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A Millennium of UK Business Cycles: insights from a
structural VAR analysis

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Non-technical Summary

Understanding business cycles is essential for interpreting economic fluctuations and designing effective policies. Nevertheless, most studies focus on relatively recent periods. This paper takes a much longer perspective, examining more than seven centuries of economic history in the United Kingdom, from 1271 to 2022. By combining historical data with modern statistical methods, it investigates how the forces driving economic expansions and recessions have evolved over time.

The results reveal a striking transformation in the nature of business cycles. Before 1900, fluctuations were largely driven by supply-side disturbances, including climate shocks, epidemics, demographic changes, and wars. In contrast, modern business cycles are predominantly driven by demand-side forces, such as changes in spending, credit conditions, and macroeconomic policies, which tend to move output and inflation in the same direction.

The paper also documents a long-run decline in macroeconomic volatility. Economic fluctuations were substantially larger in earlier centuries but gradually became more moderate as economies developed and institutions strengthened. This pattern points to a centuries-long Great Moderation, suggesting that even major modern disruptions, such as the COVID-19 pandemic, appear less exceptional when viewed against the backdrop of seven centuries of economic history.

More broadly, the findings show that business cycle dynamics are not constant through time but depend on the prevailing institutional and monetary environment. As economies increasingly face challenges related to climate change, energy transitions, demographic shifts, and migration, historical evidence on how earlier societies absorbed large supply-side shocks can provide useful insights for understanding future macroeconomic developments.

Sumário Não Técnico

Compreender os ciclos econômicos é fundamental para interpretar as oscilações da atividade econômica e formular políticas eficazes. Contudo, a maior parte dos estudos concentra-se em período relativamente mais recente. Este artigo adota uma perspectiva mais longa, analisando mais de sete séculos da história econômica do Reino Unido, de 1271 a 2022. Combinando dados históricos e métodos estatísticos modernos, investiga-se como as forças que impulsionam expansões e recessões evoluíram ao longo do tempo.

Os resultados revelam uma transformação marcante na natureza dos ciclos econômicos. Antes de 1900, as flutuações eram predominantemente determinadas por choques de oferta, associados a eventos como mudanças climáticas, epidemias, alterações demográficas e guerras. Em contraste, os ciclos econômicos modernos são impulsionados principalmente por fatores de demanda, como variações nos gastos, nas condições de crédito e nas políticas macroeconômicas, fazendo com que atividade econômica e inflação passem a se mover de forma mais sincronizada.

O artigo também documenta uma redução gradual da volatilidade macroeconômica ao longo dos séculos. As oscilações da produção e dos preços eram muito maiores no passado e se tornaram mais moderadas à medida que as economias se desenvolveram e as instituições ganharam robustez. Esse resultado é consistente com uma “Grande Moderação” observada em uma escala de vários séculos e sugere que até mesmo eventos recentes, como a pandemia de COVID-19, parecem menos excepcionais quando analisados em uma perspectiva histórica de longo prazo.

De forma mais ampla, os resultados mostram que a dinâmica dos ciclos econômicos não é invariável, mas depende do ambiente institucional e monetário de cada época. Em um contexto marcado por desafios relacionados às mudanças climáticas, à energia, à demografia e à migração, a experiência histórica pode oferecer referências valiosas para compreender como grandes choques de oferta podem afetar o crescimento, a inflação e a estabilidade macroeconômica no futuro.

A Millennium of UK Business Cycles: insights from a structural VAR analysis*

Leonardo N. Ferreira [†] Haroon Mumtaz [‡] Gabor Pinter [§]

August 17, 2026

Abstract

We study macroeconomic fluctuations in the United Kingdom over seven centuries (1271–2022) using a time-varying structural VAR with stochastic volatility. Business-cycle shocks are identified as the innovations maximising short-run output variance. Before 1900, these shocks display a stagflationary, supply-driven pattern consistent with wars, famines, and climate disruptions; post-1900 shocks become demand-driven, raising both output and inflation. Monetisation had large real effects in the sixteenth and seventeenth centuries, becoming increasingly inflationary thereafter. Output and inflation volatilities decline markedly over the full sample, suggesting a centuries-long Great Moderation. Overall, our results highlight how business cycle dynamics evolve with institutional, monetary, and structural transformations.

Keywords: Long-run data; Business Cycle shock; time-varying VAR.

JEL Codes: C32; E32; E43; N10.

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1 Introduction

Macroeconomic fluctuations have been a persistent feature of human economic history. Yet, modern empirical business cycle research typically restricts attention to the post-World War II era, often due to data availability and methodological convenience. As a result, our understanding of macroeconomic dynamics is largely derived from a relatively short and historically exceptional period.

In this paper, we take a long-run perspective and study the evolution of macroeconomic fluctuations in the United Kingdom over more than seven centuries, from 1271 to 2022. By combining historical macroeconomic data on output, inflation, and money with a structural time-varying vector autoregression (TVP-VAR) framework that accounts for measurement error in long-run macroeconomic series, we provide novel evidence on the changing nature of business cycles.

The long time span allows us to investigate a fundamental question: have the sources and propagation mechanisms of business cycles changed over time? Drawing inspiration from recent work by [Angeletos et al. \(2020\)](#), we identify the main business cycle shock in each year as the innovation that explains the largest share of short-term GDP growth variance. This agnostic approach avoids imposing modern structural interpretations on earlier eras. We estimate a time-varying VAR with stochastic volatility and fat-tailed shocks, enabling us to capture drifting macroeconomic regimes, levels of uncertainty, and non-Gaussian features that characterise pre-modern economies. Our analysis yields five main results.

First, our findings reveal a striking historical transformation in the nature of business cycle shocks. Prior to 1900, macroeconomic fluctuations were dominated by supply-side disturbances, with negative shocks reducing output per capita and raising prices – a stagflationary pattern consistent with historical famines, wars, and climate events. In contrast, from the early twentieth century onward, business cycle shocks take on a demand-driven character, producing positive co-movement between output and inflation. This regime shift coincides with the rise of fiat money, modern central banking, and active fiscal-monetary stabilization policies ([Reinhart and Rogoff, 2008, 2013](#)).

This central finding is robust to three complementary strategies that address measurement uncertainty in long-run UK data: Student- t innovations that downweight outlier observations; a real activity factor extracted via Principal Component Analysis (PCA) from five separate indicators that reduces dependence on any single measure of activity; and a dynamic factor model that explicitly accommodates measurement error across a twelve-variable panel. All three confirm the supply-to-demand transition.

Second, our results reveal a long-run decline in output and inflation volatilities. Even the turbulent business cycles of the twentieth century show smaller output fluctuations than in previous centuries, except for post-World War I recession and the temporary spike during COVID-19. Overall, this pattern suggests a centuries-long Great “Moderation” (Kim and Nelson, 1999; McConnell and Perez-Quiros, 2000; Primiceri, 2005), as economic development and stabilising institutions gradually reduced the amplitude of business cycle fluctuations.

Third, during the sixteenth and seventeenth centuries, money supply variation had substantial real effects, consistent with historical accounts that monetisation facilitated market transactions and economic expansion (Palma, 2018a,b, 2022). However, while money variation explained a significant share of business cycle fluctuations in earlier centuries, its influence became increasingly inflationary from the eighteenth century onward, consistent with a transition towards demand-dominated cycles.

Fourth, our sign-restricted VAR results for the post-1700 period show that aggregate demand disturbances capture the effects of both pure demand shocks and money supply shocks. While pure demand shocks account for a slightly larger share of output and price variation, money supply shocks also play a significant role, particularly in explaining fluctuations in money itself. Fifth, we find that the shift toward inflationary business cycle shocks is more closely linked to the expansion of base money than to financial deepening per se. While the M4/M0 ratio – our proxy for financial development – rises sharply after 1970, the demand-type characteristics of business cycle shocks had already emerged during the late nineteenth century.

By tracing the evolution of British business cycles from the medieval period to the present, our paper highlights the importance of long-run historical data for macroeconomic analysis.

We demonstrate that business cycle dynamics are not stable or universal, but instead reflect the institutional, monetary, and structural environment in which they unfold. These insights are particularly relevant for interpreting recent macroeconomic shocks – such as COVID-19 and inflation surges – within a broader historical context. This long-run perspective suggests that the demand-driven dynamics of the post-war era may constitute a historically exceptional configuration rather than a permanent feature of market economies.

Related Literature This paper primarily contributes to the literature that seeks the drivers of business cycles. Empirical studies of modern business cycles argue that business cycles are primarily driven by demand shocks, thereby challenging the more traditional view from Real Business Cycle (RBC) models ([Kydland and Prescott, 1982](#)). The finding emerges both from VAR-type models ([Shapiro and Watson, 1988](#); [Blanchard and Quah, 1989](#); [Gali, 1999](#)) as well as from more structural models ([Smets and Wouters, 2007](#); [Christiano et al., 2014](#)). More recently, the findings of [Angeletos et al. \(2020\)](#) support the existence of a main business-cycle driver which fits the notion of an aggregate demand shock. Our work extends this analysis to multiple centuries, showing how the main business-cycle shock has changed from supply-like to demand-like around 1850-1900.

Our analysis of a nearly millennium long dataset for the UK is inspired by several recent papers. [Schmelzing \(2020\)](#) documents eight centuries of global real interest rates; [Nason and Smith \(2023\)](#) study UK inflation dynamics since the thirteenth century in a univariate framework; [Broadberry and Lennard \(2024\)](#) document the emergence of modern business-cycle asymmetry over six centuries of European data; [Rogoff et al. \(2024\)](#) focus on long-run real rate trends; and [Bouscasse et al. \(2025\)](#) provide new estimates of pre-industrial productivity growth. What distinguishes our work is the joint modelling of price and quantity variables, which is essential for distinguishing between supply- and demand-type shocks in the spirit of modern structural macroeconomic models.

2 Data

Our dataset is annual, spanning the period from 1271 to 2022.¹ Our source is "A millennium of macroeconomic data", compiled by [Thomas and Dimsdale \(2018\)](#), and the harmonised GDP data per capita, constructed by [Broadberry et al. \(2026\)](#). "A millennium of macroeconomic data" contains a broad set of macroeconomic and financial data for the UK, in some cases, from 1086 to 2016. The harmonised data from [Broadberry et al. \(2026\)](#) is better suited to business cycles analysis as it deals with the excessive volatility derived from the use of different sources for the medieval, early modern and modern periods. We select the three variables that best characterise the macroeconomic dynamics throughout the centuries and update them up to 2022. These are GDP per capita, CPI, and money (M0) per capita.

3 Empirical Model

We use a time-varying VAR with stochastic volatility and fat tails to model the dynamics of these variables:

$$Y_t = c_t + \sum_{j=1}^L b_{j,t} Y_{t-j} + \Sigma_t^{1/2} e_t, \quad e \sim N(0, 1), \quad (1)$$

where $Y_t = \{\Delta y_t, \Delta p_t, \Delta m_t\}$ and $L = 2$ represents the lag length. Following [Cogley and Sargent \(2005\)](#) and [Primiceri \(2005\)](#), the coefficients are time-varying with $\Phi_t = \Phi_{t-1} + Q_\Phi^{1/2} \eta_t$, where $\Phi_t = \text{vec}([c_t, b_{j,t}])$ represents the time-varying coefficients stacked in one vector and η_t is a conformable vector of innovations. As in [Primiceri \(2005\)](#), the covariance matrix of the innovations v_t is factored, $\Sigma_t = A_t^{-1} H_t A_t^{-1'}$, where the non-zero and non-one elements of A_t follow a random walk, $\alpha_{ij,t} = \alpha_{ij,t-1} + Q_A^{1/2} v_t$. As we also model fat tails, H_t is a diagonal matrix with elements $\sigma_{i,t}^2 \frac{1}{\lambda_{i,t}}$ for $i = 1, 2, 3$. Here, $\ln \sigma_t^2 = \ln \sigma_{t-1}^2 + g^{1/2} z_t$ and $\lambda_{i,t}$ are weights that lead to a scale mixture of normals such that the orthogonalised residuals $A_t u_t \sim T(0, \sigma_{i,t}, v_{\lambda,i})$. As shown by [Geweke \(1993\)](#) this scale mixture can be obtained if one assumes that $p(\lambda_i) = \prod_{i=1}^T \Gamma(1, v_{\lambda,i})$.

Modelling fat tails is particularly important in our context, as it provides robustness against

¹As described in the appendix, we use the first 50 observations as training sample.

extreme observations that may arise from measurement error or archival uncertainty in pre-modern macroeconomic data. Rather than treating these outliers as structural shifts, the t-distribution allows the model to downweight their influence without distorting the underlying signal.²

3.1 Identification

Building on Uhlig (2004), Barsky and Sims (2011), Kurmann and Otrok (2013), Kurmann and Sims (2021), and Chahrour et al. (2023), we identify the business cycle shock as the VAR innovation that makes the largest contribution to the forecast error variance (FEV) of Δy_t at horizon 1. Angeletos et al. (2020) show this is analogous to identifying, in the frequency domain, the shock that dominates the business-cycle frequencies (1.5-8 years).

We decompose Σ_t such that $\Omega_t \Omega_t' = \Sigma_t$ where Ω_t represents a contemporaneous impact matrix. Ω_t can be written as $\Omega_t = \tilde{\Omega}_t Q$ where Q is an orthonormal matrix that rotates $\tilde{\Omega}_t$, the Cholesky decomposition of Σ_t . The structural moving average representation of the VAR model is then given by:

$$Y_t = B_t(L) \Omega_t \varepsilon_t, \quad (2)$$

where ε_t denotes the orthogonal shocks.

The k-period-ahead forecast error of the i th variable is defined as

$$Y_{it+k} - \hat{Y}_{it+k} = e_i \left[\sum_{j=0}^{k-1} B_{t,j} \tilde{\Omega}_t Q \varepsilon_{t+k-j} \right], \quad (3)$$

where e_i is a selection vector that picks out the i th variable in the set of variables. The proposed identification scheme thus amounts to finding the column of Q that solves the following maximization problem:

$$\arg \max_{Q_1} e_1' \left[\sum_{k=0}^K \sum_{j=0}^{k-1} B_{t,j} \tilde{\Omega}_t Q_1 Q_1' \tilde{\Omega}_t' B_{t,j}' \right] e_1, \quad (4)$$

²This feature is also valuable for handling modern data outliers, such as those arising during the Covid-19 pandemic.

such that $Q_1'Q_1 = 1$, where Q_1 is the column of Q that corresponds to the shock that explains the largest proportion of the FEV of the first variable in the VAR: Δy_t .

4 Results

The dynamic effects of business cycle shocks over time are vividly illustrated in Figure 1, which presents the impulse response functions (IRFs) and forecast error variance decompositions (FEVDs) associated with these shocks. Figure 1a shows the IRFs cumulated over the 5-year horizon corresponding to a business cycle shock normalised to a unit standard deviation; Figure 1b reports the corresponding forecast error variance decompositions. Figure 2 shows the time-varying volatility of each variable (solid black lines) alongside the volatility attributable to the identified business-cycle shock (dashed blue lines).

Supply Shocks as Drivers of Pre-Modern Business Cycles In earlier centuries, business cycle shocks exhibit a classic supply-side pattern, where output rises while inflation declines (Figure 1a). This pattern aligns with the frequent occurrence of wars and famines during this period.³ While extreme events such as the Black Death (1348–50) resulted in a larger contraction in population than in output – thereby increasing output per capita – our estimates indicate that typical supply-side shocks during this era tended to reduce output per capita while driving up prices. Prior to 1500, agricultural production, particularly arable farming, was highly volatile due to weather-related shocks, while industrial production and commercial or monetary factors contributed minimally to growth dynamics (Broadberry et al., 2012).

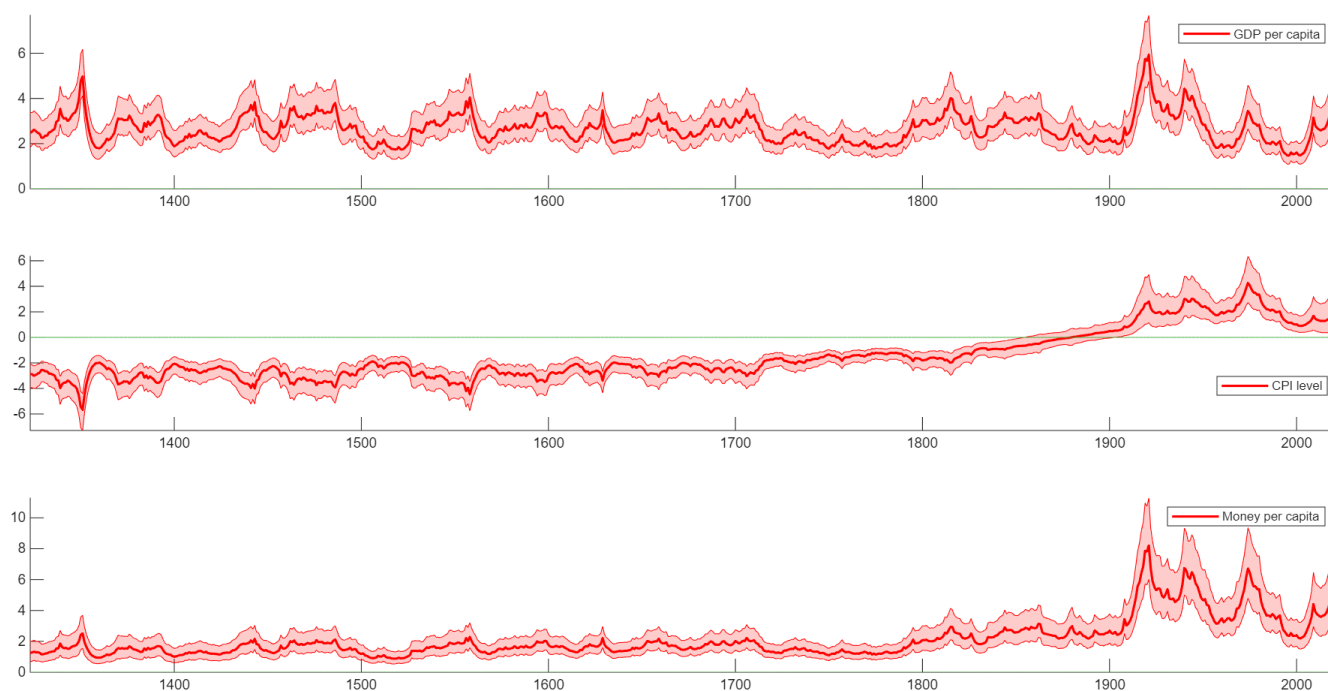
Money and Inflation The behaviour of money and inflation offers valuable insights into the historical relationship between monetary drivers of inflation – or the lack thereof – in earlier centuries. The negative conditional comovement between money and inflation growth suggests that money supply shocks, as posited by the quantity theory of money (Friedman, 1956), are unlikely to be the primary drivers of the identified business cycle shocks. To contextualise this

³Appendix Figure E.1 highlights significant realisations of the business cycle shocks associated with well-documented historical events characterized by supply-side dynamics.

Figure 1: The effects of business cycle shocks over centuries

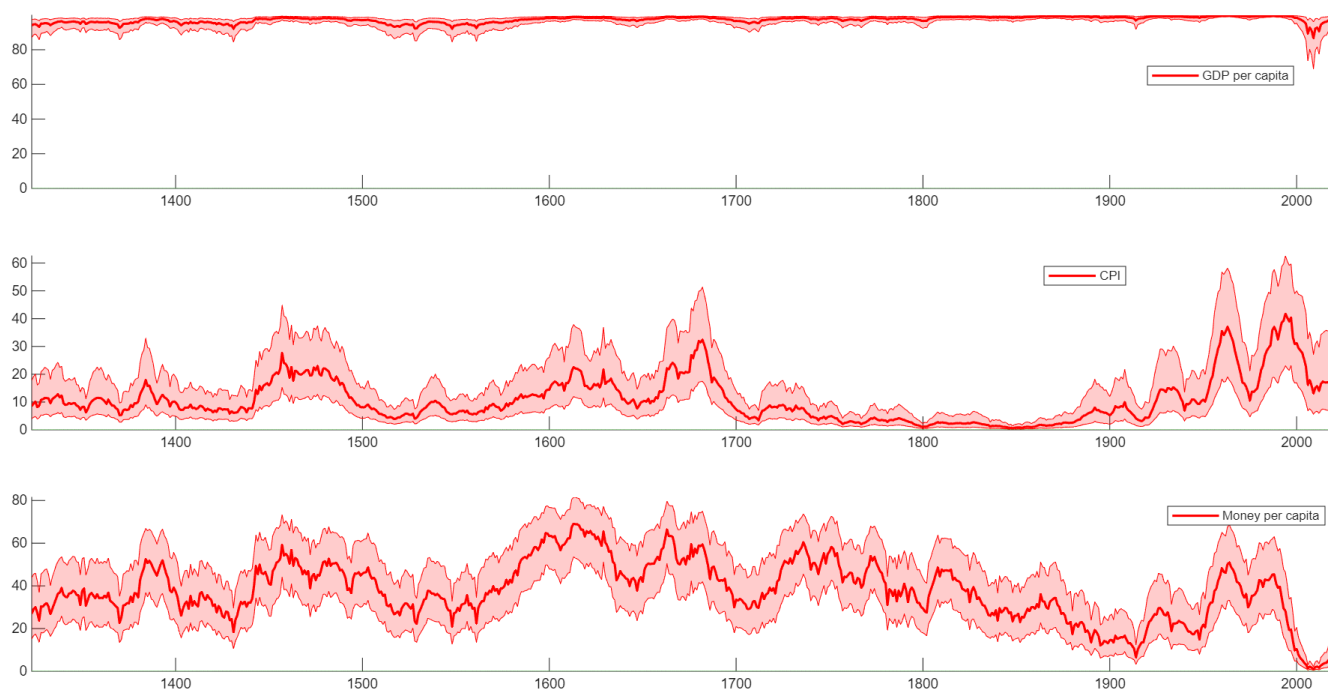
(a) Impulse response functions

Response to a BC shock at 5 year horizon



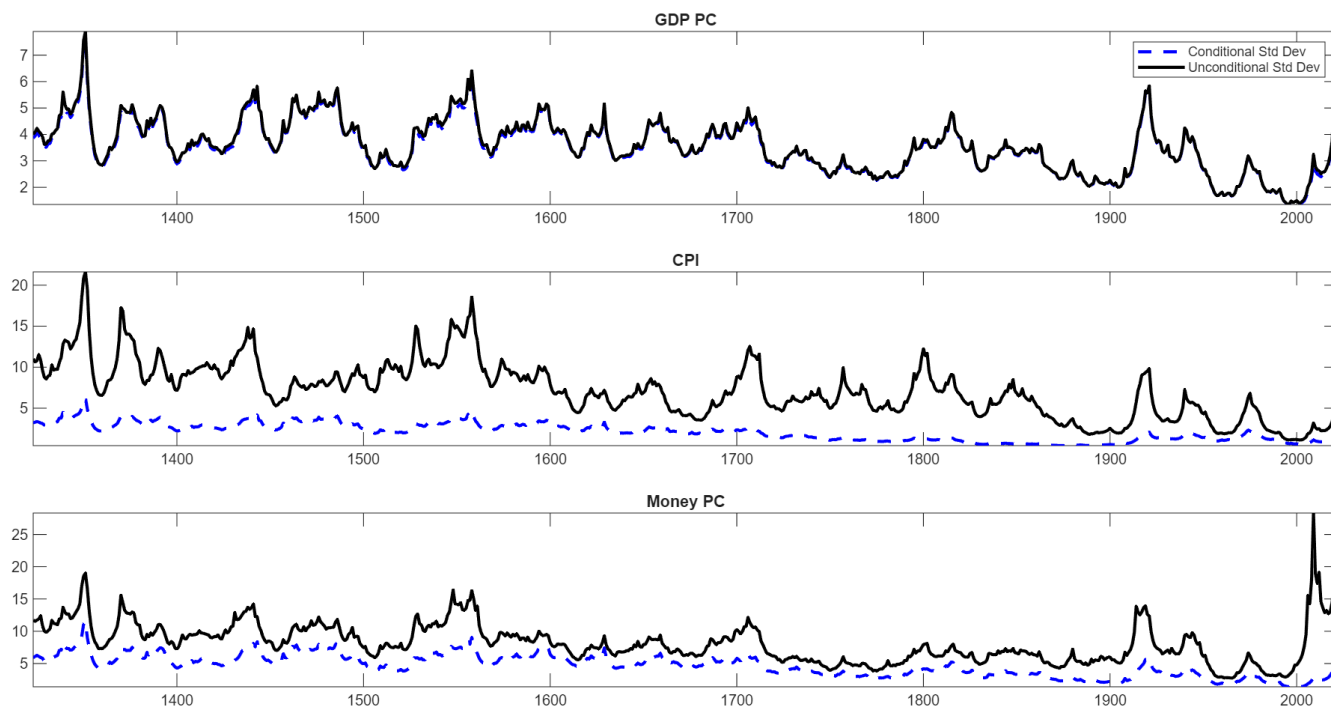
(b) Forecast error variance decomposition

Contribution of BC shock at 5 year horizon



Notes: The pink shaded areas represent the 68 percent credible sets and the red lines depict the medians.

Figure 2: Conditional Volatility



Notes: The dashed blue lines are the estimates of the time-varying volatilities of each variable conditional on the business cycle shock as in [Galí and Gambetti \(2009\)](#). The solid black lines are the estimates of the unconditional volatilities of each of these variables.

finding, historians have long debated whether the inflow of precious metals from the Americas fuelled the elevated inflation levels of the 16th century ([Hamilton, 1934](#)) or whether inflationary pressures were instead driven by real factors, such as demographic and resource constraints ([Ramsey \(1971\)](#)).⁴

Our empirical results do not definitively corroborate or refute either hypothesis, as the forecast error variance in inflation (middle panel of Figure 1b) attributed to business cycle shocks remains limited during most of the 16th century, when the price surge occurred.⁵ Specifically, business cycle shocks explain, at most, around 15% of the forecast error variance in inflation during the 16th century and approximately 30% during the 17th century. However, the variance in inflation that can be attributed to business cycle shocks appears inconsistent with channels related to the quantity theory of money, given the negative comovement between inflation and money growth induced by these shocks during this period.

⁴See [McCloskey \(1972\)](#) for a review of the debate.

⁵The price revolution quadrupled the levels of the three sectoral price series between the 1520s and 1620s. See Figure 5.01 of [Broadberry et al. \(2015\)](#).

The Real Effects of Monetisation in the 16th and 17th Centuries Despite the limited ability of the business cycle shock to explain inflation variation, it accounts for an elevated share of the variation in money throughout the pre-modern sample. As shown in Figure 1b, the forecast error variance of money attributed to the business cycle shock fluctuates broadly between 20% and 60% across the centuries, with a relative peak during the 16th and 17th centuries. This significant increase in the conditional comovement between the business cycle and money aligns with the earlier inflow of precious metals into the macroeconomy, lending empirical support to the argument that “monetisation greased the wheels of economic activity” (Abad and Palma, 2021). Empirical evidence also highlights the role of increased money supply in stimulating economic growth (Palma, 2018b).⁶ A proposed mechanism is that the greater availability of money enhanced market participation and facilitated tax collection (Palma, 2018a).⁷ Increased market participation, in turn, encouraged individuals to work additional days and hours, thereby expanding the labour supply – a phenomenon described as “an industrious revolution” (de Vries, 2008). Our findings provide empirical support for these arguments, particularly in demonstrating the unprecedentedly large real effects associated with money variation during the 17th century (Figure 1b).

During the period 1700-1900, macroeconomic volatility fell (Figure 2) and the business cycle shock has a falling explanatory power for money relative to its 16th-17th century peak, suggesting that the real effects of monetisation were gradually fading, and the shock takes on an increasingly inflationary effect during this period (middle panel of Figure 1a). The latter finding suggests an increasingly demand-like characteristic of the business cycle shock, which coincides with the development of the consumer society in Great Britain which was accelerated by the Industrial Revolution (1760–1840). By the Victorian era (1837–1901), consumer culture was firmly established, with growing emphasis on shopping as a social activity and the acquisition of goods as a marker of identity and status (Perkin, 1969).

⁶Endogenous growth models (Romer, 1990; Aghion and Howitt, 1992) extended with monetary features (Aghion et al., 2012; Chu and Cozzi, 2014; Anzoategui et al., 2016; Gil and Iglesias, 2020) provide a theoretical rationale.

⁷Search-based theories of money (e.g. Shi, 1997) could possibly rationalise why increased money growth can increase agents’ probability of having a successful match.

Demand Shocks as Drivers of Modern Business Cycles After 1900, the explanatory power of the business cycle shock for inflation rises markedly, consistent with an environment in which inflation becomes more responsive to aggregate demand conditions.⁸ The timing of UK monetary regimes is informative. The supply-to-demand transition (~1850–1900) unfolds entirely within the classical gold standard (1821–1914).⁹ The gradual nature of the shift, and its placement within a single, unchanging metallic regime, rule out the abandonment of gold as its trigger. Instead, according to [Thomas et al. \(2010\)](#), the transition is driven by deeper structural changes, such as: the rise of industrial and investment-driven business cycles, changes in fiscal policy, and growing integration into world trade.

The monetary regime nonetheless shaped the amplitude of the demand-shock signature once it emerged. The transition to modern monetary and fiscal frameworks granted governments greater flexibility to manage aggregate demand through monetary and fiscal policies, leading to inflation dynamics that were increasingly tied to economic cycles. In particular, the two world wars represent the clearest cases of money-financed fiscal expansion in our sample. UK national debt rose from 41% of GDP in 1914 to 185% in 1923, and from 153% in 1939 to 259% in 1946 ([Thomas and Dimsdale, 2018](#)). In both episodes, the Bank of England suspended or constrained convertibility (1914–25, 1931 onwards) and accommodated Treasury financing through a sharp expansion of M0 ([Thomas et al. \(2010\)](#), Chart 16).¹⁰

After World War II, frameworks continued to evolve and to make inflation more sensitive to aggregate demand shocks. This evolution is consistent with historical evidence highlighting

⁸Our main BC shock differs from [Angeletos et al. \(2020\)](#)'s in that it is inflationary. Beyond cross-country differences, this likely reflects our post-1900 UK sample, which includes the money-financed fiscal expansions of the World War I and World War II ([Capie and Webber, 1985](#); [Thomas et al., 2010](#), Charts 8 and 16) as well as the 1970s Great Inflation, which occurred under a “lack of a credible monetary policy framework” ([Thomas et al., 2010](#), pp. 285, 288). Our three-variable specification also differs from [Angeletos et al. \(2020\)](#)'s larger information set. However, this pattern is not specific to the small VAR. The dynamic factor model, which expands the information set to 12 variables, also finds the same supply-to-demand transition.

⁹The UK gold-standard chronology spans the modern part of our sample. Sterling moved onto a de facto gold standard in 1717 when Newton, as Master of the Mint, set the silver-to-gold ratio at a level that effectively drove silver out of circulation ([Officer, 2007](#)). Convertibility was suspended during the Napoleonic Wars (Restriction Period, 1797–1821). Gold was established as the sole monetary standard in 1816 and full convertibility resumed in 1821, inaugurating the classical gold standard (1821–1914). Convertibility was suspended in August 1914 amid the outbreak of World War I, restored at the pre-war parity in April 1925 ([Moggridge, 1972](#)), and finally abandoned in September 1931 ([Eichengreen, 1992](#)).

¹⁰Due to the short availability, a fiscal series will be included only in the DFM, which accommodates for an unbalanced panel. Results are unchanged.

the prevalence of inflation crises in the 20th century, driven by fiscal and monetary expansions aimed at stabilising growth and employment ([Reinhart and Rogoff, 2008](#)), and with recent work emphasising the importance of demand-type shocks in driving modern business cycles ([Smets and Wouters, 2007](#); [Christiano et al., 2014](#); [Bini et al., 2024](#)).¹¹ Our long-run results show that demand shocks emerged as the dominant drivers of business cycle fluctuations only in the twentieth century, a transition that begins under the gold standard and is consolidated by the fiscal and monetary frameworks that followed.

Money Growth and Financial Development in the 20th Century The 20th century witnessed a profound transformation in the relationship between money and macroeconomic dynamics. Figures [3a](#) and [3b](#) illustrate this changing relationship, highlighting the rapid expansion of both narrow money (M0) and broad money (M4) starting in the early twentieth century. This expansion coincides with the emergence of inflationary business cycle shocks, as shown by the blue solid line in Figures [3a](#). This pattern points to a structural break in the monetary regime and suggests that monetary expansion – whether driven by loose monetary policy or endogenous money demand – has increasingly shaped the inflation-output nexus since 1900 ([Reinhart and Rogoff, 2013](#)).

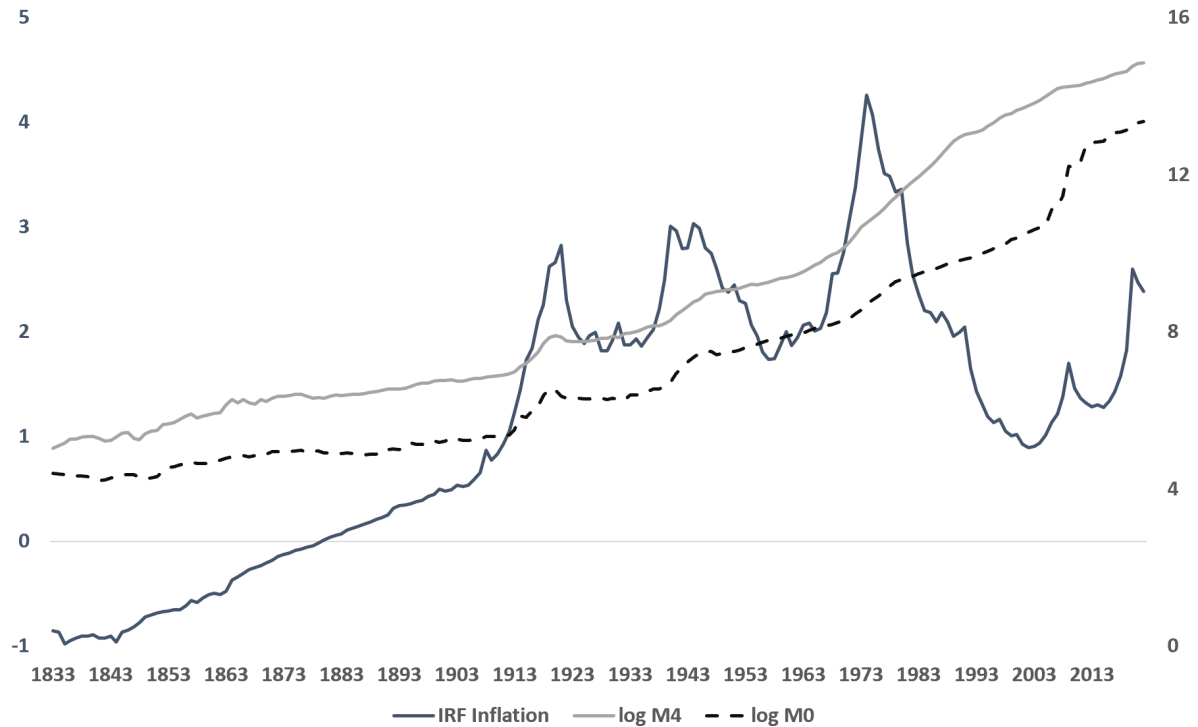
To differentiate between monetary looseness and broader financial deepening, we use the M4/M0 ratio as a proxy for financial development. As illustrated in Figure [3b](#), this ratio shows a steady increase after 1850, with a sharp acceleration post-1970. Interestingly, during this period, the business cycle shock becomes less inflationary, accompanied by a decline in inflation volatility. This observation suggests that the expansion of the financial sector is not the primary driver of inflationary pressure. Instead, the inflationary effects of the business cycle shock in the twentieth century appear to be more closely tied to the growth of base money (M0) rather than to financial development itself.

To summarise, while the significant divergence between M0 and M4 occurred more

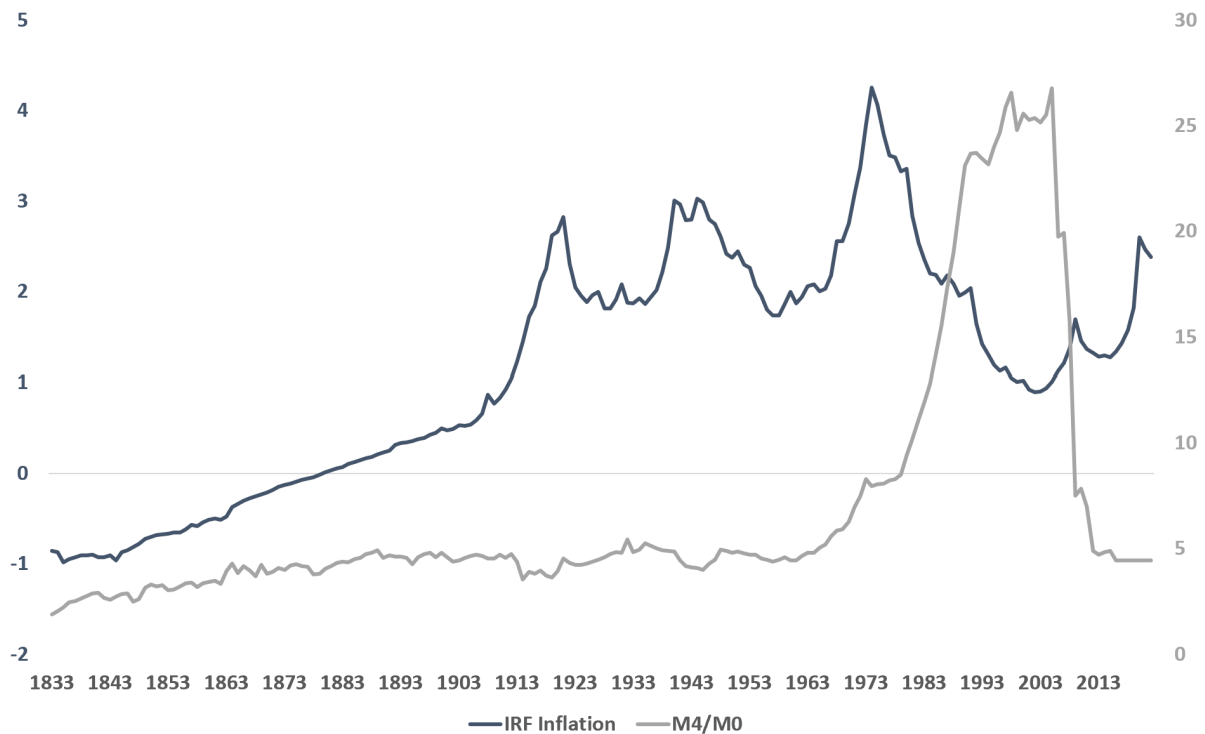
¹¹In particular, Bini et al. (2024), studying a century of U.S. data in a multivariate framework with minimal restrictions, similarly conclude that the common cycle is “generated by a combination of disturbances whose aggregate effects match what would be generally labeled as a ‘demand’ cycle”. Their finding provides cross-country support for the demand-driven character of post-1900 business cycles that we identify, and their sample begins precisely at the regime break we date in the UK data.

Figure 3: Inflationary effects and monetary developments

(a) Inflationary effects and money growth



(b) Inflationary effects and credit growth



Notes: The blue lines depict the the median IRFs of inflation cumulated over the 5-year horizon and the other lines represent the evolution of two measures of money (M4 and M0) as well as their ratio.

recently, the M4/M0 ratio rose from 1.9 in 1833 to 4.8 by 1900 – a period during which the inflation response shifted from negative to positive. This suggests that the expansion of the money supply, rather than financial development, is the more likely driver of the inflationary nature of business cycle shocks in the twentieth century. Although monetary expansion may result from loose monetary policy, shifts in aggregate demand could also stimulate money growth through changes in money demand. To disentangle these effects, we employ a four-variable VAR model with interest rates and sign restrictions, as discussed in the next section.

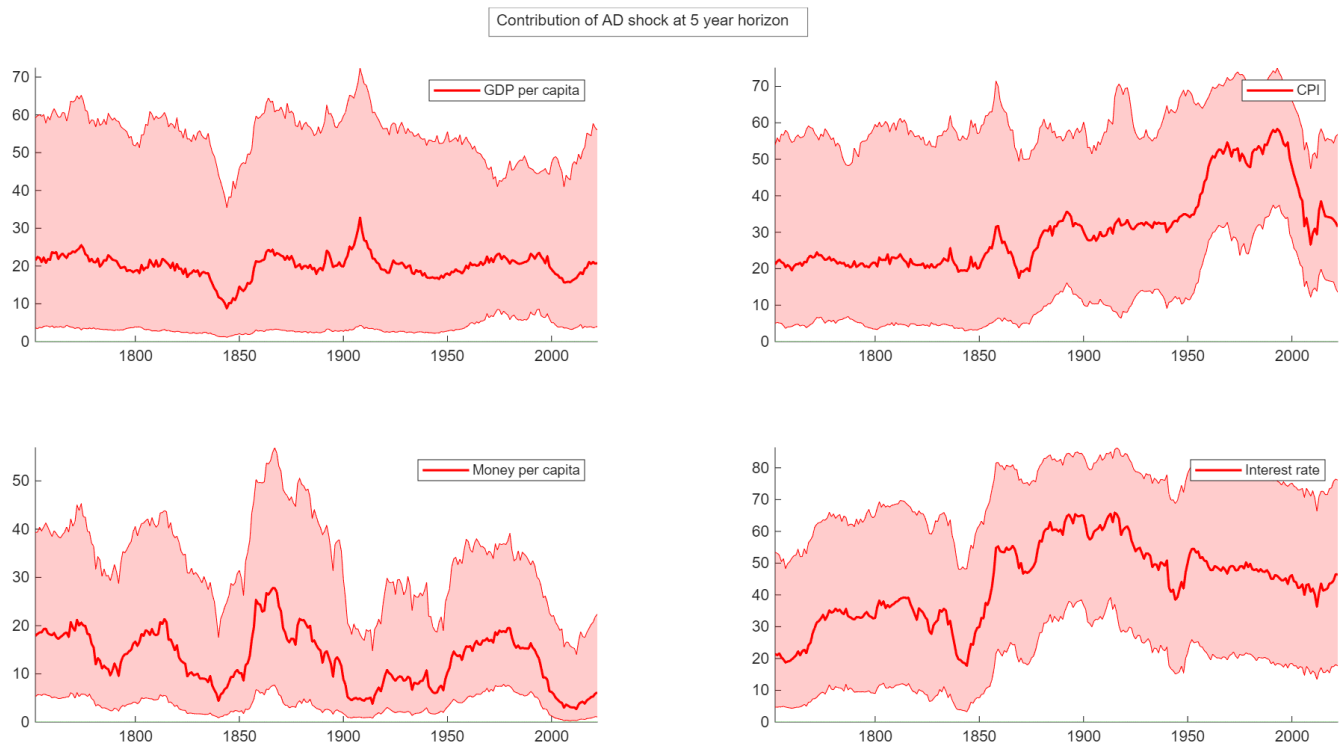
Decomposing Aggregate Demand Shocks To separate monetary supply shocks from ‘pure’ aggregate demand shocks (e.g., shifts in household preferences as described in [Smets and Wouters \(2007\)](#)), we estimate a four-variable VAR that incorporates the nominal interest rate into our baseline empirical model. While the inclusion of the nominal interest rate limits the analysis to the post-1700 period, this extension provides valuable insights.¹² Figure 4 presents the forecast error variance decompositions for the four variables in the VAR with sign restrictions.

Despite the wide probability bands, both shocks appear to significantly influence business cycle fluctuations in modern times. The median estimates indicate that pure aggregate demand shocks account for a larger share (20–30%) of output variation compared to money supply shocks (approximately 10–20%). Similarly, pure demand shocks play a more prominent role in explaining price level variation than money supply shocks. In contrast, money supply shocks explain nearly 60% of the variation in money, aligning with the emergence of modern monetary policy. Notably, the real effects of money variation appear more subdued in modern times compared to the pronounced impacts observed in the 17th century, as discussed earlier.

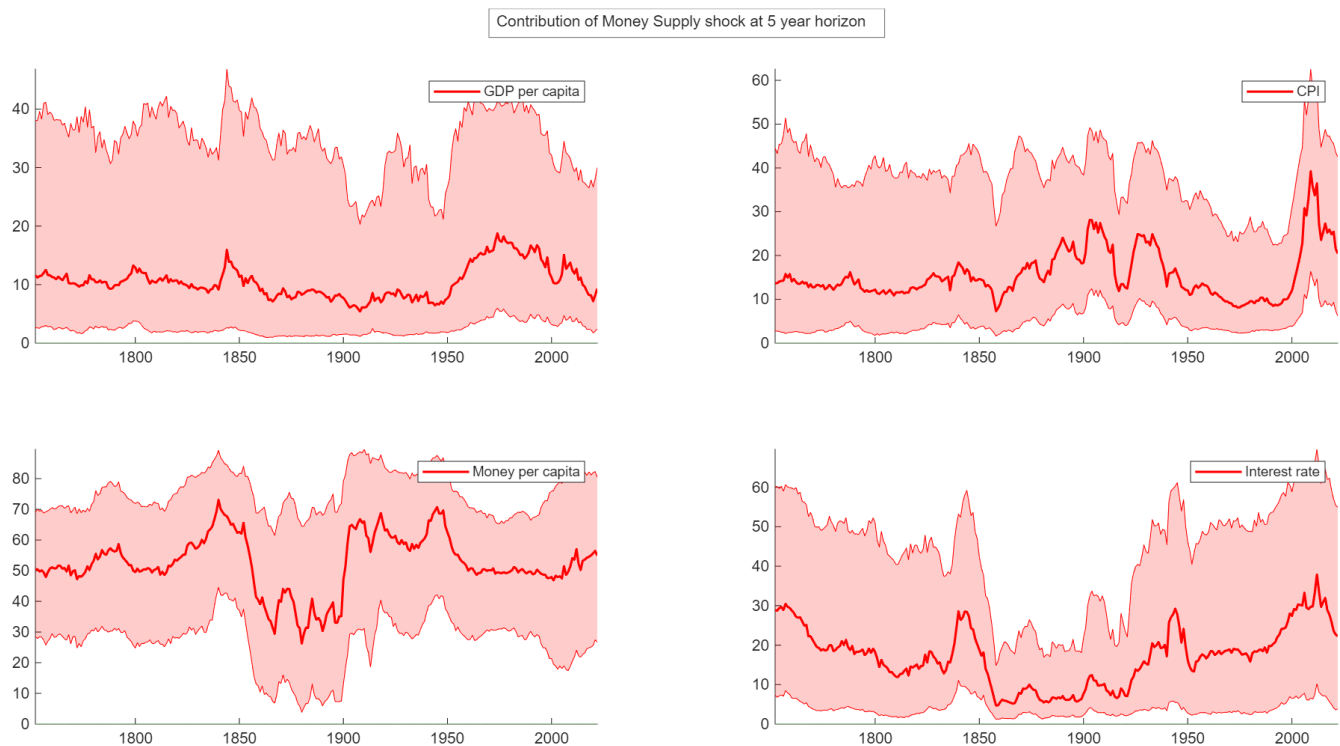
¹²[Schmelzing \(2020\)](#)’s long term nominal interest rate is available since 1311, but it does not exhibit much variation in the first centuries of the sample.

Figure 4: Decomposing aggregate demand: forecast error variance decomposition

(a) Pure aggregate demand shocks



(b) Money supply shocks



Notes: The pink shaded areas represent the 68 percent credible sets and the red lines depict the medians.

5 Robustness and Extensions

5.1 Alternative Ways of Addressing Measurement Error in Long-Run Data

A central challenge in long-run macroeconomic analysis is that the underlying data are themselves the product of historical reconstruction rather than direct measurement. UK GDP estimates for the pre-modern period combine sectoral output indicators, expenditure proxies, and interpolation between sparse benchmark observations [Broadberry et al. \(2015\)](#). The harmonised series of [Broadberry et al. \(2026\)](#) adjusts for the sub-period heterogeneity in source quality that distorted earlier estimates, but residual measurement uncertainty is unavoidable. The Student- t innovations in our baseline already downweight outlier observations of the kind that pure measurement error would produce. In this section we employ alternative approaches, showing that our central finding – a supply-to-demand transition between 1850 and 1900 – is robust to two complementary strategies that explicitly attack the measurement problem: replacing single noisy series with a common factor, and modelling measurement error directly through a dynamic factor model.

A PCA-Based Real-Activity Factor in the VAR To reduce dependence on any single measure of real activity, we construct a real-activity factor as the first principal component of five historical series: GDP per capita, aggregate GDP, real earnings, real exports, and average weekly hours worked ([Thomas et al., 2010](#); [Broadberry et al., 2026](#)). The resulting factor summarises common short-run variation in real activity that is robust to idiosyncratic noise or revision in any single indicator. We then re-estimate the baseline three-variable TVP-VAR with this factor replacing GDP per capita as the first variable.

Figure 5 reports the impulse responses. The pattern is qualitatively unchanged from Figure 1a: the main business cycle shock response of CPI is negative throughout the pre-1900 sample and turns positive between 1850 and 1900; the money response builds gradually before accelerating after 1900. The supply-to-demand transition is therefore not an artefact of GDP measurement: it emerges equally from a factor that loads on five different real indicators.

Figure 5: The effects of business cycle shocks using a real activity factor



Notes: The pink shaded areas represent the 68 percent credible sets and the red lines depict the medians.

A Dynamic Factor Model with Measurement Error Our second strategy is to expand the information set and explicitly model measurement error. We estimate a time-varying dynamic factor model on a twelve-variable panel.¹³ Importantly, since our DFM accommodates an unbalanced panel, we can include important variables, such as public sector net lending and [Schmelzing \(2020\)](#)'s measure of long-term real interest rate. The public sector net lending series enables us to capture since 1689 a relevant demand force, and the inclusion of the long-term real interest rate enables us to estimate the natural rate of interest following [Lubik and Matthes \(2015\)](#).

A short description of the model is presented in and results are presented in Section [E.6](#). Each observed series is decomposed into a common-factor component and an idiosyncratic noise term. The common factors then follow a time-varying VAR identified in the same way as our baseline. IRFs replicate the qualitative pattern of our baseline: supply-like dynamics before 1900 giving way to demand-like dynamics thereafter, with the transition dated slightly

¹³The panel comprises earnings, the GDP deflator, CPI, exports, commodity prices, GDP, GDP per capita, M4, share prices, the dollar exchange rate, the long-term real interest rate, and public-sector net lending

earlier. Moreover, the r -star (shown in Figure E.18) exhibits a declining trend through the early centuries, stabilises through the classical gold-standard era, peaks at 8.7% in 1974, and declines thereafter, broadly consistent with Schmelzing (2020).

5.2 Additional Checks

Two further exercises in the appendix confirm the stability of the baseline. Replacing the narrow-money series M0 with broad money M4 leaves IRFs virtually unchanged, with the M4 response shifting slightly upward in the twentieth century (Appendix Figure E.4).¹⁴ Replacing per-capita variables with aggregate (non-per-capita) GDP and money also leaves IRFs unchanged (Appendix Figure E.8).

Across all of these alternatives – different real-activity measures, different money measures, different scaling conventions, and an expanded information set with measurement-error structure – the supply-to-demand transition we document in the baseline is preserved. We interpret this as evidence that the pattern is a genuine feature of the long-run UK data rather than an artefact of any single measurement or modelling decision.

6 Conclusion

This paper documents how the nature and propagation of business cycle shocks in the UK have evolved over many centuries. We show that pre-modern cycles were dominated by supply-side shocks with stagflationary effects – often linked to climate shocks, demographic events and wars – while modern business cycles are predominantly driven by demand shocks. These findings highlight that business cycle dynamics are not time-invariant but are instead shaped by the prevailing institutional and monetary environment, underscoring the importance of historical perspective in understanding modern macroeconomic fluctuations. Monetisation, for instance,

¹⁴Among other holdings, M4 includes private sector’s holdings of commercial paper, bonds, Floating Rate Notes and other instruments of up to and including five years’ original maturity issued by UK Monetary Financial Institutions.

boosted real activity in earlier centuries but became increasingly inflationary as the economy transitioned to a modern monetary system.

We also show that output and inflation volatilities have declined over time, suggesting a centuries-long Great “Moderation”, as economic development and stabilising institutions gradually reduced the amplitude of business cycle fluctuations ([Romer, 1999](#)). This historical perspective reveals that even events such as COVID-19 appear less anomalous when viewed against centuries of data. In fact, the volatilities of output and inflation observed during and in the aftermath of COVID-19 are far smaller than the values estimated for the periods before 1700.

Although our analysis is historical, the results carry important policy implications. First, institutional arrangements influence both the types of shocks economies face and the way these shocks propagate. Second, supply-driven stagflationary shocks have historically been the dominant form of macroeconomic disturbance. As shocks related to climate, energy, demographics and migration become more common, understanding how supply shocks affected the economy in the past can help policymakers better prepare for disturbances whose dynamics may be similar to those of earlier centuries.

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