new annual bank failure series for the United Kingdom between 1750 and 1938, we find that at low levels, bank failures raise economic activity. This implies that creative destruction improves the efficiency of the credit intermediation performed by the

banking system. However, when the failure ratio is high, banking crises can have a large and detrimental causal effect on the economy. The clear implication of these findings for policymakers is that below a certain threshold, banks should be allowed to fail, but once that threshold is breached, rescues of failing banks may become necessary. This suggests that further research is needed to understand (1) the potential negative effects on the economy of a policy which prevents any banks from failing and (2) the effects on economic growth of policy interventions during crises and whether these interventions ameliorate the effects of banking crises on the economy.

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Appendix 1. The Construction of the Capital-Weighted Failure Ratio

This Appendix provides a list of the sources used to construct the capital-weighted failure ratio. We collected balance sheets of private and joint-stock banks from the archives of the following banks: Bank of Scotland, Barclays Bank, HSBC, Lloyds Bank and Royal Bank of Scotland. While today these banks are single entities, over the centuries they engaged in a large number of takeovers and mergers, which had the result that they now house historical records of a substantial number of extinct institutions.

In addition, we also utilized the work of contemporaries such as Gilbart (1860), who collected the balance sheets of a number of joint-stock banks in this period, as well as contemporary publications, such as the *Bankers' Almanac,* which published capitalization information from the mid-nineteenth century onwards.

DATA SOURCES

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Appendix 2. A Narrative Account of Banking Crises in the United Kingdom, 1750-1938

This Appendix discusses the classification approach we use to identify whether a banking crisis was exogenous or endogenous in nature. As outlined in the main text, the candidate crises are right-hand tail events (95^{th} percentile and above).

An exogenous banking crisis (*X*) is one which is unrelated to macroeconomic shocks. Examples include bank failures which were *preceded* by incidences of individual or widespread fraud in the banking sector, imprudent lending/borrowing practices and poor reserve management. The eventual collapse of a portion of the banking system then may *cause* a downturn in macroeconomic activity, though this is not specifically assumed. With endogenous banking crises (*N*) on the other hand, causality lies in the opposite direction. Typically, this category of banking crisis occurs following a recession, a fall in the price level or the failure of non-bank firms against which a bank is heavily exposed.

We have two subcategories of exogenous and endogenous crises as outlined in Table A1. Where crises display more than one subcategory, they are coded as such. Similar to Jalil (2015), we use a variety of newspaper publications which were active during each of the eight crises (1772, 1815-6, 1821, 1825-6, 1841, 1857, 1866, 1930) to categorize events with the classification provided in Table A1.

Table A1. *Classification of Banking Crises*

Group	*Sub-category*
Endogenous (*N*)	1. Depression (*D*)
	2. Government policy (*P*)
Exogenous (*X*)	1. Fraud (*F*)
	2. Risk management (*R*)

In the following, each crisis is documented in chronological order and is presented in the same standard format: (1) a brief context, including the capital-weighted failure ratio, (2) narrative evidence gathered from newspapers and other contemporary sources and (3) our classification of the crisis and a comparison to the existing historiography.

1772

Classification: Exogenous (*X*)

Cause: Risk management (*R*)

Context

The crisis of 1772 is often referred to as the "Ayr Bank Crisis", the collapse of which was its trigger and most famous casualty. A speculator by the name of Alexander Fordyce had mismanaged a large trade that he had financed by a loan from his own bank, which in turn was heavily indebted to the Ayr Bank. An adverse market movement bankrupted Fordyce who promptly fled to France in June 1772. The failure of the Ayr Bank resulted from their exposure to Fordyce's, combined with an inability to meet its demands. This triggered the subsequent panic which spread to the wider banking system, leading to the failure of 2.6 per cent of all UK banks.

Narrative Evidence

The Scots Magazine, a contemporary Scottish newspaper, provided detailed accounts of contemporary perceptions. Its account of the trigger of the crisis described a "melancholy scene [which] began with a rumour, of one of the greatest bankers having stopped, which afterwards proved true" (06/01/1772). The fraudulent nature of the panic was described by one newspaper which expressed indignation at the "alley transactions" of Fordyce leading to the outcome that "everybody for some days appeared to be struck with amazement and terror from the dread and uncertainty with regard to those that might be affected by this accident" (06/01/1772). The incident, which had occurred unexpectedly, was referred to as "an accident" and brought about "such distrust and such jealousy was never known" (06/01/1772), led to a panic, which manifested principally on Scottish banks in the UK that were suspected of dealing with the Ayr extensively. "But as the failure of these two houses [Ayr and Fordyce's] was supposed to be connected with many others of that country [Scotland], the gentlemen of this city were disposed to consider this a prelude to the universal bankruptcy of every safe house of that part of the kingdom" (06/01/1772). However, most banks unconnected to the event, *The Scots Magazine* observed, "went on with their usual tranquility, to answer their engagements" (06/01/1772). In spite of the banking crisis, macroeconomic conditions appeared to be buoyant as the major complaint of one contemporary report was that the banks "cannot upon the present plan keep pace with" the

"improvements of this country [Scotland] in agriculture, in foreign and domestic trade" (07/07/1772).

Classification

On the basis of the narrative evidence above and due to reporting of general "improvements" in macroeconomic conditions, we classify this crisis as exogenous (*X*), caused by poor risk management (*R*). Our conclusions are supported by other research which has reviewed this event. The Ayr Bank was associated with overtrading in an era of increased speculative activity and an "extravagant creation of credit", which undermined confidence in both Edinburgh and London (Hamilton, 1956). Additionally, instead of raising the full amount of its capital, the bank lent to its investors, which increased its leverage beyond what its books revealed (Rockoff, 2009). Kindleberger and Aliber (2011, p. 58) viewed the episode as a crisis which was precipitated by speculation and highlighted that the bank had been in the practice of borrowing on London when its acceptances came due in Scotland. It had replenished its reserves in a similar manner (Rockoff, 2009). The above observations on the bank could be summarized as poor risk management behavior. Such "foreign" capital provided by English banks typically made up the shortfall in savings which existed in Scotland but such lending was sensitive to a downturn in sentiment (Hamilton, 1956). While it has been suggested that the cause of the failure was a determination to ignore rules of prudent banking (Rockoff, 2009), recent research has suggested that restrictive banking legislation introduced prior to the event had undermined the flexibility and resilience previously exhibited by Scottish finance (Goodspeed, 2016, p. 8).

1815-6

Classification: Endogenous (*N*)

Causes: Depression (*D*), Government policy (*P*)

Context

During the suspension era (1797-1821), poorly regulated and insufficiently capitalized small private banks proliferated in the UK. These banks often issued inconvertible notes against securities of a questionable character. In this period of war-time inflation, such banks were particularly sensitive to downturns given these structural weaknesses. The major banking crisis which occurred in the aftermath of the Napoleonic wars led to the failure of 4 per cent of the UK banking system in 1815 and 7 per cent in 1816.

Narrative Evidence

The Times attempted to reveal the origins of the crisis in the following manner: "Let them all causes of our distress be enumerated, in order to apply proper remedies. 1st A superabundant harvest; 2nd foreign importation; 3rd tithes; 4th poor and other rates; 5th property and other war taxes; 6th want of credit; 7th decrease in circulating medium" (10/09/1816). The decrease in circulating medium which must cause the "want of credit" was initiated by the Bank of England contracting its note issue in preparation for the restoration of gold. Of the six causes listed, two relate directly to economic issues, three are government policies, while the fall in credit is a direct result of policy. The abundant harvest and the fall in circulation and credit assisted falling prices. Manufacturers and producers of commodities "felt the influence of depreciation in the value of their respective articles" (08/02/1816) and evidence emerges that "before the peace was concluded … iron works began to fail" (08/05/1816). This *preceded* the dramatic rise in bank failures which peaked in 1816.

The effects of the falling prices and the post-war depression manifested itself in the form of mistrust in the fragile banking system. Of the country banks' mode of operation during the suspension era, one observer noted that "any sudden reverse, any unforeseen fall in the markets, occasioned at once their own ruin, and often involved that of their creditors" (*Oxford University and City Herald*, 05/25/1816). One commentator derided the "practice" in some papers of "swelling every trivial failure in the mercantile world" as "the bad effects of such exaggerations" spread "through the whole country" and culminated in bank runs (*London Courier and Evening Gazette*, 08/16/1815). Reporting on many bank failures in Sunderland, the *Stamford Mercury* stated that the "stagnation of trade *prior* to this [failure of Cooke and Co.] was great; at the ceasing of hostilities we anticipated a trade with Holland in the export of coals, which we concluded would counteract the superabundant vessels in coasting. Alas! We are miserably mistaken" (07/12/1816). Similarly, economic conditions were blamed for the failure of Bruce and Co. whose lending to merchants placed them in a position which was "fearfully ominous of the general conditions of the commercial world" (*Taunton Courier, and Western Adviser*, 07/11/1816). They regretted that the "mercantile portion of the public" appeared to be "unfortunately progressing to a most disastrous crisis," as international trade appeared "paralyzed" with countries which are "in a still worse condition than this" leading them to the conclusion that "there is difficulty in allowing a ray of hope to struggle through" (*Taunton Courier, and Western Adviser*, 07/11/1816) for a return to normal levels of international trade.

Though the newspaper reporting during these earlier crises was not as extensive as it was to subsequently become, complaints of falling prices and poor economic conditions dominate the reporting *prior* to the bank failures which they brought about. The typical scenes above are repeated in towns across the UK where a local firm experiences bankruptcy, mass unemployment and unrest follows and smaller local banks, which may have concentrated their assets in the local economy, collapse.

Other contemporary evidence corroborates the press accounts. During one subsequent interview conducted in 1819 by a committee established to review the resumption of cash payments, the Governor of the Bank of England, George Dorrien, recounted the tradeoff the authorities faced between convertibility and macroeconomic stability during those years. While promoting the policy of a return to convertibility as it would eventually "place this country in a better situation with regard to all foreign countries", Dorrien was conscious that if the contraction was "done suddenly, it might do a great deal of mischief" and agreed that the "effect must be a proportionate fall in the prices of commodities generally" (P.P. 1819, p. 32). He additionally admitted that in the short run, this policy would mean that "the manufacturer would not be disposed to manufacture upon a low price to the same extent" (P.P. 1819, p. 32).

Classification

The narrative evidence leads us to classify this crisis as endogenous (*N*), which was caused by a combination of a post-war depression in trade (*D*) and measures taken by authorities to restore convertibility (*P*). Our classification is supported by subsequent research. Following the end of the Napoleonic wars, it was expected that the Bank of England would attempt to resume sterling convertibility as early as July 1816 (Presnell, 1956, p. 471). This was pursued through a contraction of its notes (Turner, 2014, p. 67), which, combined with falls in government borrowing and expenditure, "could not but have a deflationary influence" (Presnell, 1956, p. 470). In 1815 alone, prices fell by over 14 per cent (Thomas and Dimsdale, 2017) and were depressed further by increases in general supply at the cessation of hostilities. Reinhart and Rogoff (2009, p. 387) also cite the abundant harvest and low prices in addition to a general depression in property prices which affected production industries. It was reported that general business failures were high in autumn 1815 and early 1816, leading Presnell (1956, p. 471) to note: "That bank failures were high is not surprising, for to general economic depression there was added the deflationary expectations of the Resumption of Cash Payments".

However, with respect to the 1815-6 crisis, the case for the banking system's role in causing the crisis is not negligible. The rapid expansion of unregulated note-issuing private banks in the United Kingdom which had occurred in the suspension era has been blamed for increasing inflation and economic instability (Ó Gráda, 1994, p. 52) and the system exhibited "underlying structural weaknesses in the steady trickle of failures" which occurred (Presnell, 1956, p. 447). Nonetheless, the majority of the failures in England occurred in agricultural areas, which suffered even lower prices as a result of a plentiful harvest (Presnell, 1956, p. 471). This was exemplified in Ireland, a primarily agricultural economy, where the clustering of failures was linked to declines in agricultural prices, which "led to a fall in business confidence and to a flurry of rumour and counter rumour," resulting in bank runs and suspensions (Ó Gráda, 1994, p. 55). On balance, subsequent research supports our conclusion that the post-war deflationary slump exposed a weak banking structure to widespread ruin.

1821

Classification: Endogenous (*N*)

Causes: Depression (*D*), Government policy (*P*)

Context

Due to the emphasis on the more dramatic crises of 1815-6 and 1825-6 in the literature (Dimsdale and Hotson, 2014; Presnell, 1956; Turner, 2014), the crisis of 1821 has received limited attention amongst scholars. However, the severity of this crisis was very apparent to contemporaries. The *Scotsman* (09/15/1821) reported that throughout "extensive districts in England, and in the South of Ireland, no money was to be found in circulation" following the failures. In May 1821, convertibility was restored by the Bank of England and the period is generally synonymous with deflation. Our series confirms an increase in bank failures in this period, which increased from 2.1 per cent in 1820 to 2.6 per cent in 1821.

Narrative Evidence

In May 1821, the United Kingdom restored gold payments and this event forms the subject of a relatively large volume of reporting with its effects upon prices. Agricultural distress features prominently in contemporary reporting and a parliamentary committee was established that year to investigate its nature (P.P. 1821). The press reported that "the measure of the restoration of cash payments had the necessary effect of restricting the circulation of the country, and hence it was impossible that in the present state of things the

same prices could be obtained for corn as in former years" (*Kentish Weekly Post*, 03/06/1821). The current "misery" was viewed as the result of the fall from "fallaciously increased" prices of former times which had resulted from "excessive and unlimited issue of paper money" during the suspension era (*Bell's Weekly Messenger*, 09/10/1821). Ireland, as an agricultural region, showed the first signs of banking crisis in an environment of falling prices. A local newspaper had not anticipated that Ireland, through its bank failures, would "exhibit the first symptom of the terrible revulsion which must be necessarily felt before the return to a metallic currency" (*Dublin Evening Post*, 06/13/1820). Early in 1821, it was reported in Britain that "the depression now so universally felt by the agriculturists … must, if it continues, terminate at no very distant period in general bankruptcy" (*Bury and Norwich Post*, 01/17/1821). Deflation continued through the year and by the end of November the *Belfast Commercial Chronicle* wrote that at that point it was "remarkable, that the price of agricultural produce is regularly on the decline" (11/28/1821).

Government policy and the restoration of full convertibility was consistently linked with difficulties of the country banks facing "casual runs" for gold coin and smaller Bank of England notes when gold payments were resumed (*Staffordshire Adviser*, 04/21/1821). "Peel's Act" and the Bank Act, which respectively restored gold payments and drew in one pound notes previously issued by the Bank of England, produced the "consequence" of "some intermediate suffering" (*Bell's Weekly Messenger*, 09/10/1821). By August, trust in the private banking system had declined to such an extent that petitions were forthcoming from inhabitants of Manchester and Salford to "secure a satisfactory currency, in consequence of the cessation of the issue of small notes by the bank of England" (*Morning Chronicle*, 08/30/1820). The article continued that the "failure of many private banks, and the consequent sudden annihilation of the currency" which led to "further consequent stoppages" was due to currency policy and it was requested that "gold coin and bank of England notes may be procured at a moderate expense" to alleviate the current deficiency (*Morning Chronicle*, 08/30/1820).

Other contemporary evidence confirms the deflationary effects of the restoration on the banking system. One banker, whose bank had failed during the beginning of the crisis, attributed its demise to deflation: "it proceeded chiefly from the fall of prices, which reduced the value of the securities on which we lent money" (P.P. 1826, p. 52). As early as 1819, the Deputy Governor of the Bank of England, Charles Pole was aware of the potential effects of a contraction in the supply of money and warned against rushing convertibility. He predicted that through the consequent price falls "we must ruin one half of the commercial world at

present" through reducing note circulation by the required amount and that "a great part of the commercial community would be rendered unable to fulfil their contracts" (P.P. 1819, p. 32). Under interview in 1823, when one banker was asked specifically whether the bank failures were the cause or consequence of price falls, he answered that they were "the consequence of it, and that added to its effects" (P.P. 1823, p. 163).

Classification

The narrative evidence leads us to classify this crisis as an endogenous event (*N*), which was preceded by a depression (*D*) that was linked with the policy (*P*) of a return to gold convertibility that year. Our conclusion is supported by subsequent research. Chase (2013, p. 155) notes that the return to the gold standard was "too rapid" and "exacerbated unemployment" and that the reform "mostly derived not from a careful appraisal of economic theory and policy options, but from a vague feeling that the change was natural and morally desirable. Pressnell (1956, p. 474) observes the rise in bank failures in 1820 and 1821 and links them with "good harvests and falling prices".

1825-6

Classification: Exogenous (*X*)
Causes: Risk management (*R*), Fraud (*F*)

Context

In recent research, the crisis of 1825 has been placed alongside 2008 as the most acute banking crisis of the previous two centuries in terms of financial casualties and output effects (Turner, 2014, pp. 53-4, 62). Indeed, some fifty years later a chairman of the Manchester and Liverpool Bank recalled the event as follows: "when people went to their business that year, they did not inquire what banks were broken, but what banks were standing" (P.P. 1875, p. 340, q. 6610). In 1825 and 1826, 5.6 and 6.6 per cent respectively of all UK banks failed, which supports the conclusions of Turner (2014) that this was a uniquely extreme event.

Narrative Evidence

Contemporary accounts provide no material attention to economic considerations, instead saving their criticisms for the behavior of the banking sector. During the early stages of the crisis, there is little evidence of difficulties affecting merchants (*The Times*, 12/15/1825). Instead, we find evidence that merchants provided support to the banking

system: “During the late panic, it appears that some of the leading merchants supported those houses [banks] in which they had confidence, in the most liberal manner” (*The Times*, 12/20/1825).

The banking sector was blamed by the *Globe* who wrote that “the country bankers, imitating their example [the Bank of England] … had saturated the provinces with paper” (12/14/1825). The frenzy of the speculative environment is constantly remarked upon by the newspapers of the day. *The Times* for instance commented: “credit, gained by pretence, and given by credulity, and wasted on the projects of cupidity mingled with indiscretion – that sort of credit which is now in its last agonies” (11/29/1825). In moralistic tones, it continued that the crisis is the “natural result of eager and accumulated speculation, carried, through the facility which every adventurer was accommodated by capitalists at a loss to find vent for their money.” Further attention was focused on bankers who were “well aware, that the state to which they had brought things, by their over issues and their too ready supplies from scanty capitals, was a state most grievously oppressive and injurious to the nation” (12/08/1825). Comparing the event with the South Sea Bubble of the previous century, *The Times* wondered that considering the current episode exhibited “a much greater mass of fraud and deception in the aggregate: can we, therefore, wonder that the result has been similar?” (12/13/1825).

In later parliamentary committees, the crisis was reviewed at length by contemporaries. The direction of causality was implied by a witness interviewed in one such committee established to review the Bank of England’s charter. “The lamentable effects” of bank lending and “overissues” which preceded the crisis “entailed ruin on large classes of respectable traders and manufacturers, and much misery on a vast population” (P.P. 1831-2, p. 338, q. 4398). It was claimed that had “banks been established on sound principles” then “it would have been utterly impossible to have lent to such an enormous extent, without the possession of a large amount of real capital” (P.P. 1831-2, p. 338, q. 4398). More than twenty years later, a Member of Parliament recalled that the panic “of 1825 was confined to the banking interest”, suggesting that this crisis was not linked with events in the wider economy (P.P. 1848, p. 207, q. 1744).

Classification

Due to the absence of reporting on any adverse economic conditions in the earlier stages of the crisis and the focus falling almost entirely on the perception of the risky behavior of banks with insufficient capital, fraud and leverage featuring prominently in the

complaints, we classify this crisis as exogenous (*X*), caused by a failure of risk management (*R*) and fraud (*F*).

This conclusion is bolstered by the findings of subsequent researchers. Writing on the history of the crisis, Dimsdale and Hotson (2014, pp. 32-3) claim that the conditions were ripe for a speculative boom by the initial policy of the authorities who were concerned about reducing yields on government bonds as a result of the high public debt which prevailed in the post Napoleonic war era. This, they claim, pushed investors into riskier assets seeking a better return. These included Latin American sovereign debt and speculation in real and imaginary projects (Reinhart and Rogoff, 2009, p. 387). Independently, the Bank of England extended credit, purchased securities and increased its note circulation instead of decreasing it, despite lower rates on government debt adding to the speculative environment (Turner, 2014, p. 68). In London alone, between 1824 and 1825, an amount almost equivalent to the entire market value of the equity market was raised in capital (Turner, 2014, p. 70). Many banks which had invested in risky securities began to fail in the autumn and the collapse of the speculative boom was a major factor causing the crisis (Dimsdale and Hotson, 2014, p. 33).

The devastation which came upon the banking system provided the impetus for the introduction of joint-stock bank legislation. As already indicated by the above observation, a defining characteristic of the vast majority of failed banks had been that they were poorly capitalized small partnerships (Dimsdale and Hotson, 2014, p. 33; Turner, 2014, pp. 102-39). All of the above considerations reinforce our categorization of this crisis as exogenous.

1841

Classification: Endogenous (*N*)
Causes: Depression (*D*), Government policy (*P*)

Context

The crisis of 1841 occurred in the aftermath of the minor crisis of 1836-7, which has received considerably more attention to date, despite the lower failure rates of 0.4 and 1.8 per cent for both years, respectively. Indeed, had this earlier crisis been included here, it would have been classified as an exogenous crisis as subsequent research has highlighted aggressive risk taking and fraudulent behavior among the principal causes (Turner, 2014, p. 72). However, to reinforce the difficulty in dating events, Reinhart and Rogoff (2009, p. 387) claim that a crisis occurred during the period 1837-9, while Dimsdale and Hotson (2014, p.

27) date a recession which persisted between 1839 and 1842. It is during this economic downturn that our new measure of panics begins to rise considerably, as 2.7 per cent of UK banks failed in 1841. The previous year produced a figure of 2.2 per cent, suggesting that this episode as a whole to date has received insufficient attention as a banking crisis, which is likely due to the emphasis of contemporaries on depressed macroeconomic conditions.

Narrative Evidence

It is clear from the newspaper reporting during the period that poor economic conditions *preceded* the bank failures of 1840 and 1841. *The Times* reported in the first half of 1839 that "business is more than ordinarily dull" (05/01/1839) and the crisis became associated, among other things, with "failure of corn crops of that and the preceding year" (07/09/1841). As we may expect from the Cunliffe version of the price-specie-flow theory, to rectify the balance of payments deficit which the UK experienced, Bank Rate was raised to bring about a price reduction. While at the end of 1838 it was 4 per cent, by the end of 1839, it had reached 6 per cent, leading to a fall in prices. Such actions were heavily criticized by manufacturers in the press as having led to widespread unemployment or "injuries inflicted upon the laboring classes by the operations of the Bank of England upon the currency" (01/01/1840). The manufacturers also complained that unlike "monied capitalists", who had enjoyed higher prices for their silk imports in 1838 due to "the depreciation of the currency by the Bank of England," the "manufacturing capitalist, at all times a purchaser" now suffered as sales prices fell and incurred "heavy losses" (*Evening Mail*, 01/01/1840). The *Morning Post* claimed almost two years later that the fall in prices was being "unduly aggravated through the continual supplies furnished by persons largely indebted to their bankers, and who have been compelled, week after week, to bring them to market and dispose of them at any sacrifice in order to keep their manufactories going" (11/15/1841). The banks, in turn, came under pressure from debtors who could no longer repay their loans, selling at ever lower prices. The *Morning Post* heavily criticized the affected banks for "the unreasonable lengths to which some of them have ventured in the advances made to cotton spinners and manufacturers" (11/15/1841). The public was made increasingly aware of the banks' exposure in this manner "by means of the disclosures consequent upon the bankruptcy examinations that are going forward" (11/15/1841). For instance, the failure of Hobhouse and Co. at Bath was "owing to heavy advances to two houses engaged in the woolen manufacture" (*Hereford Journal*, 09/02/1841).

Additional contemporary evidence paints a similar picture of the crisis. During a series of interviews published by the Banking Committee in 1841, the trade deficit and its attempted rectification via rises in Bank Rate were addressed at length. A chairman of the Committee of Private Bankers expressed his view on the trade deficit and the effect it had on the banking system: "when gold is going out of the country there is generally a gloom hanging over the public mind" and "that lowers prices very much" (P.P. 1841, p. 12, q. 94). It was claimed that during the first eight months of 1839, the "foreign drain" was so severe that the Bank of England was nearly reduced to the "necessity of suspending specie payments" and that a reduction in circulation was the only course available to them (P.P. 1841, p. 65, qq. 603, 604). In this environment of a rising Bank Rate, contraction in circulation and falling prices, the archives of one regional bank show as early as February 1839, that there was a great deal of "apprehension" felt by "people congregating" who placed "severe pressure upon all the banks" (*Provincial Bank of Ireland Archive*, 02/12/1839). It was later recalled by one committee witness that the distress of 1839-41 was "an American Pressure" brought about "in consequence of a drain of bullion" (P.P. 1857-8, p. 160, qq. 2364-5).

Classification

In light of the combined narrative evidence presented above, we classify this as an endogenous crisis which was linked with government policy (*P*) and depression (*D*). To our knowledge, few researchers to date have focused on this episode as a banking crisis. However, Bordo et al. (2003) identify 1841 as an event of "severe distress" in their financial conditions index. Where it has received attention, it has been recognized as a depression that affected both industry and agriculture, which has, in turn, been linked to the depressed state of Anglo-American trade (Ollerenshaw, 1987, pp. 52-6). Dimsdale and Hotson (2014, p. 27) describe the onset of this episode as a "balance of payments crisis", prompting a rise in Bank Rate which was duly forthcoming, as discussed by the 1841 Banking Committee. In his *Business Annals*, Thorp (1926, p. 161) described the year 1841 in England in the following manner: "severe depression; many failures; widespread unemployment; foreign trade dull. Money tight." In support of our conclusion that poor economic conditions preceded this banking crisis, the question has been specifically posed by Ollerenshaw, (1987, p. 56): "what was the banks' *reaction* to this depression?"

1857

Classification: Exogenous (*X*)

Causes: Risk management (*R*), Fraud (*F*)

Context

The banking crisis of 1857 has been referred to as "one of the greatest nineteenth century crises" (Turner, 2014, p. 78) and the global nature of the event is observed by Reinhart and Rogoff (2009, p. 388) and Dimsdale and Hotson (2014, p. 25). Kindleberger (1995, p. 90) describes the chronology of its transmission from New York to London, Scandinavia and Hamburg. Our crisis series confirms it as a major episode in the United Kingdom with a failure rate of 2.7 per cent. Despite the comparatively low number of banks which failed, the new index has the advantage of capturing the significance of the comparatively large institutions which succumbed to the crisis. Among other bank closures, the three major banks which failed were the Liverpool Borough Bank, the Western Bank of Scotland and the Northumberland and Durham District Bank (Turner, 2014, p. 78).

Narrative Evidence

Though the crisis reached its highpoint in the late autumn of 1857, early signs of difficulties were observed in March with smaller failures such as that of the London and Eastern Banking Corporation, which had lent almost the entire paid-up capital of the firm to an estate held by one of the directors in Surrey (*Brechin Adviser*, 03/31/1857). By the early summer, the Royal British Bank had failed through "fraud on a wholesale scale" (*Gloucester Journal*, 05/02/1857). In the same article, the recent failures were described as owing "their origin in the first place to that never-resting rage for speculation which so largely prevails" (*Gloucester Journal*, 05/02/1857). In the autumn, the frequency of reports on bank failures increased. When a large bank failed in Hull, "it took the whole commercial public by surprise," the cause being attributed to "heavy advances" to a single company, but the newspaper reassured that it was doubtful that any "foolish panic" would occur where the public "imagine dangers that do not exist" (*London Daily News*, 09/26/1857). When the Northumberland and District Bank failed, a local newspaper summed up the sentiment: "the history of joint stock banking in Newcastle and the disasters which it has brought upon the town may be described in one expressive word – *mismanagement*" (*Newcastle Guardian and Tyne Mercury*, 12/05/1857). The failed banks there had engaged in excessive leverage and "traded with an amount of capital wholly inadequate to the extent of their business"

(*Newcastle Guardian and Tyne Mercury*, 12/05/1857). At the end of the year, the *Edinburgh Evening Courant* reported on the failure of the Western Bank of Scotland and stated that "it was not the Bank Charter Act, nor anything of that sort, which had brought about this catastrophe, but the reckless and disgraceful way in which the directors have conducted the affairs of the bank" (12/22/1857).

Additional evidence from contemporaries corroborates the views of newspapers that the roots of the crisis lay within the banking sector and a vast array of primary sources survive from which we draw upon. As the Governor of the Bank of England recalled in 1858, during an interview, in "autumn last year [1857], the trade of the United Kingdom was generally considered to be in a sound and healthy state" continuing that "the public certainly viewed trade as sound, and were little aware that a crisis of any sort was impending, far less that it was so near at hand" (P.P. 1857-8, p. vii).

With respect to individual failures, committees and reports provide additional robustness to the newspaper articles. In 1858, a report titled *The Western Bank Failure and the Scottish Banking System* published the proceedings of an inquiry into that failure and the nature of the crisis itself (W.B.F. 1858). The Governor of the Bank of England explained the Bank's refusal to grant the Western Bank assistance. He remarked that the latter's notes were "in excess of the authorized amount" and that they had lent to an "immense extent" (W.B.F., 1858, p. 4) to American houses to "which they had lost very largely". They did not keep sufficient reserves and the nature of the vast number of small depositors "who in a moment of distress would take their little all out of the bank" also had increased the riskiness of their position (W.B.F., 1858, pp. 14, 4). A Director of the Liverpool Borough Bank admitted that the bank had been in difficulty before the commercial crisis due to poor management and "the position of individual accounts" placed the bank "in exceeding danger," which was "irrespective" of "general commercial" considerations (P.P. 1857-8, p. 290, q. 4201).

Classification

We classify this crisis as an exogenous event (*X*), caused by poor risk management (*R*) and fraud (*F*). Our conclusions match Turner's (2014, p. 78) assessment that the major banks that collapsed "were all weak institutions that had been taking excessive risks for a long time." Specifically, the Northumberland and Durham District Bank failure has been attributed to excessive leverage with lending reaching 158 per cent of capital against "completely inadequate security" (Turner, 2014, p. 78). More generally, Reinhart and Rogoff (2009, p. 388) and Capie (2014, p. 13) cite "speculation" as a major feature of this crisis and Dimsdale

and Hotson (2014, p. 38) claim that the crisis had a major impact on the financial markets, while "the real economy escaped more lightly."

1866

Classification: Exogenous (*X*)
Causes: Risk management *(R)*, Fraud (*F*)

Context

The crisis of 1866 has often been referred to as the "Overend Gurney Crisis". The refusal of the Bank of England to bail out that institution, which "rebutted the principle of 'too big to fail'", triggered a panic in the banking sector (Flandreau and Ugolini, 2014). While it is typically viewed as having occurred in 1866, subsequent research has shown that failures of a number of significant banks continued into 1867 (Turner, 2014, pp. 82-4). A total of 3.2 per cent of the UK banking population failed in 1866.

Narrative Evidence

Newspaper reporting at the time held the view that this crisis was limited to the newly-formed finance and banking companies and was the result of lax lending safeguards, speculation and fraudulent practices. In May, the most acute month of the panic, a number of articles appeared in *The Times* (05/12/1866), which fitted the perception that this crisis was confined to the banking sector and was unrelated to macroeconomic activity. Its suddenness was remarked upon as "nothing had happened since the day before to justify such a fear as was everywhere shown" and the panic was said to have "had no solid foundation." Deriding recent practices of lending long against increasingly shorter borrowing, it reported that "a particular course of unsound business has broken down, but the position of ordinary bankers and merchants remained unaffected." *The Observer* confirmed that the majority of the crowd in the city "composed of men who, judging from their levity or appearance, had not any interest at stake in the great panic" (05/13/1866). Suspicious of the rapidity of the formation of the finance companies and the lack of paid-up capital, *The Times* (05/07/1866) doubted the credibility of "the very magnitude of the dividends declared" complaining that "their doings [are] all in the dark" and blamed the depression in those company share prices upon "the liabilities with which they are saddled. People are afraid of 'calls'."

The cynicism from the press was supported by contemporary interviewees. In a committee which examined the flotation of the finance companies, a Chief Clerk of the Rolls

explained that "undoubtedly the facility for forming joint-stock companies has furnished the means of committing some of the frauds which have been committed", the extent of which was "very great." He continued that "companies are got up [established] simply to procure the promotion money" (P.P. 1867, p. 95, qq. 1483-5).

Classification

Due to the suddenness of the event and the suspicion amongst newspapers that "unsound business" was at play, we classify this crisis as exogenous (*X*), which resulted primarily from poor risk management (*R*) and fraudulent practices (*F*). Turner (2014, p. 80) describes the buildup to this crisis, citing a number of recent finance company flotations which had incorporated under limited liability following an Act of 1862, many of which had been of a "dubious nature". Such companies had been lending against low quality securities to limited liability companies at high interest rates. These companies were largely borrowing long term to construct railways throughout the UK. When the railway companies began experiencing difficulties, their finance companies suffered pressure, a number of whose shareholders had not subscribed their full allotment and began selling shares in panic. Following a share price fall of almost 50 per cent in 4 months, the largest company in difficulty, Overend, Gurney and Co. collapsed on 10 May 1866 with losses of £5 million. On the following day, "Black Friday", a "violent panic" descended on the money market and the Bank Act was suspended and this "psychological palliative" brought the panic to an abrupt end (Turner, 2014, p. 81).

Clapham (1958, p. 266) argued that the crisis was not based upon real or monetary phenomena. In summary, subsequent research and other contemporary reports support our conclusion that this event was not caused by macroeconomic activity.

1930

Classification: Endogenous (*N*)
Cause: Depression (*D*)

Context

The crisis of 1930 occurred during the early stages of the international downturn which subsequently became the Great Depression. While the interwar years of the British economy have received considerable attention from economists and economic historians, the perception prevails that while bank failures were synonymous with the depression in the US

(Friedman and Schwartz, 1963), the UK banking system did not suffer extensively (Crafts and Fearon, 2013, pp. 2, 20). Instead, the literature has tended to focus on other factors, such as the reduction in hours worked, the exchange rate, the failure of policy and the fall of the old staple industries (Lennard, 2018). However, our new data reveals that the banking system was considerably affected, with a failure rate of 2.4 per cent in 1930.

Narrative Evidence

The narrative evidence from the newspapers paints the bleak picture of economic conditions one would expect from "a period of prolonged industrial depression" (*The Times*, 02/28/1929). As early as New Year's Day in 1929, *The Times* was already reporting of "distress in the mining districts" and that 1928 had been an "exceedingly difficult one for the coal trade" (01/01/1929). These events *preceded* the rise in bank failures in our series.

Similar to the crisis of 1841, contemporaries recognized that falling prices were related to the downturn. Some criticized the US for a restrictive monetary policy, which led to "depressing the prices of goods by raising the price of gold" and foresaw that if "a moderate rise in the price of produce" was not forthcoming to sellers (exporters), then "the certainty of non-payments and bankruptcies" would materialize (*The Times*, 11/15/1929). Also like 1841, banks had debtors on their books selling in a market of falling prices. For instance, a London bank, J. Horstman & Co. Ltd., had failed as it had been making loan advances on "the security of merchandise on bills of exchange" until it transpired that the merchandise had been "over-valued" (*Derby Telegraph*, 12/02/1929). The record from one bankruptcy court, as early as January 1929, seemed to predict the difficulties banks would come to face during the following years. The failure of an iron processor who appeared there, "was due to the slump" and "the only debtor, the bank, suffered on account of the securities given by defendants" (*Buckingham Advertiser and Free Press*, 01/12/1929).

As international trade continued to decline through 1930, the shipping industry predictably suffered, leading one newspaper to suggest that the struggling "big firms which have been financed by the banks must be considered" (*Yorkshire Post and Leeds Intelligencer*, 04/24/1930). It suggested that the banks "bring pressure to bear upon their clients to cease unprofitable operations" in the hope that the shipyard owners may accept a sale "value not unreasonably higher than scrap value" for their properties upon which they had been "waging a losing fight for years". Consequently, it is implicit that the loans which the banks had originally granted would not be repaid. The larger banks which survived were reluctant to lend in the current economic climate as was stated at a dinner for the Institute of

Bankers: “banking after all, is very like the wireless broadcasting service – of little use unless there is an adequate ‘receiving apparatus’” (*Yorkshire Post and Leeds Intellegencer*, 02/08/1930).

Classification

Due to all of the above observations, we classify this crisis as endogenous (*N*), brought about by economic depression (*D*), which culminated in the failure of banks that had lent to particularly depressed industries. As already mentioned, though the bulk of subsequent research has tended to focus on the depressed macroeconomic conditions of the era, our analysis finds support in some subsequent studies. Bordo et al. (2003) and Bernanke and James (1991) identify a crisis in 1931, the latter citing an external drain, combined with rumors of threat to London merchant banks with heavy European (particularly Hungarian and German) links.

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The second part of the dissertation studies the macro origins of fluctuations using the narrative record to identify the causal effect of macroeconomic shocks. Chapter 3 examines how monetary policy affected the economy during the classical gold standard. Chapter 4 analyses the impact of economic policy uncertainty in the interwar period. Chapter 5 measures the macroeconomic effects of banking crises between 1750 and 1938.

Tryckt av Media-Tryck, Lund 2018 Svanenmärkt trycksak, 3041 0903

Department of Economic History
School of Economics and Management

Lund Studies in Economic History 87
ISBN 978-91-87793-46-2
ISSN 1400-4860