ORIGINAL ARTICLE

Dating business cycles in the United Kingdom, 1700–2010

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Abstract

This paper constructs a new chronology of the business cycle in the United Kingdom from 1700 on an annual basis and from 1920 on a quarterly basis to 2010. The new chronology points to several observations about the business cycle. First, the cycle has significantly increased in duration and amplitude over time. Second, contractions have become less frequent but are as persistent and costly as at other times in history. Third, the typical recession has been tick-shaped with a short contraction and longer recovery. Finally, the major causes of downturns have been sectoral shocks, financial crises, and wars.

KEYWORDS
business cycles, economic history, United Kingdom

JEL CLASSIFICATION
E32, N13, N14

As with any modern economy, the British economy is subject to recurring fluctuations in economic activity, which are typically called business cycles. They are not uniform sine waves but irregular phenomena driven by different shocks across an economic structure that is not itself constant, which policy interventions may attenuate or amplify. These fluctuations have their own narrative and are often described as booms or busts.

While there is a rich history of trying to timestamp these events for the United Kingdom, going back to the seminal contributions of Burns and Mitchell, Gayer et al., Ashton, and Rostow, the

result is a patchwork of chronologies, which do not provide a clear, long-run picture of the peaks and troughs in British economic activity.[1] Although impressive in the *longue durée*, the evidence is imperfect.

A reliable record of the turning points in the business cycle is important for a number of reasons. First, this contextualizes modern slumps and recoveries in terms of past experience. Second, business cycle chronologies provide an important input into economic research, such as for highlighting periods of expansion and contraction and for studying non-linearities over booms and busts.[2] Third, recording the past incidence of expansions and contractions allows us to calculate not only the unconditional probability of each event but also the conditional probability, which may help us to answer questions such as why recessions occur. And turning full circle, we hope that this chronology may help scholars write their own narratives about particular episodes in economic history.

In this paper, we construct a new chronology of the business cycle in the United Kingdom. The chronology extends back to 1700 on an annual basis and back to 1920 on a quarterly basis. To do so, the National Institute of Economic and Social Research (NIESR) has formed the UK Business Cycle Dating Committee, comprising leading academics and policymakers. The chronology is based on the authors' judgement in consultation with the committee and the most reliable national accounts available. In the interest of transparency, we provide a narrative overview of each business cycle. As the quality of the national accounts is not perfect, we communicate the uncertainty with reliability grades.

A number of business cycle facts emerge from the new chronology. First, the business cycle has increased in both duration and amplitude between the long eighteenth century (1701–1816) and the postwar period (1948–2009), extending in duration from 3.4 to 16 years and rising in amplitude from 3.2 per cent to 51.9 per cent. Second, recessions since the Second World War have been longer and more severe than in the *Pax Britannica* (1817–1908), although less so than the transwar period (1909–47).[3] Third, the average recession has been tick-shaped with a short contraction and a slightly longer recovery. Fourth, the main causes of British recessions have been sectoral shocks, financial crises, and wars.

This paper is structured as follows. Section I discusses previous chronologies of the British business cycle. Section II outlines the methodology. Section III details the data. Section IV presents the results. Section V concludes. Appendix A reports the membership of the UK Business Cycle Dating Committee. Appendix B describes a history of business cycles in the United Kingdom between 1700 and 2010. Appendix C overviews our quarterly gross domestic product (GDP) estimates for the United Kingdom between 1938 and 1955. Appendix D provides additional information.

I | PREVIOUS RESEARCH

Recording the peaks and troughs in British economic activity has a long history. In 1946, Burns and Mitchell published chronologies of the UK business cycle up until 1938, from 1792 on an

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[1] Burns and Mitchell, *Measuring business cycles*; Gayer et al., *The growth and fluctuation of the British economy*; Ashton, *Economic fluctuations in England*; Rostow, 'Cycles in the British economy'.

[2] Mountford and Uhlig, 'What are the effects of fiscal policy shocks?'; Auerbach and Gorodnichenko, 'Measuring the output responses to fiscal policy'; Lennard, 'Did monetary policy matter?'; Tenreyro and Thwaites, 'Pushing on a string'; Ramey and Zubairy, 'Government spending multipliers in good times and in bad'.

[3] The rough dating of these epochs follows from the business cycle turning points.

annual basis and from 1848 on a monthly basis, that were based on 141 time series covering different periods.[4] The series measured production, construction, and other areas of real activity but also commodity prices, security markets, interest rates, and money and banking. A number of chronologies followed in this tradition, focusing on a range of disaggregated time series, such as Gayer et al. for the period 1792–1848, Ashton for the eighteenth century, and Rostow for the years 1788–1914.[5]

Economic historians have revisited the British business cycle chronology. Capie and Mills developed an annual set of business cycle dates between 1870 and 1912 using deviations from an estimated trend in real GDP.[6] Klovland derived a monthly chronology for the period 1850–1914, based on a composite cyclical indicator and a modified version of the Bry and Boschan algorithm.[7] The composite cyclical indicator is a weighted average of railway freight receipts, tonnage of ships engaged in the coasting trade, bank clearings, raw material imports, non-cotton exports, raw cotton consumption, and cotton goods exports, where the series were detrended using a Hodrick–Prescott filter and the weights determined subjectively. Broadberry et al. use their new series of real GDP and a Hodrick–Prescott filter to construct a set of annual turning points between 1270 and 1870.[8]

In the postwar period, the Central Statistical Office (CSO), forerunner to the Office for National Statistics (ONS), maintained a quarterly 'reference chronology', covering the 1950s to the 1990s, based on turning points in real GDP.[9] The Organisation for Economic Co-operation and Development (OECD) continues to produce a set of turning points for the United Kingdom using detrended real GDP and a version of the Bry and Boschan algorithm, which extends back to 1955 on a monthly basis.[10]

There is, however, scope to improve on existing chronologies in a number of ways. First, a wealth of new macroeconomic data has been constructed recently that was not available as inputs into existing chronologies. As a number of studies have pointed out, the relative lack of data available to, and the effort devoted by, the National Bureau of Economic Research, for example, compromises the reliability of their chronology for the United Kingdom.[11] Second, many of the existing chronologies use detrended data. As section II shows, this is not current best practice and may introduce systematic biases. Third, no single chronology covers both a significant stretch of history and the present. As a result, Friedman and Schwartz, Chadha et al., and Chadha and Nolan have linked various existing chronologies to form a long-run record.[12] However, these series are constructed in different ways, which may lead to incorrect inference about how the business cycle

[4] Burns and Mitchell, *Measuring business cycles*, p. 20.

[5] Gayer et al., *The growth and fluctuation of the British economy*, p. 348; Ashton, *Economic fluctuations in England*, pp. 172–3; Rostow, 'Cycles in the British economy', p. 77.

[6] Capie and Mills, 'Money and business cycles in the U.S. and U.K.'.

[7] Klovland, 'A reassessment of the United Kingdom business cycle chronology'; Bry and Boschan, *Cyclical analysis of time series*.

[8] Broadberry et al., 'British business cycles'.

[9] Central Statistical Office, 'A review of CSO cyclical indicators'.

[10] Organisation for Economic Co-operation and Development, 'OECD composite leading indicators'; Bry and Boschan, *Cyclical analysis of time series*.

[11] Capie and Mills, 'Money and business cycles in the U.S. and U.K.'; Friedman and Schwartz, *Monetary trends in the United States and the United Kingdom*, p. 308; Klovland, 'A reassessment of the United Kingdom business cycle chronology'.

[12] Friedman and Schwartz, *Monetary trends in the United States and the United Kingdom*, p. 77; Chadha et al., 'An examination of UK business cycle fluctuations'; Chadha and Nolan, 'A long view of the UK business cycle'.

has evolved over time. Fourth, for periods with multiple chronologies, it is not clear which is the most reliable. Five chronologies cover the eighteenth century, for example.

To illustrate the degree of consistency between overlapping chronologies, a concordance matrix is shown in table 1. Concordance measures the degree to which two series are simultaneously in a state of contraction or expansion, where 0 indicates that the two series are perfectly unsynchronized and 100 that the two are perfectly synchronized. This exercise shows that, while there is some agreement between turning points across existing chronologies, there is also a good deal of disagreement. Ashton's chronology, for example, is consistent with Broadberry et al.'s series in just 54 per cent of years between 1700 and 1802 and with Rostow's chronology in 67 per cent of years between 1788 and 1802 and so on.[13] This review suggests that there is scope for a new chronology that consistently spans the period from 1700 to the present.

II | DATING BUSINESS CYCLES

A business cycle is composed of two phases: an expansion and a contraction. An expansion is a significant increase in economic activity from the trough to the peak. A contraction is a significant decrease in economic activity from the peak to the trough.[14]

The definitions of the phases hinge upon the significance of the change in economic activity. We interpret significance in terms of depth and duration. Depth is important so that trivial changes in economic activity are not classified as a specific phase. Duration is vital so that fleeting changes in economic activity are not recorded separately.

Identifying expansions and contractions is challenging. A number of fundamental issues must be confronted. It is to these that we now turn.

An important issue is whether to study many disaggregated time series or a single aggregated measure. Burns and Mitchell used a wide array of series as inputs.[15] At that time, aggregate measures of economic activity, such as real GDP, were still in their infancy, particularly given the focus on not only the twentieth but also the nineteenth century.[16]

There is, however, an important issue with focusing on many individual time series. How should the various 'specific cycles' in each time series, which might be contradictory, be weighted to determine the 'reference cycle' in the overall economy? Burns and Mitchell note that 'there were cases in which the turning points were widely scattered, and others in which they were concentrated around two separate dates'.[17] According to Romer, the precise method used to reconcile these discrepancies 'appears to be left deliberately vague', noting that 'they seem to rely on

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[13] Ashton, *Economic fluctuations in England*; Broadberry et al., 'British business cycles'; Rostow, 'Cycles in the British economy'.

[14] There is some discrepancy in the literature as to whether the peak should be classified as part of the expansion or contraction (Berge and Jordà, 'Evaluating the classification'). As economic activity is expanding up to the peak, sometimes rapidly, it seems odd to consider it as part of the contraction, particularly if we consider how agents may perceive the state of the economy in real time. We therefore date the contraction from the observation following the peak to the trough and the expansion from the observation following the trough to the peak.

[15] Burns and Mitchell, *Measuring business cycles*.

[16] Burns and Mitchell, *Measuring business cycles*, p. 73; Rockoff, 'On the controversies'.

[17] Burns and Mitchell, *Measuring business cycles*, p. 77.

TABLE 1 Concordance matrix (%), 1700–2010

	Ashton	Broadberry et al.	Rostow	Gayer et al.	Burns and Mitchell	Klovland	Capie and Mills	OECD	CSO	New
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1)	100	54	67	64	73					58
(2)	54	100	72	68	71	86				91
(3)	67	72	100	100	98	78	84			76
(4)	64	68	100	100	98					75
(5)	73	71	98	98	100	78	79			75
(6)		86	78		78	100	79			72
(7)			84		79	79	100			65
(8)								100	79	68
(9)								79	100	69
(10)	58	91	76	75	75	72	65	68	69	100
Frequency	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Quarterly	Quarterly	Annual and quarterly
Sample	1700–1802	1700–1870	1788–1914	1792–1848	1792–1938	1850–1914	1870–1912	1955–2010	1958–92	1700–2010

Note: The degree of concordance between chronology x and y is: $C_{xy} = \frac{1}{T}\sum_{t=1}^{T}[S_t^x S_t^y + (1 - S_t^x)(1 - S_t^y)]$, where $S_t^j = 1$ if chronology j is in a state of expansion at time t and zero otherwise.

Source: See section I.

subjective judgement and an informal weighting scheme for deciding which series to use as their main guide'.[18]

As a result, most modern business cycle chronologies use aggregate measures of economic activity to identify turning points. For example, chronologies produced by leading research organizations, such as the Centre for Economic Policy Research, the National Bureau of Economic Research, and the Spanish Economic Association, focus on real GDP (and some of its components) and employment, while many chronologies produced by academics, such as Romer, Davis, Berge and Jordà, Jordà et al., Martínez-García et al., and Broadberry et al. use real GDP (or industrial production when real GDP is unreliable or unavailable).[19]

Focusing on an aggregate measure of economic activity, such as real GDP, has a major advantage. As GDP can be expressed as the weighted sum of its components, where the weights represent the share of GDP, it resolves the problem of how to weight many individual time series. On the expenditure side, it includes consumption, investment, government expenditure, exports, and imports. On the income side, it incorporates average earnings, employment, and profits. On the output side, it includes the production of the agricultural, industrial, and services sectors. These components are, in turn, aggregates of many more sub-components.

A potential concern of using an aggregate measure of economic activity, such as real GDP, is measurement error, particularly given the uncertainty associated with historical national accounts.[20] However, the measurement error in the aggregate is, at least in part, a reflection of measurement error in the underlying components. Therefore, it is not clear that focusing on individual time series, as opposed to an aggregate measure of economic activity, would circumvent the issue of measurement error. However, using balanced estimates of real GDP would help to ameliorate this problem, as real GDP is adjusted on the basis of the reliability of its underlying components.

Overall, we focus on an aggregate measure of economic activity. In theory, whether using many individual time series or an aggregate, the results should be similar because series such as employment, industrial production, and real GDP 'only fluctuate substantially when many of the individual components fluctuate'.[21] Stock and Watson show in practice that 'date then aggregate' and 'aggregate then date' methods produce similar turning points for the United States in the postwar period.[22]

The measure of economic activity that we study is real GDP. On an annual basis, there are estimates going back to the 1700s and beyond and, on a quarterly basis, back to 1920. From the mid-nineteenth century these are balanced estimates that combine information from the income, expenditure, and output sides. An alternative measure of economic activity is industrial production. However, the economic importance of industry has changed over time, meaning that its fluctuations may not be representative of those in the wider economy. Indeed, different shocks to the economy are likely to generate movements in industrial output that either lead or lag behind

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[18] Romer, 'Remeasuring business cycles'.

[19] Centre for Economic Policy Research, 'Euro Area Business Cycle Dating Committee'; National Bureau of Economic Research, 'US business cycle expansions and contractions'; Spanish Economic Association, 'Spanish Business Cycle Dating Committee'; Romer, 'Remeasuring business cycles'; Davis, 'An improved chronology of U.S. business cycles'; Berge and Jordà, 'A chronology of turning points in economic activity'; Jordà et al., 'When credit bites back'; Martínez-García et al., 'A contribution to the chronology of turning points'; Broadberry et al., 'British business cycles'.

[20] Solomou and Weale, 'Balanced estimates of UK GDP'.

[21] Romer, 'Remeasuring business cycles'.

[22] Stock and Watson, 'Indicators for dating business cycles'.

the broader economy. In addition, industrial production data are not available throughout the period under investigation, as there is a gap around the Second World War. There are also well-known measurement issues in the estimates of industrial production in periods such as the late nineteenth century, which are discussed by Hildreth and Solomou and Thomas.[23]

Another important issue is whether to study the level or the cycle of the time series. According to Romer, the National Bureau of Economic Research has shifted between practices.[24] The dates prior to 1927 were derived using detrended data, while the turning points identified after have been based on data in levels.

A major issue with detrending is that it could lead to systematic biases in the identification of turning points. As Romer argues, 'if the extremes in a series are fairly smooth and the upward trend is significant, then the peak in the detrended data will come before the actual peak and the trough in the detrended data will come after the actual trough'.[25] Both Romer and Davis demonstrate that the use of detrended data introduced biases into the National Bureau of Economic Research's chronology for the period before the Great Depression.[26] Another issue with detrending is that it will classify 'growth recessions' as contractions, which are not typically considered genuine recessions in the literature.[27] Finally, there are a battery of methods for removing trends, upon which the dating of turning points and the 'business cycle facts' will depend.[28]

Dimsdale and Thomas look at UK 'growth cycles' using a variety of popular detrending measures and show that large differences occur depending on the assumptions made about the trend and cycle and how they are correlated.[29] They conclude that detrending typically makes a priori assumptions about the shocks driving both trend and cycle, recommending that a narrative approach, which is adopted in this paper, is necessary to validate those assumptions and to understand the drivers of cycles.

For these and other reasons, Harding and Pagan argue 'there is no need to perform a detrending operation to analyse the business cycle'.[30] Once the reference chronology is established in levels, this then forms the basis for further investigation of the drivers of fluctuations in each phase, including attempts to remove trend components on the basis of additional assumptions about how they evolve. Indeed, the majority of recent chronologies published by researchers are based on data in levels, as well as the modern dates published by the Centre for Economic Policy Research, National Bureau of Economic Research, and Spanish Economic Association.[31] In light of these considerations, we focus on data in levels.[32] However, in section IV we discuss periods that display

[23] Hildreth, 'A random walk through the climacteric'; Solomou and Thomas, 'Feinstein fulfilled'.

[24] Romer, 'Remeasuring business cycles'.

[25] Romer, 'Remeasuring business cycles'.

[26] Romer, 'Remeasuring business cycles'; Davis, 'An improved chronology of U.S. business cycles'.

[27] Romer, 'Remeasuring business cycles'; Davis, 'An improved chronology of U.S. business cycles'.

[28] Canova, 'Detrending and turning points'; idem, 'Detrending and business cycle facts'; Harvey and Jaeger, 'Detrending, stylized facts and the business cycle'.

[29] Dimsdale and Thomas, *UK business and financial cycles since 1660*.

[30] Harding and Pagan, 'Dissecting the cycle'.

[31] Romer, 'Remeasuring business cycles'; Davis, 'An improved chronology of U.S. business cycles'; Berge and Jordà, 'A chronology of turning points in economic activity'; Jordà et al., 'When credit bites cack'; Centre for Economic Policy Research, 'Euro Area Business Cycle Dating Committee'; National Bureau of Economic Research, 'US business cycle expansions and contractions'; Spanish Economic Association, 'Spanish Business Cycle Dating Committee'.

[32] Romer and Romer, 'NBER recession dates', emphasize the value of 'economic slack', measured as the difference between GDP and potential GDP and between actual unemployment and the natural rate. However, reliable estimates of potential

well-established growth cycles, where, for example, the growth in activity slowed but did not lead to a reduction in output.

The literature is divided between two schools of thought. The first is based on rules to classify expansions and contractions. These chronologies have typically been produced by academics.[33] The second is based on expert judgement to chronicle the business cycle. These dates have generally been determined by research institutes.[34] An advantage of a rule is that it is transparent and reproducible. A disadvantage, however, is that the ultimate chronology will depend on the rule, the parameters of which are likely to be arbitrary. On balance, we use discretion to classify phases in economic activity. To mitigate the reduced transparency involved with judgement, Appendix B gives a detailed description of every peak and trough between 1700 and 2010. This issue is revisited in section IV with a comparison of chronologies based on rules and discretion.

Identifying turning points in the level of economic activity is relatively straightforward. However, describing intervals between peaks or troughs is less so, as there are alternative definitions of the business cycle. While most chronologies define business cycles in this way, some emphasize deviations from normal or potential that might prevail given flexible prices.[35] Others focus on specific frequencies so that shorter- and longer-term fluctuations are considered to belong not to the business cycle but to an irregular component, longer-run cycle, or trend.[36] These unavoidable conceptual issues should be kept in mind.

The true state of the economy is unobservable.[37] While fluctuations in GDP may be a good approximation, it is measured with error. Despite our focus on the most reliable vintage for each period, this measurement error has ebbed and flowed over time.[38] As a result, some cycles in GDP may be spurious. In order to communicate this classification uncertainty, we assign each recession a reliability grade, which takes one of five values: very low, low, medium, high, or very high. In doing so, two factors are considered. The first is the signal to noise ratio. While not explicitly calculated, this factor balances the fact that some contractions are more significant than others (signal) and the fact that the accuracy of the data changes over time (noise). The logic is that a small, short-lived contraction or expansion is more likely to be an artefact than a large, persistent one for a given level of measurement error. The second factor is narrative evidence. There are a number of histories of British business cycles and a wealth of contemporary sources that can be used to ascertain the potential reliability of downturns that we identify in the data.

GDP and the natural rate are not available for most of the sample period and statistical estimates based on time series filters are subject to the criticisms above.

[33] Romer, 'Remeasuring business cycles'; Davis, 'An improved chronology of U.S. business cycles'; Berge and Jordà, 'A chronology of turning points in economic activity'; Jordà et al., 'When credit bites back'; Martínez-García et al., 'A contribution to the chronology of turning points'.

[34] Centre for Economic Policy Research, 'Euro Area Business Cycle Dating Committee'; National Bureau of Economic Research, 'US business cycle expansions and contractions'; Spanish Economic Association, 'Spanish Business Cycle Dating Committee'.

[35] Romer, 'Remeasuring business cycles'; Davis, 'An improved chronology of U.S. business cycles'; Berge and Jordà, 'A chronology of turning points in economic activity'; Jordà et al., 'When credit bites back'; Martínez-García et al., 'A contribution to the chronology of turning points'; Broadberry et al., 'British business cycles'; Romer and Romer, 'NBER recession dates'; Centre for Economic Policy Research, 'Euro Area Business Cycle Dating Committee'; National Bureau of Economic Research, 'US business cycle expansions and contractions'; Spanish Economic Association, 'Spanish Business Cycle Dating Committee'.

[36] Chadha and Nolan, 'A long view of the UK business cycle'.

[37] Berge and Jordà, 'Evaluating the classification'.

[38] Feinstein, *National income, output and expenditure*; Sefton and Weale, *Reconciliation of national income and expenditure*.

TABLE 2 Data sources

Variable	Source	Coverage	Units
Panel A. Annual			
Gross domestic product	Broadberry et al., *British economic growth*, pp. 239–44)	Great Britain, 1700–1870	1700=100
Balanced estimates of gross domestic product	Solomou and Weale, 'Balanced estimates of UK GDP'	United Kingdom, 1870–1913	£ millions in constant prices
Compromise estimates of gross domestic product at factor cost	Mitchell, *British historical statistics*, p. 836	United Kingdom, 1913–20	1913=100
Balanced estimates of gross domestic product at factor cost and market prices	Sefton and Weale, *Reconciliation of national income and expenditure*, pp. 258–65	United Kingdom, 1920–48	£ millions in constant prices
Gross domestic product at market prices	Office for National Statistics (ONS), 'GDP'. Series ID: ABMI	United Kingdom, 1948–2010	£ millions in constant prices
Gross value added at basic prices	ONS, 'GDP'. Series ID: ABMM	United Kingdom, 1948–2010	£ millions in constant prices
Panel B. Quarterly			
Gross domestic product at factor cost and market prices	Mitchell et al., 'Monthly GDP estimates for Inter-war Britain'	United Kingdom, 1920–38	£ millions in constant prices
Gross domestic product at factor cost and market prices	Appendix C	United Kingdom, 1938–55	£ millions in constant prices
Gross domestic product at market prices	ONS, 'GDP'. Series ID: ABMI	United Kingdom, 1955–2010	£ millions in constant prices
Gross value added at basic prices	ONS, 'GDP'. Series ID: ABMM	United Kingdom, 1955–2010	£ millions in constant prices

Source: See section III.

III | DATA

This section outlines the data that are used to identify peaks and troughs in economic activity. The sources are listed in table 2.

A major input into the chronology is the national accounts. On an annual basis, Broadberry et al. have constructed a series of output for Great Britain between 1700 and 1870.[39] Solomou and Weale have produced a balanced series of real GDP for the United Kingdom between 1870 and 1913 by allocating the discrepancy between the expenditure and output estimates on the basis of their subjective reliabilities.[40] Mitchell has calculated a compromise series of real GDP for the

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[39] Broadberry et al., *British economic growth*. According to Broadberry et al., 'British business cycles', the amplitude of GDP is believed to be higher prior to 1720 because of the more limited information available to construct estimates of agricultural output.

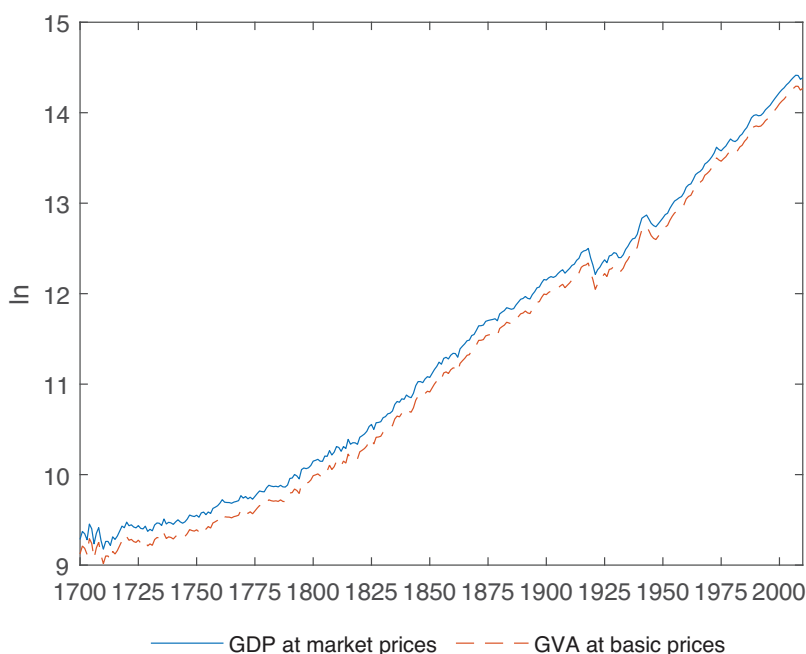[40] Solomou and Weale, 'Balanced estimates of UK GDP'.

FIGURE 1   Annual GDP, 1700–2010. *Source:* See panel A of table 2. [Colour figure can be viewed at wileyonlinelibrary.com]

United Kingdom covering the period from 1913 to 1920 as the arithmetic mean between national expenditure and income (in addition to some adjustments).[41] Sefton and Weale have balanced UK real GDP from 1920 to 1948.[42] The ONS have calculated GDP and gross value added (GVA) for the United Kingdom for the period since 1948.[43] A composite annual series of GDP at market prices and GVA at basic prices is shown in figure 1.

On a quarterly basis, Mitchell et al. have estimated UK real GDP between 1920 and 1938 based on high-frequency indicators, annual GDP, and a dynamic factor model.[44] The ONS have produced UK GDP and GVA for the period since 1955.[45]

However, there is a gap between 1938 and 1955. As a result, we construct a data set of annual and quarterly data from primary and secondary sources and estimate a variety of temporal disaggregation models to estimate quarterly GDP.[46] The data, methodology, and results are discussed in appendix C. All of the series have been seasonally adjusted at source and are consistent with the annual estimates. An unbroken quarterly series of GDP at market prices and GVA at basic prices is plotted in figure 2.

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[41] Mitchell, *British historical statistics*.

[42] Sefton and Weale, *Reconciliation of national income and expenditure*.

[43] Office for National Statistics, 'GDP'.

[44] Mitchell et al., 'Monthly GDP estimates for inter-war Britain'.

[45] Office for National Statistics, 'GDP'.

[46] Chow and Lin, 'Best linear unbiased interpolation'; Denton, 'Adjustment of monthly or quarterly Series'; Litterman, 'A random walk'; Proietti and Moauro, 'Dynamic factor analysis'; Mitchell et al., 'Monthly GDP estimates for inter-war Britain'.
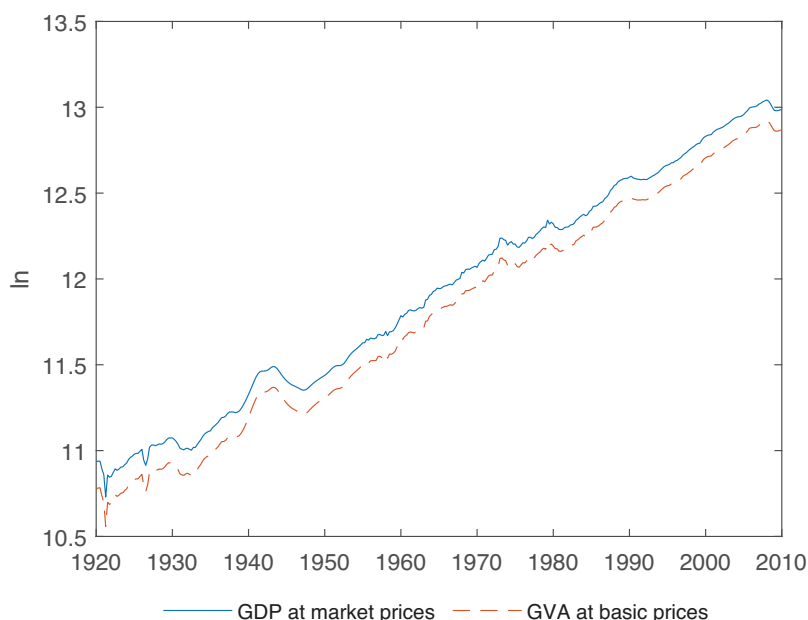
FIGURE 2 Quarterly GDP, 1920–2010. *Source*: See panel B of table 2. [Colour figure can be viewed at wileyonlinelibrary.com]

Between 1700 and 1870, the historical national accounts are not for the United Kingdom but for Great Britain. As a result, Ireland is not included between the Act of Union in 1800 and 1870. Therefore, during this period, the peaks and troughs should be interpreted as relating to Great Britain and not necessarily to the United Kingdom as a whole.[47]

IV | RESULTS

This section documents the major results. The first part compares the new record with existing chronologies. The second presents some key summary statistics for the business cycle. The third summarizes the explanations for recessions given in the historiography. The final part investigates whether expansions are duration dependent.

How does the new chronology compare with existing accounts? The last column of table 1 shows the concordance between the new chronology and nine others that cover the eighteenth century onwards. The mean concordance is 75, suggesting a relatively high degree of synchronization. This implies that the majority of turning points are well established in the historiography but also that a minority are not. Our chronology is least concordant with Ashton's list, who had to rely on many disaggregated series, as historical national accounts were not available.[48] It is most concordant with Broadberry et al.'s record.[49] The two chronologies use the same underlying data, but

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[47] The estimates of real GDP are adjusted for the emergence of the Irish Free State in the 1920s.

[48] Ashton, *Economic fluctuations in England*.

[49] Broadberry et al., 'British business cycles'.

a key difference is that Broadberry et al. study detrended data, whereas we focus on the data in levels, which may account for the small differences.[50]

A useful exercise is to compare our chronology based on discretion to one derived from a rule. A sensible benchmark is Harding and Pagan's algorithm, which identifies peaks and troughs as local minima and maxima that satisfy various conditions.[51] For annual data, these are a minimum phase duration of one year, a minimum cycle duration of two years, and a minimum phase amplitude of 15 per cent that overrides the duration conditions.[52] Table 1 of appendix D shows that all of our phases and cycles satisfy these requirements. The minimum phase is one year, the minimum cycle is two years, and the minimum amplitude is −0.4 per cent. As a result, the two chronologies are perfectly synchronized. For quarterly data, the usual minima for the Harding and Pagan algorithm are two quarters for the duration of a phase, five quarters for the duration of a cycle, and 10.4 per cent for the amplitude of a phase.[53] Although we do not have predetermined conditions, table 2 of appendix D shows that the shortest phase is two quarters, the shortest cycle is 16 quarters, and the lowest amplitude is −1.2 per cent. The two chronologies are highly synchronized with a concordance of 88 per cent, but there are some differences. The Harding and Pagan algorithm identifies three additional recessions (1920:IV–1921:II, 1937:IV–1938:II, 1961:III–1961:IV), shortens two recessions (1930s and 1990s), and splits one recession in two (1970s).[54]

We now turn to the business cycle facts. The annual and quarterly turning points are listed in tables 3 and 4.[55] The periods of recession are shown alongside the natural logarithms of GDP at market prices and GVA at factor cost in figures 3 and 4.

This information is summarized in table 5, which shows the number, duration, frequency, and amplitude of contractions, expansions, and cycles for a number of sub-periods. The first sub-period is 1701–1816, which was a long century of war, beginning with the War of the Spanish Succession and ending with the Napoleonic Wars. The second sub-period is 1817–1908, which roughly corresponds to a stretch of relative peace known as the *Pax Britannica*. The third sub-period is 1909–47, which broadly relates to the transwar period. The final sub-period is 1948–2009, which is approximately the postwar period.

Over the course of more than three centuries, there have been 59 contractions, lasting 1.5 years on average, implying that the British economy has been in a state of recession 29.5 per cent of the time. The average output loss, from peak to trough, has been 4 per cent. However, this has been far from constant over time. Recessions have become less frequent, occurring roughly every other year in the eighteenth century, every fourth year in the *Pax Britannica* and transwar periods, and every ninth year since the Second World War. While the frequency of recessions has declined to a historical low, the duration and amplitude have not. Postwar recessions have been longer on average than those in the eighteenth and nineteenth centuries, although not as long as those during the transwar period, and have been more costly than those in the nineteenth century, albeit not as much as downturns in the eighteenth century or the transwar period.

Expansions have increased in duration, frequency, and amplitude over time. Between the long eighteenth century and the postwar period, the average expansion has lengthened from 1.8 to 13.8

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[50] Broadberry et al., 'British business cycles'.

[51] Harding and Pagan, 'Dissecting the cycle'.

[52] There is also a symmetric window condition, which is set to 1 for annual data and 2 for quarterly data.

[53] Harding and Pagan, 'Dissecting the cycle'.

[54] Harding and Pagan, 'Dissecting the cycle'.

[55] This data is available in the supporting information.

TABLE 3 Annual turning points in the United Kingdom, 1700–2010

Peak	Trough	Peak	Trough	Peak	Trough
1701	1703	1769	1770	1846	1847
1704	1706	1771	1772	1849	1850
1708	1710	1773	1774	1854	1855
1712	1713	1777	1779	1857	1858
1714	1715	1781	1783	1860	1862
1718	1719	1784	1785	1878	1879
1720	1721	1786	1788	1883	1885
1722	1724	1792	1794	1891	1893
1725	1727	1796	1797	1899	1900
1728	1729	1802	1804	1902	1903
1730	1731	1805	1806	1907	1908
1733	1735	1807	1808	1918	1921
1736	1737	1810	1812	1925	1926
1738	1740	1813	1814	1929	1931
1742	1744	1815	1816	1943	1947
1747	1749	1817	1819	1973	1975
1750	1751	1825	1826	1979	1981
1753	1754	1836	1837	1990	1991
1755	1756	1838	1839	2007	2009
1761	1765	1840	1842		

Source: See sections II and III.

TABLE 4 Quarterly turning points in the United Kingdom, 1920–2010

Peak	Trough
1926:I	1926:III
1930:I	1932:III
1943:II	1947:II
1973:II	1975:III
1979:II	1981:I
1990:II	1992:II
2008:I	2009:II

Source: See sections II and III.

years, the mean frequency has risen from 53.9 per cent to 88.7 per cent, and the average amplitude has increased from 7.6 per cent to 62.5 per cent.

The joint implication is that the business cycle has increased in both duration and amplitude, extending in duration from 3.4 to 16 years and rising in amplitude from 3.2 per cent to 51.9 per cent between the long eighteenth century and the postwar period.

The rising duration of business cycles has implications for the literature that uses time series filters to estimate business cycles. For example, the Baxter-King and Christiano-Fitzgerald models
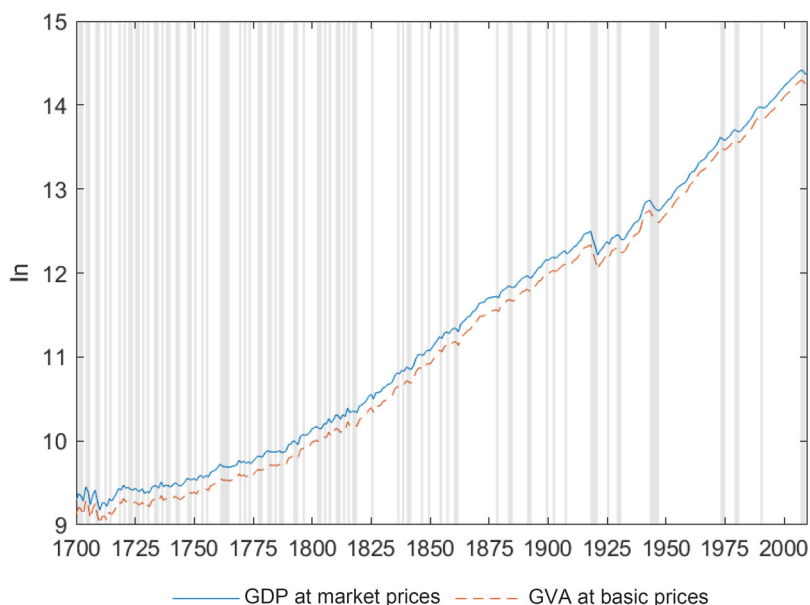
FIGURE 3 New annual chronology of British business cycles, 1700–2010. *Note:* Shaded areas represent recessions. *Source*: See sections II and III. [Colour figure can be viewed at wileyonlinelibrary.com]
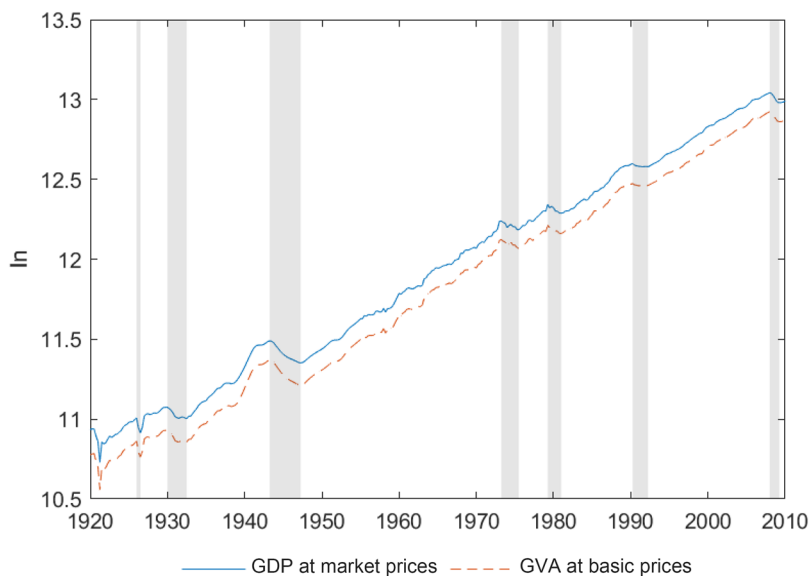

FIGURE 4 New quarterly chronology of British business cycles, 1920–2010. *Note*: Shaded areas represent recessions. *Source*: See sections II and III. [Colour figure can be viewed at wileyonlinelibrary.com]

typically retain cycles of 1.5 to 8 years.[56] For British business cycles since the twentieth century, this suggests that these filters would misidentify some of the business cycle as part of the lower

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[56] Baxter and King, 'Measuring business cycles'; Christiano and Fitzgerald, 'The band pass filter'.

TABLE 5 Amplitude, duration, and frequency of British business cycles, 1700–2010

	1701–1816	1817–1908	1909–47	1948–2009	1701–2009
Contractions (peak to trough)					
Number	35	16	4	4	59
Mean duration (years)	1.5	1.3	2.5	1.8	1.5
Mean frequency (%)	46.1	22.8	25.6	11.3	29.5
Mean amplitude (%)	−4.0	−2.1	−12.0	−2.8	−4.0
Expansions (trough to peak)					
Number	34	16	4	4	58
Mean duration (years)	1.8	4.4	7.3	13.8	3.7
Mean frequency (%)	53.9	77.2	74.4	88.7	70.5
Mean amplitude (%)	7.6	15.7	32.0	62.5	15.3
Cycles (peak to peak)					
Number	34	16	4	4	58
Mean duration (years)	3.4	5.8	9.0	16.0	5.3
Mean frequency (%)	100	100	100	100	100
Mean amplitude (%)	3.2	13.0	19.9	51.9	10.4

Source: See section IV.

frequency components, such as the trend. This is also evidence against filtering prior to business cycle dating.

The shape of recessions is a question of great importance. Does economic activity fall and rise according to a short, sharp V-shape, a double-dip W-shape, or a more permanent L-shape? Figure 5 plots the mean recession profile. In the first year of a contraction, GDP falls, on average, by 2.5 per cent. In the second year, growth returns but the level of economic activity remains below the peak. The recovery is complete in the third year as the pre-recession peak is surpassed. Therefore, British recessions have been somewhat tick-shaped, with a short contraction and longer recovery. The standard errors around these point estimates are relatively large, demonstrating the heterogeneity of recessions in British history.

The long historiography on British business cycles is a rich resource for understanding the causes of recessions, from Thorp's annals for the late eighteenth to the early twentieth centuries to Dow's history of major recessions since the First World War.[57] In appendix B, we summarize the shocks associated with each recession since 1700 that have been advanced in the previous literature to give an indication of what have been the historic drivers of business cycles. Table 6 presents the results.

The dominant cause of fluctuations in the eighteenth century was sectoral shocks concentrated in agriculture. This characterization is consistent with previous research. Tooke and Newmarch, in their famous analysis of prices, first emphasized the potential role of sector-specific shocks such as bad harvests.[58] Later, Ashton writes of the 1700s that 'among the causes of instability of economic life in this century variations in the yield of the soil must be given first place'.[59] The largest

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[57] Thorp, 'Annals of England'; Dow, *Major recessions*.

[58] Tooke and Newmarch, *A history of prices*.

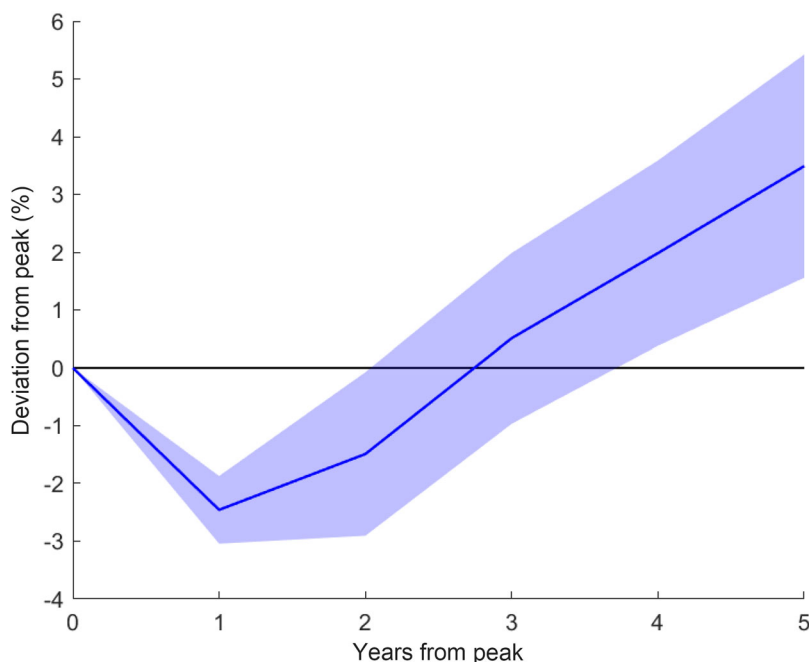[59] Ashton, *Economic fluctuations in England*, p. 62.

FIGURE 5   The shape of recessions. *Note*: Shaded area represents the 95 per cent confidence interval. *Source*: See section IV. [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 6   The share of recessions due to various shocks (%)

	1700–1800	1800–1900	1900–2010	1700–2010
Animal spirits	0.0	0.0	6.3	1.2
Commodity price shock	0.0	7.4	12.5	4.7
Economic policy	2.3	3.7	25.0	7.0
Financial crisis	18.6	25.9	6.3	18.6
International shock	4.7	14.8	12.5	9.3
Labour supply	0.0	0.0	12.5	2.3
Public health crisis	7.0	0.0	0.0	3.5
Sectoral shock	46.5	29.6	6.3	33.7
Unknown	2.3	3.7	6.3	3.5
War	18.6	14.8	12.5	16.3

Source: See appendix B.

recession associated with agricultural shocks is that of 1709–10, related to the Great Frost, which reduced GDP by over 20 per cent. However, as Broadberry et al. note, the size of the recession is likely to be overstated, given the measurement error involved with the use of probate data for the estimation of agricultural output before 1720.[60]

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[60] Broadberry et al., 'British business cycles'.

The next most important drivers of eighteenth-century recessions were wars and financial crises. Britain was involved in a succession of wars during this period. The disruption to trade that accompanied wars frequently led to weaker exports and economic downturns. Financial crises also emerged as the natural outcome of the growing pains of a developing industrial economy. According to Hoppit, 'growth provided the temptation, credit the snare, and crises destruction and perdition'.[61]

In the nineteenth century sectoral shocks remained important but to a lesser extent. Solomou finds a significant correlation between fluctuations in agricultural output and aggregate economic activity as late as 1890, although the association ended thereafter.[62] Financial crises of various types continued. Matthews notes 'most major cyclical contractions … were accompanied by crises'.[63] After the major disruption of the Napoleonic Wars, which ended in 1815, war became a less important factor in the nineteenth century, with the United Kingdom involved in smaller conflicts.

As economies opened up to trade and capital flows in the nineteenth century, shocks to commodity prices and international trade have become regular causes of recessions. UK exports and world trade became closely related over the nineteenth century, with the United Kingdom accounting for just under half of world trade in manufactures. As competitors such as the United States and Germany began to catch up, the relative competitiveness of the UK economy became an influence on the export cycle from 1870.[64]

After the nineteenth century, many of these shocks continued, but economic policy became increasingly important. In the eighteenth century, the scope for monetary policy shocks was limited by the usury laws that were binding until 1833.[65] Thereafter, monetary policy was largely concerned with maintaining the gold standard, at the heart of which was the Bank of England. Bank Rate would typically rise in response to external deficits and flows of gold overseas and generally acted as a stabilizing influence – it was rarely the driver of recessions. Fiscal policy was a major source of instability during the 1700s, but it was mainly used in response to war.[66] The lack of major conflicts in the nineteenth century meant fiscal policy was relatively stable, with persistent primary surpluses helping to reduce the debt burden of the Napoleonic Wars.

In the twentieth century, policy became increasingly used as an active tool to achieve macroeconomic objectives, although these were not always aimed at minimizing economic fluctuations but at the stabilization of the exchange rate and inflation. The pursuit of macroeconomic goals with economic policy has not always been smooth. There are the well-documented 'stop–go' cycles during the 1950s and 1960s, in which expansionist periods of 'go', where the aim of policy was to try and boost the economy and lower unemployment, would lead to balance of payments problems. This then forced the authorities into a 'stop' phase, where monetary and fiscal policy were tightened. The fluctuations these policy changes caused were relatively mild. GDP growth was positive in both the 'stop' and 'go' phases, leading to a 'growth cycle', with the economy avoiding outright recessions. The same was not true of the recessions of the 1970s, 1980s, and early 1990s, where economic policy played a key role in the downturn in economic activity.

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[61] Hoppit, 'Financial crises in eighteenth-century England'.

[62] Solomou, 'Economic fluctuations', pp. 263–4.

[63] Matthews, *The trade cycle*, p. 138.

[64] Hills et al., 'The UK recession in context'.

[65] Dimsdale and Thomas, *UK business and financial cycles since 1660*.

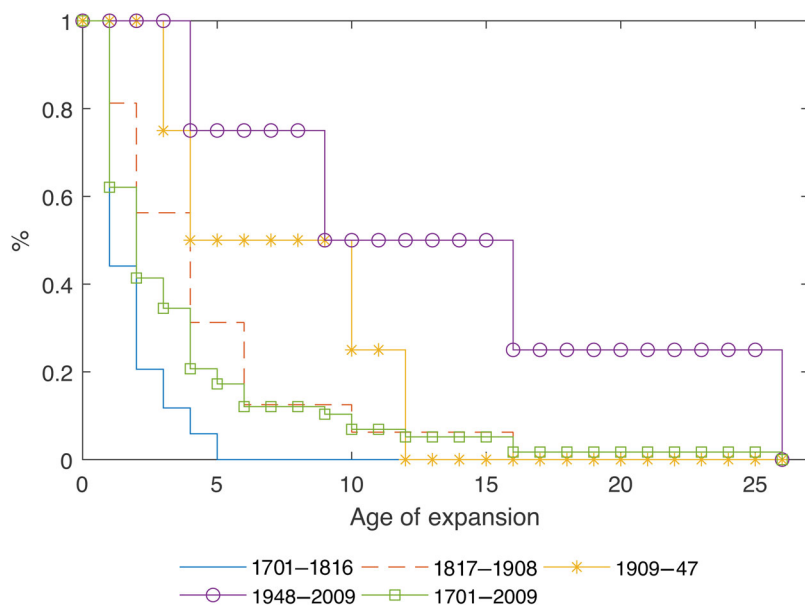[66] Barro, 'Government spending'.

FIGURE 6 Kaplan–Meier survival estimate. *Source*: See section IV. [Colour figure can be viewed at wileyonlinelibrary.com]

Although public health crises in the eighteenth century meant labour supply shocks played some role in economic downturns, it was not until the twentieth century that these became prominent. Labour became more unionized at the beginning of the twentieth century, and this often led to stoppages and demands for better working conditions, which could influence recessions, such as the fall in working hours in the recession after the First World War.[67]

An important question in macroeconomics is whether expansions exhibit duration dependence. Despite its importance, however, the literature is divided on the answer.[68] As recessions are rare, small samples are a problem in this literature. By extending the chronology back to the recession-prone eighteenth century, we are able to investigate this question using the largest sample yet.

A common method for studying duration dependence is the Kaplan–Meier nonparametric estimator of the survival function, which is plotted in figure 6.[69] The line with square markers shows that 62 per cent of expansions lasted longer than one year, 41 per cent more than two years, and so on between 1700 and 2009. The other lines show the survival function for various sub-periods. Between 1701 and 1816, the probability of an expansion lasting five years was 0 per cent. Between 1948 and 2009, the likelihood had risen to 75 per cent. The successive shifting to the right of the survival function as the sample period approaches the present shows that expansions were more likely to reach a given age in each period than was the case in the period before. To summarize, expansions of the long eighteenth century had little chance of surviving to old age, as more than

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[67] Boyer and Hatton, 'New estimates of British unemployment'.

[68] Diebold and Rudebusch, 'A nonparametric investigation of duration dependence'; Sichel, 'Business cycle duration dependence'; Zuehlke, 'Business cycle duration dependence reconsidered'; Castro, 'The duration of business cycle expansions'.

[69] Kaplan and Meier, 'Nonparametric estimation from incomplete observations'. See Beaudry and Portier, 'Duration dependence in US expansions', for an explanation of parametric and nonparametric methods.

half had ended within two years. However, by the postwar period, expansions were much more likely to reach old age, as 50 per cent made it to age 15.

V | CONCLUSION

The British business cycle, as with the economy itself, has fundamentally changed over three centuries. The cycle has quadrupled in length between the eighteenth century and the postwar period. Recessions are less frequent than at any point in history. When recessions do occur, however, they are as deep and as durable. Historically, the major cause of recessions was sectoral shocks, mainly in agriculture, but these had faded by the twentieth century. Financial crises have been a persistent bane of the British economy, being at the root of 1 in 5 recessions since 1700. Over this time, macroeconomic policy has also evolved as a source of both business cycle amplification and attenuation.[70]

An economic statistic is only as good as its component parts. A business cycle chronology is no different. In this paper, we have made full use of the corpus of national accounts available for the United Kingdom. As the mass of economic information evolves over time, so too will the business cycle chronology. Looking to the past, new data would be valuable to address the inconsistencies in quality and quantity over time, be it improved estimates of GDP for the nineteenth century, balanced estimates of GDP for the First World War, or high-frequency estimates of GDP prior to 1920.[71] Looking ahead, as Blue Books continue to be published, the chronology will be extended to include the expansions and contractions from the second decade of the twenty-first century onwards.

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[70] See Chadha, *The money minders*, for an overview of the development of modern economic policy analysis.

[71] See Solomou and Thomas, 'Feinstein fulfilled', for new income-based estimates for the nineteenth century.

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