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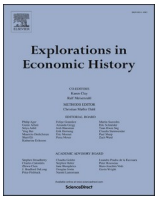

European business cycles and economic growth, 1300–2000

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ABSTRACT

The modern business cycle features long expansions combined with short recessions, and is thus related to the emergence of sustained economic growth. It also features significant international co-movement, and is therefore associated with growing market integration and globalisation. When did these patterns first appear? This paper explores the changing nature of the business cycle using historical national accounts for nine European economies between 1300 and 2000. For the sample as a whole, the modern business cycle emerged in the nineteenth century.

1. Introduction

Until recently, most systematic data-based analysis of business cycles was conducted only on very modern data, limited to the nineteenth and twentieth centuries (Schumpeter, 1939; Thomas, 1954; Coppock, 1959; Ford, 1969; Bergman et al., 1998; Chadha and Nolan, 2002). Even for the nineteenth century, this was often only possible using disaggregated data offering partial coverage of the economy (Burns and Mitchell, 1946; Gayer et al., 1953). In the last two decades or so, however, there has been dramatic progress in the quantification of economic activity between the fourteenth and nineteenth centuries, leading to estimates of aggregate GDP as well as output series for individual sectors of the economy (Malanima, 2011; van Zanden and van Leeuwen, 2012; Álvarez-Nogal and Prados de la Escosura, 2013; Broadberry et al., 2015, 2022; Krantz, 2017; Malinowski and van Zanden, 2017; Palma and Reis, 2019; Ridolfi and Nuvolari, 2022; Pfister, 2022). This has now led to a rich literature on economic growth, shedding light on the European Little Divergence, or reversal of fortunes between Mediterranean Europe and the North Sea area, as well as the Great Divergence between Europe and Asia (de Pleijt and van Zanden, 2016; Broadberry, 2021). For a growing sample of European economies, these data are available at annual frequency, so that the time is now ripe to conduct business cycle analysis to complement the study of economic growth and also to explore the interrelationships between short run fluctuations and long run trends.

This paper begins by analysing the changing nature of the business cycle of the nine European economies for which we have data, reaching back as far as the late thirteenth century. Here, we make use of established methods to considerably extend our knowledge of the "business cycles facts" to cover the pre-industrial period as well as the modern period, and establish quantitatively for the first time how the transition occurred in Europe (Bergman et al., 1998; Harding and Pagan, 2002; Broadberry et al., 2023). We show that for the sample as a whole: (1) Contractions were as frequent as expansions before the nineteenth century, but by the second half of the twentieth century expansions occurred almost 90 per cent of the time. (2) The duration of expansions increased while the duration of contractions decreased from the nineteenth century. (3) The rate of growing during expansions showed no trend increase, while the

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rate of shrinking during contractions trended down over time. (4) As a consequence of the changes in duration and rate, the amplitude of expansions decreased during the eighteenth and nineteenth centuries before increasing substantially during the twentieth century, while the amplitude of contractions followed a similar pattern until the second half of the twentieth century when it decreased strongly rather than increasing sharply. We also provide the same information for each of the nine economies in Appendix 1 to demonstrate that these trends were widely experienced across Europe.

Previous systematic work on the synchronisation of economic activity across nations has also been limited to the period since the mid-nineteenth century (Backus and Kehoe, 1992; Bergman et al., 1998; Craig and Fisher, 2000; A'Hearn and Woitek, 2001; Mathy and Meissner, 2011; Jordà et al., 2017). The second step in this paper is thus to investigate the extent of synchronisation across countries since 1300 and to document how the degree of international co-movement changed over time. This is done by measuring the correlation of real GDP per capita growth between countries for the period 1300–2000, broken down into 7 sub-periods. The number of statistically significant positive correlations between country pairs rose above 20 per cent for the first time in the nineteenth century and reached 66.7 per cent during the second half of the twentieth century. The main conclusion that we draw from the time path of the changing business cycle facts and the changing degree of international co-movement is that the modern business cycle first emerged in Europe in the nineteenth century.

We then examine some of the most significant contractions and expansions during four main periods, exploring their implications for long run trends in economic activity. We consider first the effects of the Black Death, which led to a catastrophic decline in Europe's population from the mid-fourteenth century to the late fifteenth century. Some writers have seen this major negative shock to population as having a positive impact on GDP per capita, while others have claimed a negative effect (Broadberry, 2021; Jedwab et al., 2022; Prados de la Escosura et al., 2022). We show that although the Black Death had a hugely negative effect on GDP, its impact on per capita GDP was generally positive. However, as population recovered during the early modern period, the gains were sustained only in Britain and the Netherlands, leading to a reversal of fortunes between Mediterranean and northwest Europe. Our second major shock is the European Religious Wars of the sixteenth century following the Protestant Reformation, which created a number of major contractions (Wilson, 2008; Becker et al., 2016). The Reformation is also sometimes seen as consolidating the reversal of fortunes between Mediterranean and northwest Europe through effects on long run growth, particularly through human capital formation (Becker et al., 2023). Here, however, we focus on how the short run business cycle effects of the religious wars affected long run growth rather than a wider assessment of the long run growth effects of the Reformation. We also note that the religious wars involved international alliances and are associated with a number of major contractions, which led to a significant increase in the degree of international synchronisation.

The third shock considered here is the Industrial Revolution, which is widely seen as one of the most important turning points in human history, but has so far been analysed almost completely in terms of long run growth without any reference to short run business cycle fluctuations (Landes, 1969; Mathias, 1969). Using annual data for many European economies we demonstrate that British forging ahead and the spread of this Great Enrichment to the rest of Europe owed more to a reduction in the contribution of contractions than to an increase in the contribution of expansions to long run growth. Our fourth shock encompasses much of the first half of the twentieth century, which included the two World Wars and the Great Depression. We confirm that leaving the gold standard promoted early recovery from the Great Depression, in line with the finding of Eichengreen and Sachs (1985), but also show how it affected long run growth. Although many of the largest contractions of the last seven centuries occurred during or immediately after the two World Wars, there was also a strong negative relationship between the depth of wartime contractions and the strength of postwar expansions, particularly across World War 2.

Finally, we examine the business cycle for an aggregate European GDP per capita series estimated as a chained index from the individual country series, using population weights. In contrast to the unweighted average of the ratios (frequency, duration, etc.) for each country, this involves calculating the ratios for the weighted average of GDP per capita across all countries. This confirms all the main results derived from the unweighted average of the ratios. We discuss the interaction between the short run business cycle (as measured by annual growth rates) and the level of GDP per capita.

2. Data

Quantification of economic activity at the macro level before the mid-nineteenth century received a major boost with the publication of Maddison's (2001), *The World Economy: A Millennial Perspective*, which set out levels and growth rates of GDP, population and GDP per capita for the world covering the whole of the second millennium. However, Maddison's estimates contained a large amount of "guesstimation" or "controlled conjectures", with a number of observations set at or close to $400 in 1990 international prices. This is equivalent to most people living at "bare bones subsistence", or the World Bank poverty level of $1 per day, with a small rich elite on top. Furthermore, Maddison provided his conjectural estimates only for a small number of years, which precludes business cycle analysis.

However, stimulated by Maddison's work, economic historians have begun to produce estimates of per capita income in a national accounting framework, based on contemporary data and available at annual frequency. This is possible because medieval and early modern Europe was much more literate and numerate than is often thought, and left behind a wealth of data in documents such as government accounts, customs accounts, poll tax returns, parish registers, city records, trading company records, hospital and educational establishment records, manorial accounts, probate inventories, farm accounts, tithe files and other records of religious institutions. With a national accounting framework and careful cross-checking, it is possible to reconstruct historical national accounts back to the medieval period.

For some European countries, abundant quantitative information has survived, so that historical national accounts can be

constructed directly on a sectoral basis in great detail. Britain has the richest data, with historical national accountants able to build on decades of detailed data processing by generations of scholars as well as well-stocked archives (Broadberry et al., 2015). The Dutch and Swedish data are also of sufficient quality to reconstruct GDP from the output side using the direct method, although in both cases the data sources are thinner for the pre-1500 period (van Zanden and van Leeuwen, 2012; Krantz, 2017). For other countries, where information on sectoral output is more limited or where there has been less processing of the existing data, but data on wages and prices are widely available, Malanima (2011), Álvarez-Nogal and Prados de la Escosura (2013) and others have developed an indirect or short-cut method for reconstructing GDP, building on pioneering work by Crafts (1985) and Wrigley (1985). In the indirect method, the economy is first divided between agriculture and non-agriculture. In the agricultural sector, output is estimated via a demand function, making use of data on population, real wages and the relative price of food, together with elasticities derived from later periods and the more recent experience of other less developed economies. An allowance can also be made for international trade in food. For the non-agricultural sector, output is assumed to have moved in line with the urban population, but an allowance can be made for higher productivity in the non-agricultural sector.

The major input into our analysis of the business cycle is GDP per capita (Ramey and Ramey, 1995; Berge and Jordà, 2013; Jordà et al., 2013, 2017). We do not use GDP because estimates of GDP per capita are available for the nine economies throughout the medieval period, whereas estimates of GDP are only available for five economies over the same interval. This is due to the fact that the primal data series for the indirect method is the real wage, which is inherently on a per capita basis. For these economies, GDP can only be estimated by multiplying the GDP per capita series by long run estimates of population. Since these population estimates are usually interpolated with only a small number of benchmarks, this potentially distorts the volatility of the GDP series that could be problematic for the analysis of business cycles. Nevertheless, in Appendix 3 we show that where both series are available the business cycle facts are similar using GDP per capita and GDP.

Table 1 sets out the start dates for each series and the years for which there are gaps, while the data sources are listed together with the notes under the table. The data reach back to the late thirteenth century in the cases of Britain, France and Spain, the first half of the fourteenth century in Sweden, Italy and the Netherlands, the fifteenth century in Poland and the first half of the sixteenth century in Germany and Portugal. The British, Dutch and Swedish series have been derived using the direct method, while the other series have been reconstructed using the indirect method.

Fig. 1 plots the annual logarithmic growth rate of GDP per capita for each country. This is a stationary series in all cases, although the amplitude varies considerably across countries. Before conducting the analysis in Section 4, we note some features of the growth fluctuations in each country. For the case of Great Britain in Fig. 1A, it should be noted that for the pre-1870 period we are using the harmonised data from Broadberry et al. (2022), which reduced the variation in the amplitude of the GDP series between the medieval, early modern and modern periods. This deals with the varying volatility of the grain yields in the agricultural output series from Broadberry et al. (2015), which are derived from different sources for the medieval, early modern and modern periods. The excessive variation in volatility between periods can be corrected using the relative volatility of the grain price series over the same periods, as these prices are taken from consistent sources over the whole period.

Turning to the case of France in Fig. 1B, the data before 1850 are constructed using the indirect method (Ridolfi and Nuvolari, 2022). In general, the level of volatility is moderate, with GDP per capita growth rates remaining between ±10 per cent bands for much of the time, but with a significant number of both large negative and positive shocks. The Spanish data in Fig. 1C are the revised estimates by Prados de la Escosura (2017) and Prados de la Escosura et al. (2022). Although the pre-1850 data are primarily constructed using the indirect method, the demand-based agricultural output data have been cross-checked with supply-side estimates using tithe data. Again, the GDP per capita series exhibits a modest degree of volatility, with growth rates remaining within the ±10 per cent bands for much of the time.

The Swedish data in Fig. 1D are based on the direct method throughout, built up from sectoral data on output. However, fewer sources were available for the pre-1560 period, especially for the years before circa 1400, which may help to explain the extremely low volatility during the fourteenth century (Krantz, 2017). Sweden was not alone in experiencing high volatility during the fifteenth century, which was also experienced by Italy and Spain. The Italian data in Fig. 1E are based on the indirect method for the pre-1860

Table 1
Data Sources.

Country	Start date	Interpolated data
Great Britain	1270	
France	1276	
Spain	1277	
Sweden	1300	
Italy	1310	
Netherlands	1348	1809–1814
Poland	1409	1801–1810, 1900–1909, 1911–1912, 1914–1919, 1921–1928, 1939–1947
Germany	1500	
Portugal	1530	1852–1854, 1856–1860, 1862–8644

Sources and notes: Data since 1870 from the Maddison Project Database (2020). Data before 1870 as follows: Great Britain: Broadberry et al. (2015, 2022); Feinstein (1972). France: Ridolfi and Nuvolari (2022). Spain: Prados de la Escosura (2017, 2022). Sweden: Schön and Krantz (2012); Krantz (2017). Italy: Malanima (2011). Netherlands: van Zanden and van Leeuwen (2012). Poland: Malinowski and van Zanden (2017). Germany: Pfister (2022). Portugal: Palma and Reis (2019).

period. Here, we are using the data of Malanima (2011), which refer to Central and North Italy, excluding the South. Although a new series by Chilosi and Ciccarelli (2023) includes the whole of Italy, the data for the South are only available for a small number of benchmark years, so that it cannot be used for business cycle analysis. The Italian data for the modern period exhibit huge volatility around World War 2, with a sharp decline in output at the end of the war, followed by rapid growth during the recovery from the 1950s to the 1970s. The data for the Netherlands in Fig. 1F are based on the direct method throughout the period, although the data are rather less abundant for the period before 1500, and display low volatility compared with the Dutch Golden Age between circa 1500 and 1640, when the high volatility reflects a very high degree of openness to international trade (van Zanden and van Leeuwen, 2012). The Dutch economy also displays a similar pattern to Italy across World War 2.

The Polish data in Fig. 1G are based on the indirect method before the twentieth century (Malinowski and van Zanden, 2017). The

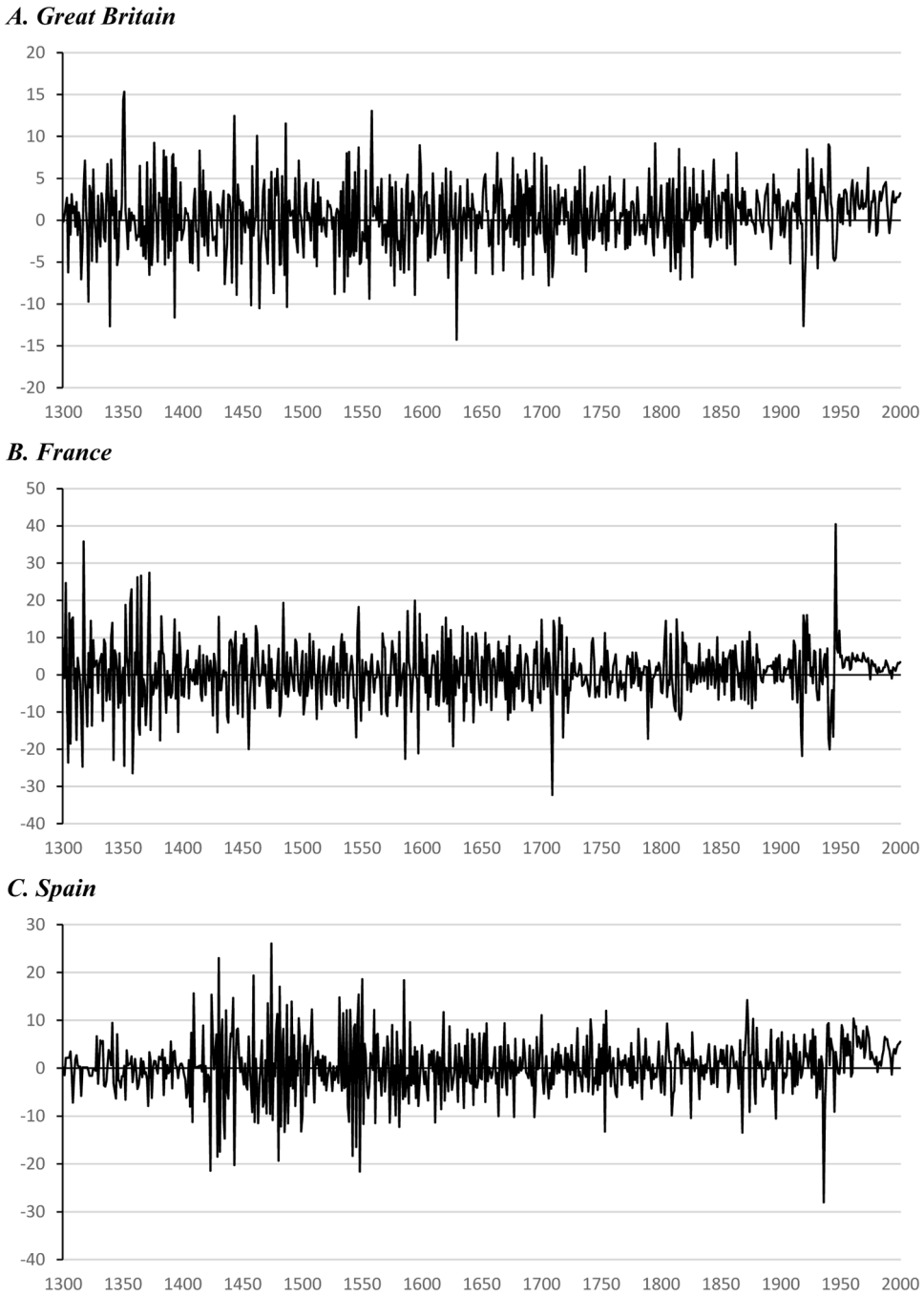

Fig. 1. The Business Cycle in GDP per capita, 1300–2000 (%).

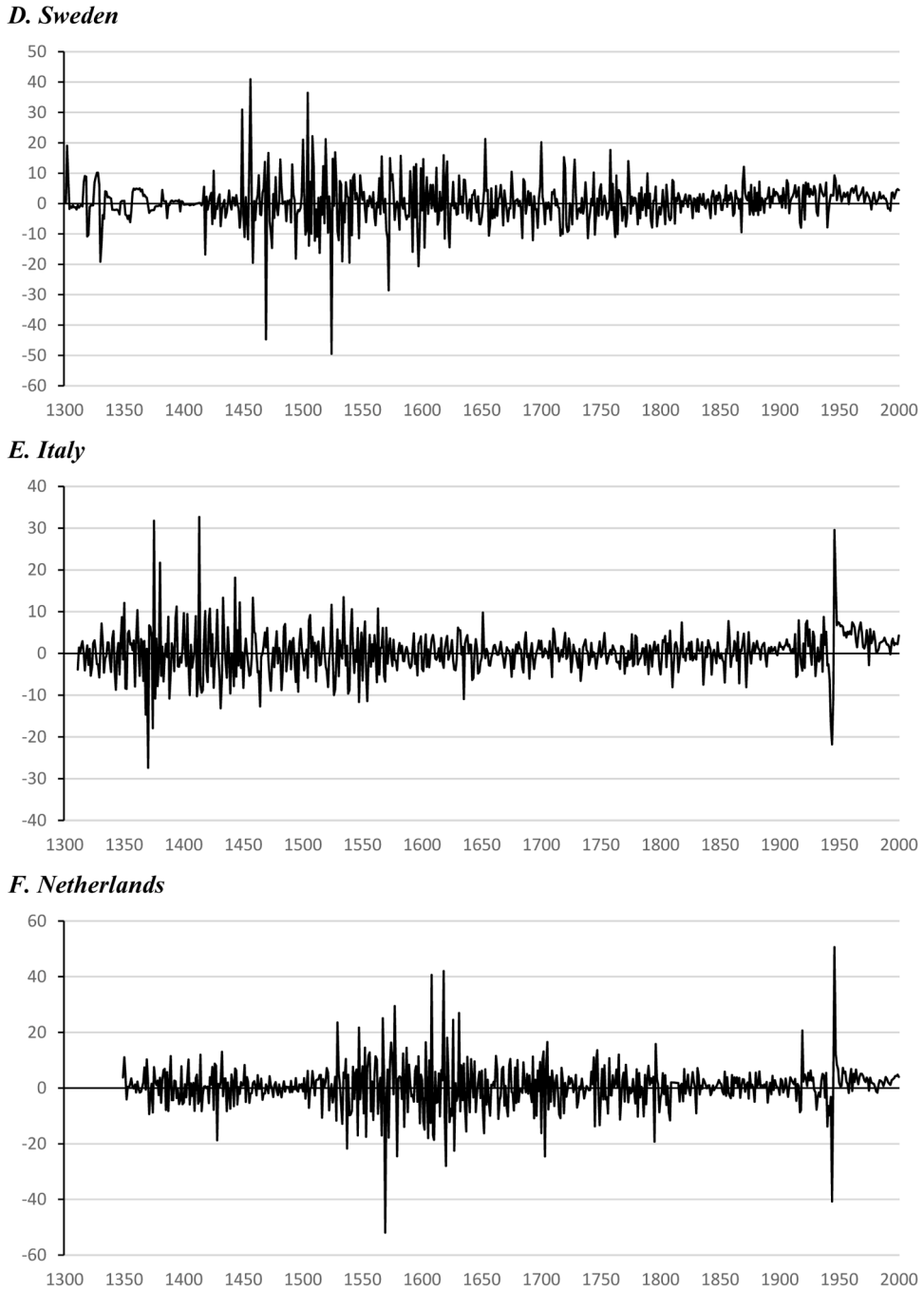

Fig. 1. (*continued*).

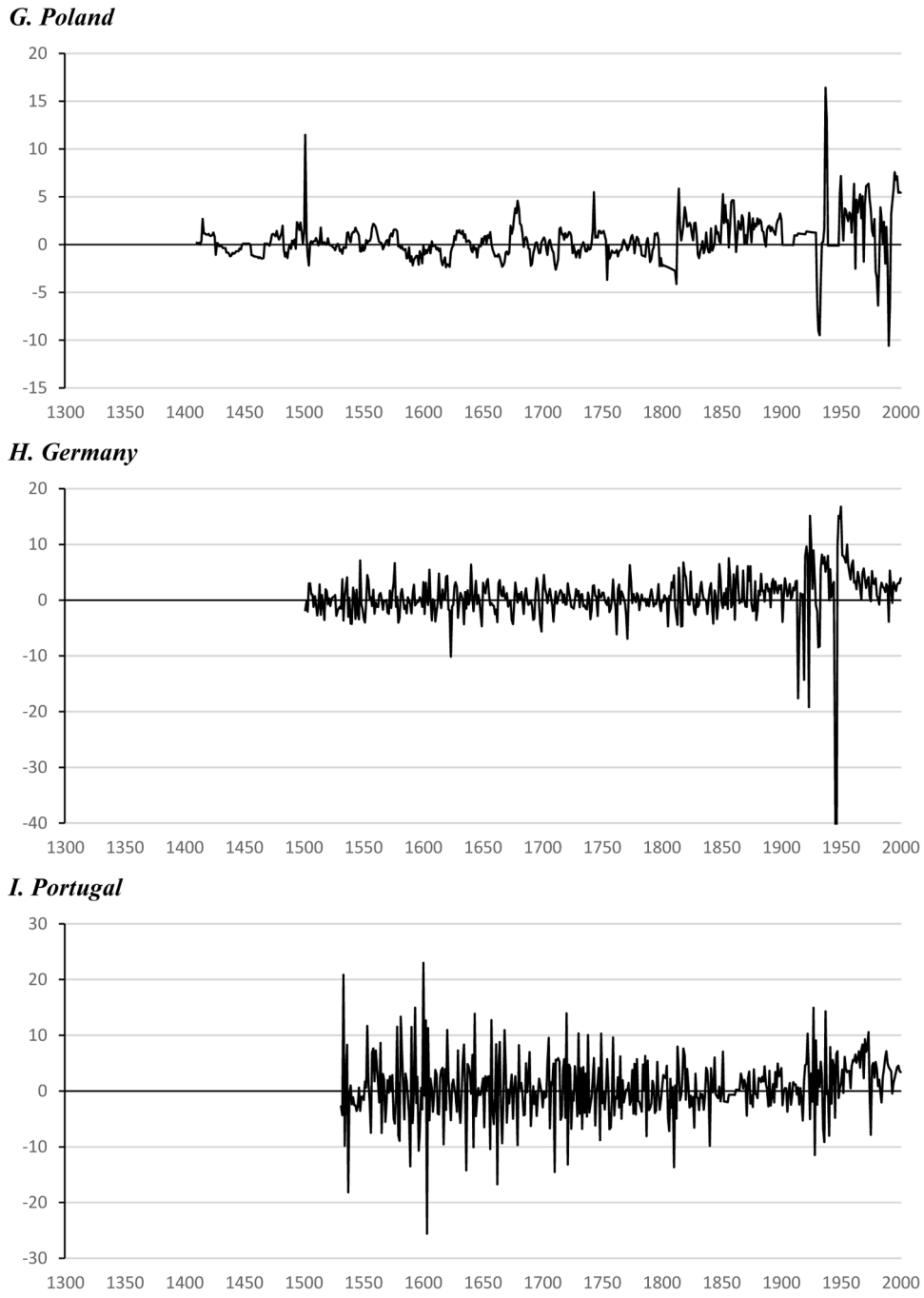

Fig. 1. (*continued*).

series for the period 1410–1800 covers the territory of the Voivodeship of Cracow, anchored on a benchmark estimate of GDP per capita for 1578, while the series for the period 1800–1910 covers roughly the territories that are currently in Poland, anchored on a benchmark for 1870 (Malinowski and van Zanden, 2017: 400). The Voivodeship of Cracow contained only around 10 per cent of the population of Poland in the late sixteenth century, but it is nevertheless reassuring that the two series meet at around the same level in the early 1800s. Although official estimates for the post-World War 2 data before 1990 are based on the Soviet concept of Net Material Product (NMP) rather than GDP and also relied on non-market prices, they have been reworked by western researchers. Even though Alton's (1970) estimates for Poland have been criticised, they appear to fit reasonably well with the pre-World War 2 and post-1990 data and remain widely used (Vonyó and Markevich, 2021: 279–280). The Polish data are much less volatile than in all other countries before the nineteenth century, which suggests that Malinowski and van Zanden (2017) were more successful in capturing the trend in

real GDP per capita than the cycle. We nevertheless keep Poland in the sample, since it is the only country representing eastern Europe.

The German growth data in Fig. 1H are constructed using the indirect method before 1850 and, like the Polish data, Pfister's (2022) series stands out as having relatively low volatility during this period. However, the situation is very different in the twentieth century, when the German economy exhibits very high volatility around the two World Wars, with the collapse at the end of World War 2 going off the scale, but followed by a very rapid and sustained expansion. The Portuguese data in Fig. 1I are based on the series by Palma and Reis (2019), reconstructed using the indirect method. The Portuguese cycle shows declining amplitude until the end of the nineteenth century then a return to high volatility during the twentieth century.

3. Identifying business cycles

A business cycle is composed of two phases, an expansion followed by a contraction. An expansion is an increase in economic activity from the period following the trough to the peak, while a contraction is a decrease in economic activity from the period following the peak to the trough. To identify business cycles, we apply a simple algorithm that identifies expansions, E_t, and contractions, C_t, in the natural logarithm of a time series, y_t, as:

1. $E_t = 1$ if $\Delta y_t > 0$
2. $E_t = 1$ if $\Delta y_t = 0$ and $E_{t-1} = 1$
3. $E_t = 0$ otherwise
4. $C_t = 1 - E_t$

where Δ is the difference operator. Steps 1 and 2 define an expansion as a year of positive economic growth or a year of zero economic growth if it was preceded by an expansion, which ensures that the latest observation "in a horizontal zone is chosen as the turning date" (Burns and Mitchell, 1946: 58). Steps 3 and 4 define a contraction as a year of negative economic growth or a year of zero economic growth if it was preceded by a contraction. Peaks, P_t, and troughs, T_t, are defined as:

$$P_t = \begin{cases} 1 & \text{if } E_t = 1 \text{ and } E_{t+1} = 0 \\ 0 & \text{otherwise} \end{cases} \tag{1}$$

$$T_t = \begin{cases} 1 & \text{if } C_t = 1 \text{ and } C_{t+1} = 0 \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

The algorithm ensures that peaks and troughs alternate, that the minimum phase is at least one year and that the minimum cycle is at least two years, which are standard criteria of business cycle dating algorithms (Harding and Pagan, 2002).

The objects of interest are frequency, duration, rate and amplitude. At the country level, frequency is defined as the fraction of time spent in a phase, duration is the average length of a phase, rate is the average log growth rate in a phase and amplitude is the product of average duration and average rate of a phase. At the aggregate level, frequency, duration and rate are unweighted averages of the country-level numbers. Amplitude is aggregate average duration multiplied by aggregate average rate. The averages are calculated as arithmetic means.

We study the natural logarithm of real GDP per capita to calculate rate and amplitude because of the symmetry of expansions and contractions. For example, a fall in the level of a time series from 100 to 90 is a change of −10 per cent; a rise from 90 to 100 is a change of 11.1 per cent. The same pattern in the log of a time series is −0.105 log points and 0.105 log points respectively. However, using the natural logarithm, as opposed to the level, does not affect the dating of expansions, contractions, peaks or troughs.

Beyond the fact that it is not feasible to use expert judgement to identify business cycles in nine economies since the Middle Ages, the issue of rules versus discretion is minimal with annual data. By any definition, a year of rising economic activity is an expansion; a year of falling economic activity is a contraction. As a result, our algorithm perfectly reconstructs the business cycle chronology for the United Kingdom between 1700 and 2010 that was based on the judgement of the UK Business Cycle Dating Committee (Broadberry et al., 2023).

An old issue in business cycle dating is whether to detrend the data or not (Romer, 1994). There is a strand of historical literature that removes the trend, such as Ciccarelli and Fenoaltea (2007), Andersson and Lennard (2018) and Dimsdale and Thomas (2019). However, the emerging consensus is to study the data in levels (Harding and Pagan, 2002; Broadberry et al., 2023). The main reason is that there are many methods for detrending, each with different possible specifications, which will affect the dating of turning points and the business cycle facts (Canova, 1994, 1998; Dimsdale and Thomas, 2019; Broadberry et al., 2023). In any case, the two approaches measure different objects: when the data are detrended, the focus is on growth cycles; when the data are in levels, the focus is on classical cycles. In this setting, the classical cycle is the object of interest, as it best reflects the changing nature of the business cycle over time. Filtering, by its nature, compresses some of this heterogeneity. For example, filters only retain fluctuations if the duration and amplitude are within a predetermined range and economies mechanically spend approximately 50 per cent above trend and 50 per cent below.

At this point it is worth noting that the dampening of contractions is not merely the result of the economy moving from technological stagnation to trend technological progress. In a world with zero trend technological progress, an expansion must lead to positive GDP per capita growth, while a contraction must lead to negative growth. Imagine now that steady positive trend technological progress emerges for the first time but the distribution of expansions and contractions in the cycle remains unchanged. In this case, the rate of contraction must decline, consistent with the patterns seen in the data, but notice what happens on the expansion side: the rate

of expansion increases, which is strongly at variance with what happened in the data. Historically, a decline in the rate of expansion occurred together with an even bigger decline in the rate of contraction. A numerical example might help to clarify the issue. Imagine an economy with no trend technological progress and alternating periods of expansion at +2 per cent and contraction at −2 per cent. Now consider adding trend technological progress at 1 per cent per period. If nothing else changes, we should expect to see an economy alternating between expansions of +3 per cent and contractions of −1 per cent. Therefore, there is an increase in the rate of expansion that is completely at variance with the historical pattern. Rather than seeing the cycle as affected by an exogenous trend that can be removed, we see the trend as emerging from the changing nature of the business cycle, the most important aspect of which was a growing resilience to negative shocks.

4. Analysis

4.1. The business cycle facts

We begin the analysis by setting out in Table 2 the basic business cycle facts for the sample of nine European countries. The numbers are shown for both expansions (trough to peak) and contractions (peak to trough). To detect changes in these statistics, we break the sample into sub-periods: 1300–1350, 1350–1500, 1500–1700, 1700–1815, 1815–1914, 1914–1950, and 1950–2000. This periodisation has been chosen to align with well-known epochs in economic history and to be broadly consistent with the estimated break dates in GDP per capita found for a sample of European economies (Crafts and Mills, 2017; Prados de la Escosura and Rodriguez-Caballero, 2022).

The first result is that contractions were about as frequent as expansions before the nineteenth century, but by the second half of the twentieth century expansions occurred almost 90 per cent of the time. A second finding is that the duration of expansions increased from the nineteenth century while the duration of contractions decreased over the same period. A third result is that the rate of growing during expansions followed a U-shaped pattern over time but ended up lower in the second half of the twentieth century than before 1700, while the rate of shrinking during contractions trended down apart from a blip during the turbulent period of the two World Wars and the Great Depression between 1914 and 1950. These three results reflect the importance of reducing the frequency and rate of negative growth in economies achieving the transition to long run sustained economic growth (Broadberry and Wallis, 2017). The finding that the rate of growing during expansions did not increase more strongly during the transition to sustained economic growth may at first sight seem counter-intuitive, but it is consistent with the findings of Easterly et al. (1993) that, in today's world, poor economies grow faster than rich economies when they are growing, and are poor because they grow less frequently and experience rapid rates of negative growth during contractions.

Our fourth finding is that the amplitude of expansions also followed a U-shaped pattern but ended up much higher during the second half of the twentieth century than before 1700, while the amplitude of contractions trended down apart from a blip between 1914 and 1950. The increasing amplitude of expansions after 1815 follows directly from the growing duration combined with a relatively stable rate of expansion, while the declining trend in the amplitude of contractions over the same period is due to the falling trends in both the duration and rate of contractions.

The changing nature of the business cycle in Europe thus appears to be related to the emergence of sustained long run economic growth. The pre-modern business cycle is characterised by broadly similar frequencies of expansions and contractions, short expansions and contractions of similar length, and also similar rates and amplitudes of contractions and expansions. At around the end of the Napoleonic Wars, however, we see the beginnings of a systematic change in the nature of the European business cycle with a higher frequency of expansions than contractions, longer expansions and shorter contractions with similar rates of contractions and expansions, and higher amplitudes of expansions combined with lower amplitudes of contractions. These changes were associated with a general quickening of the pace of long run economic growth and continuously rising living standards (Broadberry and Wallis, 2017).

Data for each of the nine European economies are provided in Appendix Table A1 to demonstrate that the patterns we have identified were experienced across a broad range of countries rather than being created as a statistical artefact from very diverse trends in different parts of Europe. Only Poland deviated significantly from the four patterns outlined above, reflecting the dramatic geopolitical and economic upheavals in eastern Europe during the twentieth century. All nine countries exhibit the first trend of a roughly 50:50 frequency of expansions and contractions before the nineteenth century with the frequency of expansions rising to around 90 per cent by the second half of the twentieth century. However, Poland missed out on both the sharp rise in the duration and amplitude of expansions and the sharp fall in the rate and amplitude of contractions in the post-1950 period as the socialist system followed a different path from the rest of the continent before collapsing in 1989.

How has macroeconomic volatility changed over the last seven centuries? Table 3 reports the mean, standard deviation and coefficient of variation of real GDP per capita growth by period. Before 1815, European economies suffered not only from low growth but also high volatility, which is consistent with the symmetry, duration and violence of expansions and contractions in Table 2. After 1815, however, there was an upturn in growth and a moderation in volatility. In the transwar period, economies experienced a return to instability. A new standard was set after World War 2 with high growth and low volatility.

4.2. International co-movement

So far, we have focused our attention on the changing properties of the European business cycle for the sample of nine economies as a whole. However, it is also interesting to examine how economic activity was synchronised across those economies and how the degree of international co-movement changed over time. To do this, we examine the correlation of the logarithmic growth rate of GDP

Table 2
The European Business Cycle, 1300–2000.

	1300–1350	1350–1500	1500–1700	1700–1815	1815–1914	1914–1950	1950–2000	1300–2000
	Expansions (Trough to peak)							
Frequency (%)	52.2	51.5	50.3	50.9	63.7	62.5	89.3	56.6
Duration (years)	2.8	2.5	2.5	2.3	3.5	4.3	12.2	2.9
Rate (% per year)	4.5	4.4	4.4	3.3	2.7	5.5	3.7	3.8
Amplitude (%)	12.6	11.0	11.0	7.6	9.5	23.7	45.1	11.0
	Contractions (Peak to trough)							
Frequency (%)	47.8	48.5	49.7	49.1	36.3	37.5	10.7	43.4
Duration (years)	3.1	2.6	2.4	2.4	1.9	2.5	1.3	2.3
Rate (% per year)	−4.5	−4.2	−4.3	−3.3	−2.4	−6.5	−1.6	−3.8
Amplitude (%)	−14.0	−10.9	−10.3	−7.9	−4.6	−16.3	−2.1	−8.7
Observations	243	997	1777	1044	900	333	459	5706

Notes: This table shows the frequency, duration, rate and amplitude of European business cycles in GDP per capita between 1300 and 2000 for nine European economies.

Table 3
Volatility of GDP per capita Growth by Period.

	Mean (μ)	Standard deviation (σ)	Coefficient of variation (σ/μ)
1300–1350	0.3	6.8	21.8
1350–1500	0.1	6.8	62.6
1500–1700	0.1	6.6	78.1
1700–1815	0.1	4.7	84.8
1815–1914	0.8	3.3	4.0
1914–1950	1.0	9.1	9.2
1950–2000	3.1	2.7	0.9
1300–2000	0.5	5.9	12.1

Notes: This table shows the mean, standard deviation and coefficient of variation of logarithmic growth rates of GDP per capita between 1300 and 2000 for nine European economies.

Table 4
Number of Significant Positive Correlations between Country Pairs of GDP per capita Growth by Period.

	Significant positive pairwise correlations	Possible pairwise correlations	Percentage of significant positive pairwise correlations
1300–1350	2	10	20.0
1350–1500	3	21	14.3
1500–1700	5	36	13.9
1700–1815	6	36	16.7
1815–1914	8	36	22.2
1914–1950	8	36	22.2
1950–2000	24	36	66.7

Notes: This table shows the international co-movement of logarithmic growth rates of GDP per capita between 1300 and 2000 for nine European economies.

per capita between countries for the period 1300–2000, broken down into 7 sub-periods. The results are summarised in Table 4, and the matrices of correlation coefficients are shown for each sub-period in Appendix 2.

Since we are interested in the evolution of a common European business cycle, we focus our attention only on statistically significant (at the 10 per cent level) positive pairwise correlations. During the period 1300–1350, we have data for five countries so that the number of possible pairwise correlations is limited to 10 $[(N^2 - N)/2$, where N is the number of countries]. In this period there were only two significant positive correlations, between Britain and France and between France and Sweden (see Table A2.1), or 20 per cent of all possible pairwise correlations. This suggests a reasonably high level of synchronisation in a short period of high population pressure, dominated by the Great European Famine of 1315–1317 and the arrival of the Black Death in the late 1340s (Lucas, 1930; Herlihy, 1997).

For the period 1350–1500, the number of countries for which we have data increases to seven so that the number of possible pairwise correlations rises to 21, while for the period after 1500 we are able to include all nine countries so that the number of possible pairwise correlations goes up to 36. Although the number of significant pairwise positive correlations increases to 3 for the period 1350–1500, this is a decrease in the proportion of possible pairwise correlations to 14.3 per cent. The proportion of significant pairwise correlations increases after 1700 and again after 1815, rising above 20 per cent for the first time during this period of increasing

globalisation (O'Rourke and Williamson, 1999). Although there was no change during the period of de-globalization between 1914 and 1950, the share of significant positive pairwise correlations jumped to 66.7 per cent during the period 1950–2000.[1]

Our results for the period since 1815 are broadly consistent with the findings of Bergman et al. (1998), who included 10 European countries together with the United States, Canada and Japan, to identify an international business cycle. Although their data start later in the nineteenth century, they find relatively few significant positive pairwise correlations between these 13 economies during the heyday of the first era of globalization, amounting to just 15.4 per cent of possible cases during the period 1873–1913. Perhaps surprisingly, they find significant positive pairwise correlations rising to 35.9 per cent during the interwar period (1920–1938). This suggests that our finding of no increase in the percentage of significant positive pairwise correlations during 1914–1950 is driven by what happened during the two World Wars rather than by the interwar period, when the Great Depression resulted in all economies moving into recession at the same time, followed by a period of recovery. Between 1950 and 2000, Bergman et al. (1998) find significant positive pairwise correlations in 34.6 per cent of cases during the period 1948–1972, rising to 59.0 per cent of cases between 1973 and 1995. These patterns of international synchronisation will be addressed further in Section 5.4, which considers the effects of the two World Wars and the Great Depression. It seems that although the massive negative shock of the Great Depression increased synchronisation, the effects of the two World Wars more than offset this.

There exists no hard and fast rule for identifying a critical juncture in the degree of international co-movement. The number of significant positive correlations of GDP per capita growth across countries as a percentage of all possible pairwise correlations in Table 4 was increasing from 1700 onwards, in line with Europe's global maritime expansion (de Zwart and van Zanden, 2018). However, the percentage did not rise above the pre-Black Death level of 20 per cent until the end of the Napoleonic Wars, which would fit well as a critical juncture with the break in the frequency and duration of expansions and contractions in Table 2. The period of deglobalisation between 1914 and 1950 briefly paused this upward trend before it was resumed after 1950.[2]

5. Major European contractions and expansions

We have shown how the nature of the business cycle changed in Europe together with the emergence of sustained long run economic growth, and in this section we highlight a number of key episodes along the way, where major contractions or expansions also had significant implications for long run growth.

5.1. The Black Death

The most important business cycle event during the late medieval period was surely caused by the arrival of the Black Death in the mid-fourteenth century, which had a devastating effect on the population of Europe. In Britain, for example, the Black Death dealt devastating blows to the supply of labour and the demand for goods and services. Population declined by one third within three years of its arrival in 1348, and by more than 60 per cent by the mid-fifteenth century, and recovery to the pre-Black Death level would not be reached until the seventeenth century. As a result, GDP fell to little more than half of its pre-Black Death level by the mid-fifteenth century and recovery to the 1348 level would not be reached until the 1560s. No subsequent contraction would ever be as deep and prolonged. However, the upshot for GDP per capita was dramatically different, as the reduced number of survivors found that neither land nor capital had declined, thus increasing per capita supply of these crucial factors of production. Given these dramatic changes in factor proportions, landless labourers found they could command higher real wages in a labour market characterised by excess demand, so that the per capita income gains were spread widely across the economy. Hence GDP per capita increased by around one-third in the first three years, rising to more than 40 per cent by the beginning of the fifteenth century as the plague kept returning, further reducing the population (Broadberry et al., 2015, 2022). These very divergent long run trends of GDP and per capita GDP, combined with the similar short run peaks and troughs, can be seen in Fig. 2A, which plots the British series together with the population data.[3]

However, the Black Death affected other economies in a range of ways, which contributed to a reversal of fortunes between the northwestern and Mediterranean parts of Europe, in what has come to be known as the European Little Divergence. In Fig. 2B, we see that there was a similar sustained increase in GDP per capita in the Netherlands, although the decline in population was substantially less than in Britain, reaching a maximum decline of around a quarter by the 1360s. As a result, the increase in GDP per capita more than offset the decline in population so that GDP quickly rose above its 1348 level by the mid-1350s and population was already above its pre-Black Death level by the 1430s (van Zanden and van Leeuwen, 2012).

Turning to Mediterranean Europe, Fig. 2C charts the situation in Spain, where the scale of the negative shock to population was similar to that experienced in the Netherlands rather than in Britain. However, in contrast to the rest of western Europe, Spain did not

[1] The significance of a correlation coefficient is a positive function of the number of observations, which varies from period to period. For example, the period 1500-1700 has 201 observations; the period 1950-2000 has 51 observations. Therefore, a given correlation coefficient could be significant in one period and insignificant in another. To assess the importance of this issue for our results, we recalculate the significance assuming 201 observations in each period, which shows a similar pattern of a rising fraction of positive and significant correlations from 1700-1815.

[2] In Appendix 3, we examine the sensitivity of the business cycle facts and international synchronisation to measurement error.

[3] The lower volatility of the population data reflects reality rather than a statistical artefact. Although there is some interpolation in the English population series from Broadberry et al. (2015), it should be noted that after 1541, when continuous annual data from Wrigley and Schofield (1989) become available, the increase in volatility is relatively small.

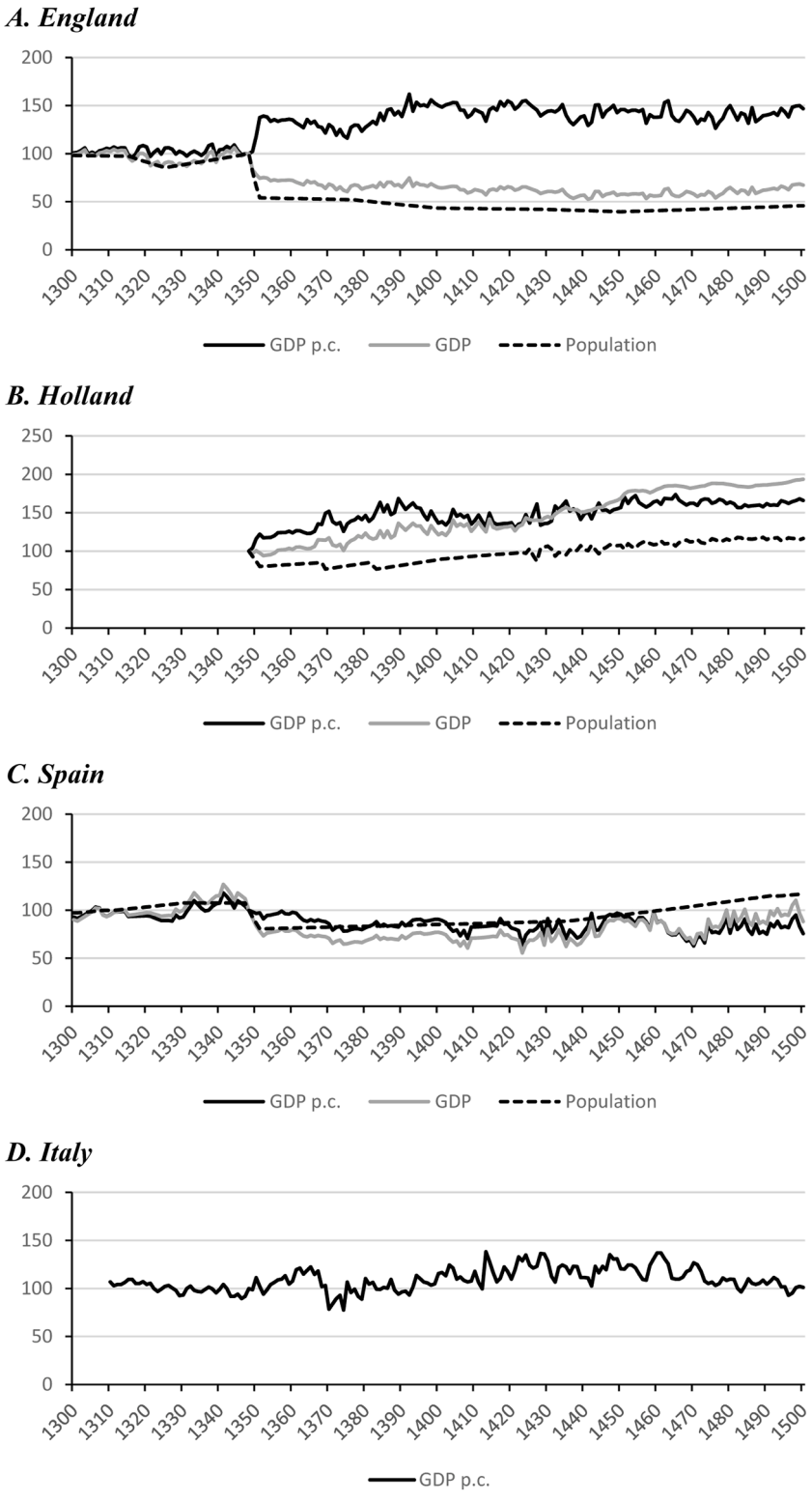

Fig. 2. Population, GDP and GDP per capita in Four European Economies, 1300–1500 (1348=100).

experience an increase in per capita income, which has been attributed by Álvarez-Nogal and Prados de la Escosura (2013) to the high land-to-labour ratio in a frontier economy during the Reconquest period. Instead of reducing pressure on scarce land resources, Spanish population decline destroyed commercial networks and further isolated an already scarce population, reducing specialisation and the division of labour. Thus Spain did not share in the general west European increase in per capita incomes after the Black Death.

Finally, Fig. 2D illustrates the intermediate case of Italy, where there was some initial increase in GDP per capita in the 1350s and 1360s after the arrival of the Black Death, but this was not sustained during the 1370s to the 1390s. Although there were further periods of expansion during the fifteenth century, they were also not sustained so that by 1500 Italy was back at its pre-Black Death level of GDP per capita (Malanima, 2011).

To understand the role of business cycles in the differential long run performance of these two northwest European and two Mediterranean economies, we analyse the contributions of expansions and contractions using the formula set out by Broadberry and Wallis (2017). Long run economic performance, measured by the rate of growth of per capita GDP over periods of fifty years or so is the aggregation of short run changes measured at the annual level. Long run economic growth, g, is a combination of 4 factors: (1) the frequency with which an economy is in an expansion phase, $f(+)$, (2) the rate at which it grows during an expansion, $g(+)$, (3) the frequency with which an economy is in a contraction phase, $f(-)$ and (4) the rate at which it shrinks during a contraction $g(-)$. Thus:

$$g = \{f(+)g(+)\} + \{f(-)g(-)\} \quad (3)$$

We use this identity in Table 5 to decompose GDP per capita growth during the crucial period 1349–1400 following the Black Death.

The key thing that we seek to understand is the much higher growth of GDP per capita during the 1349–1400 period in Britain and the Netherlands, compared with Spain and Italy, shown in the last line of Table 5. The first thing to note is that Britain does not stand out as exceptional on the expansion side. Its frequency of expansion was lower than in all the other three economies and its rate of expansion was not unusually high. Rather, the secret of Britain's success in having the highest GDP per capita growth rate lay on the contraction side. Despite having a high frequency of contraction, Britain had one of the lowest rates of contraction, and thus a low contribution of contractions. Second, the frequency of expansion in the Netherlands was only slightly higher than in Spain and Italy. Third, the differences in the contributions of expansions and contractions were determined largely by the rates of expansion and contraction. The highest rate of expansions was in Italy, which had the highest contribution of expansions, but this was offset by Italy also having the highest rate of contraction and thus the highest contribution of contractions, so that its overall rate of GDP per capita growth was relatively modest. Although Spain had the lowest contribution of contractions, it still ended up with negative overall GDP per capita growth because its contribution of expansions was even lower.

5.2. *The European Wars of Religion*

The reversal of fortunes between northwest Europe and Mediterranean Europe highlighted in the previous section has been attributed to many factors, including the Protestant Reformation of the sixteenth century, and this correlation is apparent in the downward trend of GDP per capita in catholic Spain relative to the increasingly protestant Netherlands and Germany in Fig. 3. The most famous version of this line of argument is Weber's (1930) thesis that the protestant work ethic should be seen as the spirit of capitalism, but more recently the argument has been couched in terms of the emphasis placed by Martin Luther on reading the Bible, which encouraged universal schooling and hence boosted human capital accumulation (Becker and Woessmann, 2009; Becker et al., 2023). Weber's thesis has been subject to much criticism, including the observations that (1) performance amongst Catholic and Protestant nations and regions was quite varied, and (2) there are other potential explanations for this variation (Kersting et al., 2020). However, our main concerns here are firstly with the effects on short run business cycles and how they may have affected the long run trajectory of GDP and per capita GDP, and secondly with the effects on international synchronisation.

One economic consequence of the Reformation was a number of serious European Wars of Religion, including the Eighty Years' War in the Spanish Netherlands and the Thirty Years' War in the Holy Roman Empire. To what extent did these war shocks lead to

Table 5
Contributions of Expansions and Contractions to Long Run Economic Performance, 1349–1400.

	GBR	NLD	ESP	ITA
	Expansions (Trough to peak)			
Frequency (%)	50.0	57.7	55.8	55.8
Rate (% per year)	4.7	4.0	1.8	6.1
Contribution (% per year)	2.3	2.3	1.0	3.4
	Contractions (Peak to trough)			
Frequency (%)	50.0	42.3	44.2	44.2
Rate (% per year)	−3.1	−4.0	−2.6	−7.1
Contribution (% per year)	−1.6	−1.7	−1.2	−3.1
GDP per capita growth	0.8	0.6	−0.2	0.3

Notes: This table shows the frequency, rate and contribution of business cycles in GDP per capita between 1349 and 1400 for four European economies.

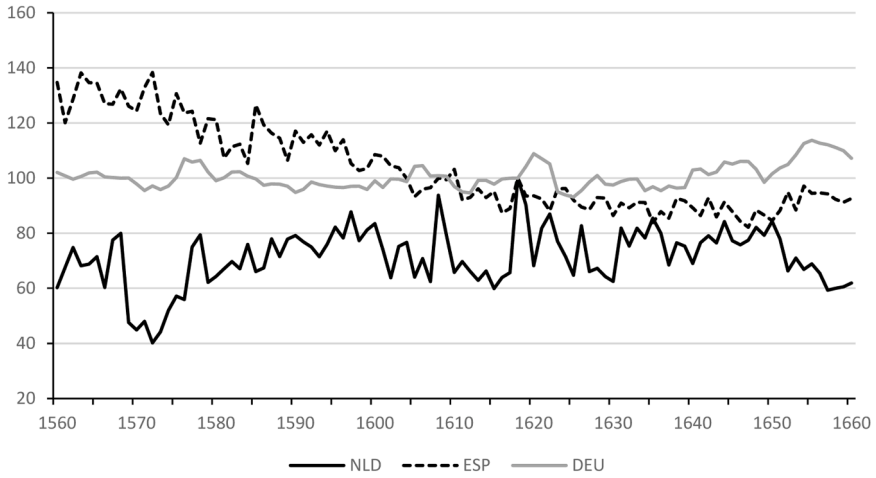

Fig. 3. GDP per capita in Three European Economies, 1560–1660 (1618=100).

significant contractions and what were their long run consequences? The start of the Eighty Years War, or Dutch Revolt, coincided with the second deepest contraction in Dutch history during 1568–70. Although there were further serious contractions in 1578–79 and 1600–02, these were not obviously worse than other contractions during the Twelve Years' Truce between 1609 and 1621, or indeed the final phase of the war between 1621 and 1648, which formed a side-theatre of the Thirty Years' War. Furthermore, the Netherlands was the fastest growing European economy during the early modern period, so these negative war shocks did not lead to adverse effects on long run growth.

To what extent did the involvement of many countries in these European religious wars of the sixteenth and seventeenth centuries affect the degree of international synchronisation? Until 1635 the Thirty Years War remained a largely internal German affair, but with some external interventions by other European powers, including Sweden and Denmark in addition to Spain and the Netherlands. During the second phase between 1635 and 1648, the conflict spread further afield as France became more heavily involved. Based on GDP per capita growth for the seven economies involved in the conflict, we find that the degree of international synchronisation increased between the pre- and post-1618 periods, as the proportion of statistically significant positive correlations rose from 0 per cent in 1560–1618 to 9.5 per cent in 1618–1660.[4]

5.3. *The Industrial Revolution*

The final and decisive phase of the European Little Divergence was the Industrial Revolution. The precise dating of this important episode varies among economic historians but is generally agreed to have begun in Britain during the eighteenth century and spread to much of western Europe by the late nineteenth century. Here we examine the links between the short run business cycle fluctuations and the long run growth of per capita GDP between 1750 and 1870. Fig. 4 charts the growth of GDP per capita in the four European economies that we also examined in the period following the Black Death. Setting GDP per capita in all four economies equal to 100 in 1750, we see that Britain had already grown faster by the end of the eighteenth century and pulled further ahead during the nineteenth century. Examining the period 1751–1800 in more detail in Table 6, we see in the final row that GDP per capita growth was slightly faster in Britain than in the Netherlands, and substantially faster than in Spain and Italy. Note, further, that this was due mainly to the fact that Britain had the lowest rate and contribution of contractions, despite also having a relatively low rate and contribution of expansions. Again we see that the crucial evolution of the business cycle for long run economic performance lay in the dampening of contractions rather than in the acceleration of expansions.

5.4. *The two World Wars and the Great Depression*

The four deepest contractions of GDP per capita amongst the sample of nine European countries between 1300 and 2000 occurred during and after World War 2, and although slightly less severe, the contractions during and after World War 1 were also very serious. However, the division of Europe into warring groups that reduced trade with each other resulted in a reduction in synchronisation of overall economic activity. Between these two very disruptive wartime periods, the Great Depression from 1929 was an important negative peacetime shock that increased co-movement, particularly when considered together with the recovery periods of the 1920s and later 1930s (Bergman et al., 1998).

Fig. 5A plots GDP per capita in France, Britain, Germany and the Netherlands during and after World War 1. The deepest contraction during the war, as measured by the amplitude of a continuous decline, was in France between 1916 and 1918, as the

[4] The seven countries are Germany, Spain, Netherlands, France, Sweden, Italy and Portugal.

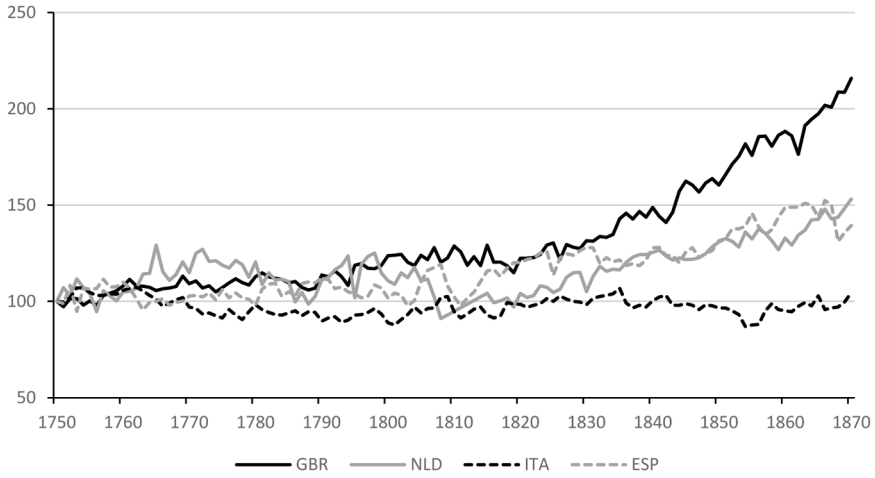

Fig. 4. GDP per capita in Four European Economies, 1750–1870 (1750=100).

Table 6
Contributions of Expansions and Contractions to Long Run Economic Performance, 1751–1800.

	GBR	NLD	ESP	ITA
	Expansions (Trough to peak)			
Frequency (%)	54.0	56.0	52.0	48.0
Rate (% per year)	2.5	4.8	3.0	1.8
Contribution (% per year)	1.3	2.7	1.6	0.9
	Contractions (Peak to trough)			
Frequency (%)	46.0	44.0	48.0	52.0
Rate (% per year)	−2.0	−5.6	−3.2	−2.1
Contribution (% per year)	−0.9	−2.5	−1.5	−1.1
GDP per capita growth	0.4	0.2	0.0	−0.2

Notes: This table shows the frequency, rate and contribution of business cycles in GDP per capita between 1751 and 1800 for four European economies.

demands of total war deepened in the main land theatre (Hautcoeur, 2005: 170–173). However, the negative impact of the war was surely more severe in Germany, where three substantial contractions occurred between 1913 and 1923. The largest amplitude was during the contraction of 1913–1915 as mobilisation deprived agriculture of male labourers and horses, and also industry of key workers, while blockade reduced the supply of other key inputs. Further severe shocks followed in 1918–1919 at the end of the war and again during the hyper-inflation of 1923 (Ritschl, 2005: 43–51). Britain experienced an expansion of GDP per capita at the beginning of the war, but a very severe contraction during the postwar reconversion to peace as government expenditure was sharply reduced (Broadberry and Howlett, 2005: 207–210). Although the Netherlands was a neutral country, it was caught geographically between the two main belligerent powers. From the outset of the war, the Netherlands suffered from measures taken by Britain and Germany to prevent trading with the enemy, and Dutch trade was hit hard during the last two years of the war by the intensification of the German U-boat campaign and the Allied blockade (de Jong, 2005: 138). The different timing of wartime shocks in a world economy divided into different groups that traded less with each other resulted in a reduction of synchronisation.

In Fig. 5B we see the contrasting paths followed during the Great Depression by economies which left the gold standard early and those that remained on gold until 1936. Britain left gold in September 1931 and was immediately followed by a number of countries that made up the Sterling bloc, including Sweden. Freed from the need to follow deflationary monetary policies, these countries began their recovery from the Great Depression early, as emphasised by Eichengreen and Sachs (1985). France and the Netherlands, by contrast, clung to gold until 1936 and thus became locked into deflationary monetary policies with adverse consequences for the long run path of GDP per capita. By 1938, the difference in the change of GDP per capita since 1929 between Sweden and the Netherlands amounted to around 30 per cent. Short run policy decisions thus had important long run consequences.

The deepest contraction in World War 2 occurred in Germany at the end of the war, as the country collapsed and was occupied by Allied troops. In Fig. 5C, we see that in marked contrast to the experience of the 1914–1918 conflict, Germany entered a phase of expansion at the beginning of World War 2, reaching peak mobilisation in 1944 (Abelshauser, 1998: 123–124). Recovery began in 1947 and the expansion continued uninterrupted until 1975. Britain also experienced an expansion at the start of the war as mobilisation drew in previously unemployed resources, and the contraction that began after peak mobilisation in 1943 lasted until 1947, but had a much smaller amplitude than in Germany (Broadberry and Howlett, 1998: 43–47). France and the Netherlands suffered deep

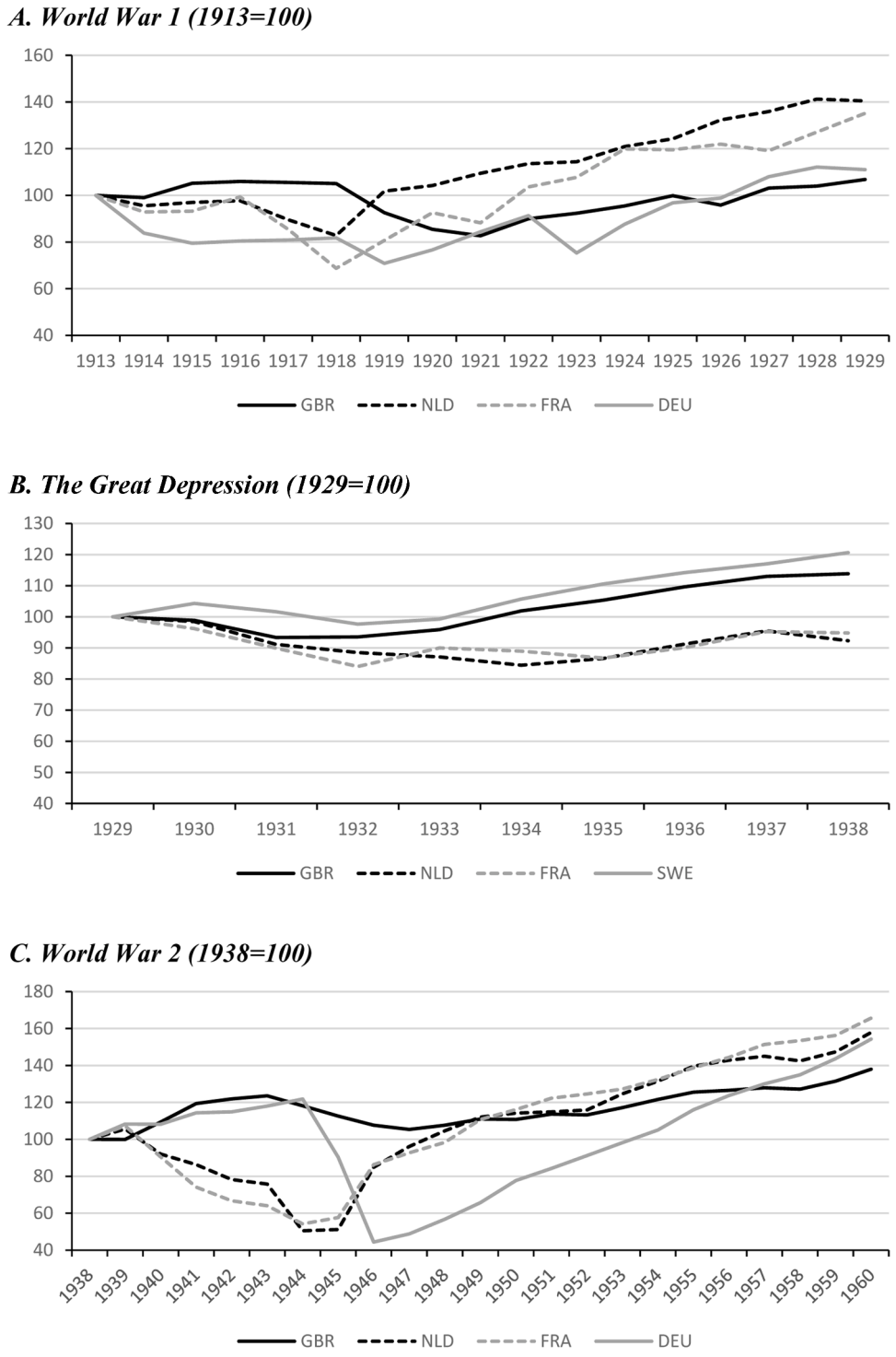

Fig. 5. GDP per capita during and after the Two World Wars and the Great Depression.

contractions lasting from 1939 to 1944. Both countries were occupied by Germany from the middle of 1940 and subjected to a strategy of exploitation. Milward (1977: 135–136) characterises Germany's strategy of exploitation of occupied territory as shifting from a short-term opportunistic approach to a long-term continuing-contribution approach from 1942 onwards, as the prospect of a short war receded. As the degree of exploitation increased, resistance grew and the economy contracted further, reaching a 1944 trough in both France and the Netherlands. Liberation led to a dramatic recovery, with the expansion lasting uninterrupted until 1975 in France and

Table 7
The Aggregate European Business Cycle in GDP per capita, 1300–2000.

	1300–1350	1350–1500	1500–1700	1700–1815	1815–1914	1914–1950	1950–2000	1300–2000
	Expansions (Trough to peak)							
Frequency (%)	54.0	53.0	53.2	51.7	72.0	56.8	94.1	58.7
Duration (years)	1.7	2.0	1.9	2.2	3.4	2.8	13.7	2.4
Rate (% per year)	4.3	3.5	2.0	1.8	1.7	4.1	3.2	2.6
Amplitude (%)	7.3	7.0	3.8	4.0	5.8	11.5	43.8	6.2
	Contractions (Peak to trough)							
Frequency (%)	46.0	47.0	46.8	48.3	28.0	43.2	5.9	41.3
Duration (years)	1.5	1.8	1.7	2.1	1.3	2.3	1.0	1.7
Rate (% per year)	−4.5	−3.8	−2.3	−1.6	−1.4	−3.8	−0.5	−2.7
Amplitude (%)	−6.8	−6.8	−3.9	−3.4	−1.8	−8.7	−0.5	−4.6
Observations	50	151	201	116	100	37	51	700

Notes: This table shows the frequency, duration, rate and amplitude of aggregate European business cycles in GDP per capita between 1300 and 2000, derived from a weighted average series across nine European economies.

1961 in the Netherlands.

The rapid postwar growth after both world wars has stimulated economic historians to examine the relationship between the depth of the wartime contraction and the strength of the postwar expansion. This negative relationship seems clearest in the case of World War 2, and has been seen in the recent literature on growth as a special case of catching-up growth, the most popular explanation for Europe's Golden Age of growth between 1950 and 1973 (Abramovitz, 1986; Dumke, 1990). For World War 1, Eichengreen (1994: 297–298) also claims a negative relationship between the depth of the wartime contraction and the scale of the growth rate during the 1920s. However, the relationship was not as strong as after World War 2, and indeed of the four economies shown in Fig. 5A, Britain and Germany grew relatively slowly despite experiencing two of the largest negative wartime shocks amongst west European economies.

6. Towards a European business cycle

Our European business cycle facts in Table 2 were based on an unweighted average of the ratios for each country, with the turning points varying in different countries. This is reminiscent of the approach of Burns and Mitchell (1946), who constructed their reference cycle for a single economy from a wide range of time series with different peaks and troughs, at a time when GDP estimates were not widely available. Since GDP estimates became widely available, it has been common practice to derive business cycle peaks and troughs from aggregate GDP, which can be thought of as a weighted average of the individual series underpinning the aggregate measure. Here, we therefore examine the business cycle for an aggregate GDP per capita series for our sample of economies, as they became increasingly synchronised. Despite the incompleteness of our European historical national accounting database, it does cover a large share of the population and GDP of western Europe. For 1870, for example, although we cover only 55 per cent of the total European population of 310 million, this includes 89 per cent of the west European population of 180 million (Malanima, 2009: 9).

Table 7 sets out the basic business cycle facts for the aggregate European business cycle derived from a weighted average series across our nine European economies. The weights used here are population estimates from Malanima (2009: 9) for the period 1300–1870 and the Maddison Project Database (2020) for the period since 1870. The aggregate European GDP per capita series is constructed as a Paasche quantity index, chained using weights for 1400, 1500, 1600, 1700, 1800, 1870, 1913, 1950 and 2000.[5]

The main results from Table 2 are all confirmed in Table 7 and in some cases come out more clearly. First, contractions were about as frequent as expansions before the nineteenth century but by the second half of the twentieth century expansions occurred more rather than slightly less than 90 per cent of the time. Second, the duration of contractions decreased from the nineteenth century while the duration of expansions began to increase slightly earlier from the eighteenth century. Third, the rate of growing during expansions followed a U-shaped pattern over time but ended up lower in the second half of the twentieth century than before 1500, while the rate of shrinking during contractions trended down apart from a blip between 1914 and 1950. Fourth, the amplitude of expansions also followed a U-shaped pattern but ended up much higher during the second half of the twentieth century than before 1500, while the amplitude of contractions trended down apart from a blip between 1914 and 1950.

Fig. 6 plots out the aggregate GDP per capita series for Europe using the chained index for the period 1300–2000, showing both the short run business cycle fluctuations using annual growth rates in part A, and the effect of the transition to modern economic growth on the level of GDP per capita in part B. In Fig. 6A, the short duration and relatively high rates of expansion and contraction between 1300

[5] An alternative way to construct an aggregate European business cycle is to use principal components analysis. This is similar to other recent work on historical business cycles, such as Sarferaz and Uebele (2009), Ritschl et al. (2016), Albers (2018) and Andersson and Lennard (2018). To explore this alternative, we take log first differences of real GDP per capita for each country and estimate the first principal component using the correlation matrix. The correlation between the log first difference of the chained index and the first principal component is 0.79 ($p < 0.01$) between 1530 and 2000, which suggests that the European business cycle is not very sensitive to the method of aggregation.

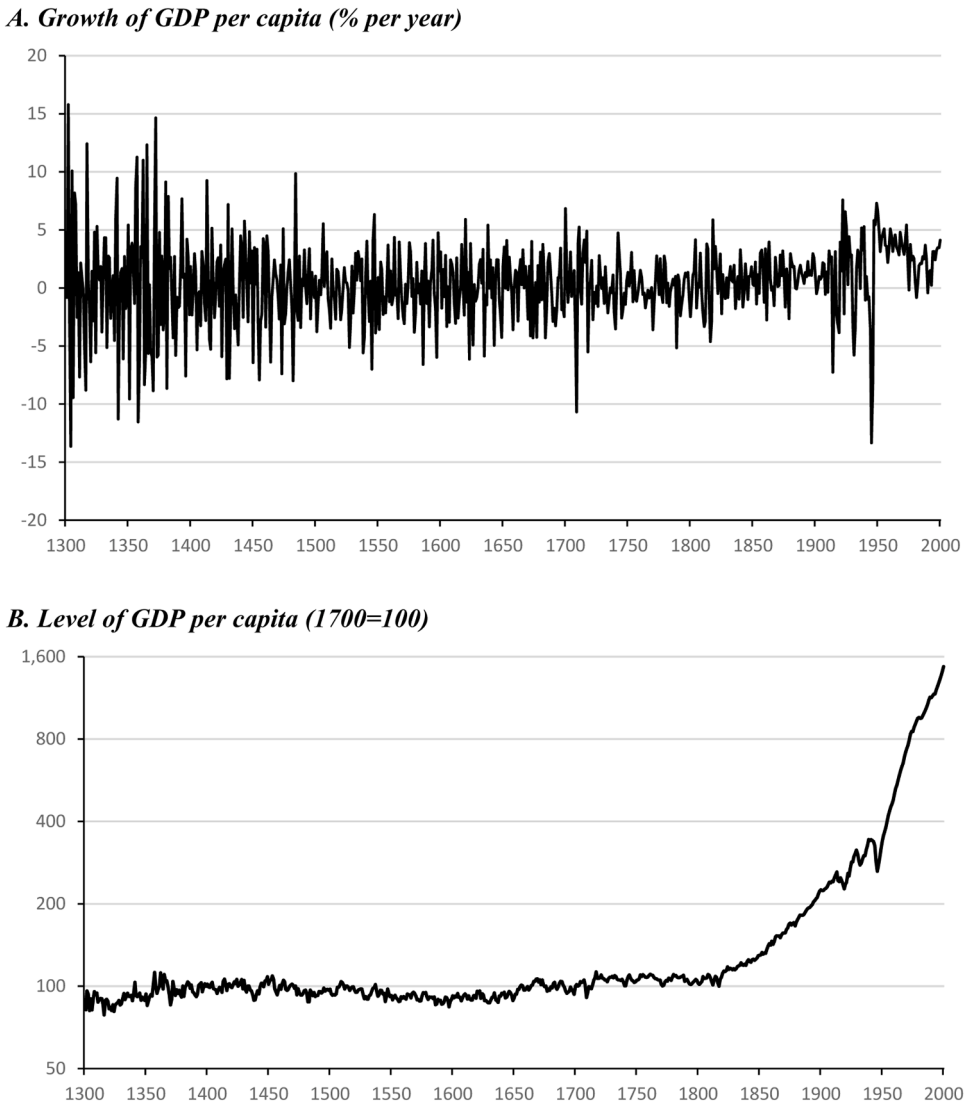

Fig. 6. Aggregate GDP per capita Series for Europe, 1300–2000.

and 1500, combined with the broadly equal frequencies of expansion and contraction, result in the high amplitude and bunching together of peaks and troughs during this period. This was followed by a period of reduced amplitude between 1500 and 1700, as rates of expansion and contraction both decreased, accompanied by stable durations and broadly equal frequencies. The years between 1815 and 1914 were characterised by an asymmetric increase in the duration and amplitude of expansions combined with a decrease in the duration and amplitude of contractions. This was followed by a more symmetric increase in the amplitude of contractions as well as expansions between 1914 and 1950, as the world economy faced the major shocks of two World Wars and the Great Depression. Asymmetry returned between 1950 and 2000 as the frequency of contractions fell to just 5.9 per cent and the duration of expansions increased to 13.7 years.

The upshot of these developments for the level of GDP per capita can be seen in Fig. 6B. Although there was a small boost to European GDP per capita after the Black Death as a result of the permanent gains in northwest Europe analysed in Table 5 and temporary gains elsewhere, most of these gains had been lost by the mid-seventeenth century. A return to growth is visible during the second half of the seventeenth century, but only taking the level of GDP per capita back to its post-Black Death peak. Sustained modern economic growth only emerged for the aggregate European economy after 1815. The negative impact of the two World Wars and the Great Depression is clearly visible, but was followed by a remarkable period of stable growth during the second half of the twentieth century. During this Golden Age, contractions almost disappeared altogether.

7. Some implications for future research

To the best of our knowledge, this is the first quantitative paper on the European business cycle covering the period from the late medieval period to the present. We have deliberately eschewed analysis of the causes of the business cycle patterns identified here, since this would require a further major exercise in data collection for each possible explanatory variable. We do nevertheless think that it will be possible in the near future to advance our understanding of the role of monetary and fiscal developments, where work on some of the key variables reaching back to the late thirteenth century has already begun for at least some of the economies in our sample.

For example, in the case of Britain, it is now possible to assemble annual estimates of coin in circulation, broader monetary aggregates and central government revenue for the period since 1270, thanks to the work of Mayhew (2013), Palma (2018) and O'Brien and Hunt (1999). Annual money supply series are also available for some of the other countries in our sample for at least some sub-periods (Glassman and Redich, 1985; Sousa, 1991; Springer, 2006; Ögren and Edvinsson, 2014; Chen et al., 2021). Although Bonney (1999) and the European State Finance Database (https://www.esfdb.org/Default.aspx) have established long run trends in government revenue for many European countries, annual series are not always available on either a consistent or continuous basis.

8. Conclusions

This paper has explored the changing nature of the business cycle in Europe between 1300 and 2000. Using historical national accounting data on GDP per capita for a sample of nine economies, we show how the pre-modern business cycle was characterised by similar frequencies of expansions and contractions, short expansions and contractions of similar duration, and also similar rates and amplitudes of contractions and expansions. However, around 1815 we begin to see the appearance of the typical modern business cycle with a higher frequency of expansions compared with contractions, longer expansions and shorter contractions with similar rates of growing and shrinking, and higher amplitudes of expansions compared with lower amplitudes of contractions. These findings suggest that the long run growth rate of the economy is intimately tied up with the business cycle through the dampening of contractions, as highlighted by Broadberry and Wallis (2017).

An examination of international co-movement also identifies the growing importance of the synchronisation of the European business cycle across countries. The number of significant positive correlations of growth rates of GDP per capita across countries expressed as a percentage of all possible pairwise correlations increased after 1700, in line with the acceleration of Europe's global maritime expansion. However, this percentage only passed the 20 per cent threshold in the nineteenth century, which fits well with the timing of other aspects of the changing nature of the European business cycle.

The paper goes on to analyse some of the most significant contractions of economic activity from the Black Death of the fourteenth century to the two World Wars and Great Depression of the twentieth century, exploring the implications for the emergence of a synchronised European business cycle and sustained modern economic growth. Despite the incompleteness of our sample of European economies, we take a tentative step towards an analysis of an aggregate European business cycle, which confirms all the main findings. Given the exploratory nature of the paper, we end by setting out some implications for further research.

CRediT authorship contribution statement

Stephen Broadberry: Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jason Lennard:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Data availability

Data will be made available on request.

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Appendix 1: European business cycles, 1300–2000

Tables A1.1 to A1.9 show the frequency, duration, rate and amplitude of business cycles in GDP per capita for Britain, France, Spain, Sweden, Italy, the Netherlands, Poland, Germany and Portugal, respectively.

Table A1.1
The British Business Cycle in GDP per capita, 1300–2000.

	1300–1350	1350–1500	1500–1700	1700–1815	1815–1914	1914–1950	1950–2000	1300–2000
	Expansions (Trough to peak)							
Frequency (%)	58.8	52.3	52.7	53.4	60.0	59.5	82.4	56.8
Duration (years)	2.0	2.0	1.9	1.8	2.5	3.7	6.8	2.2
Rate (% per year)	3.1	3.6	3.2	2.9	2.8	3.8	2.7	3.1
Amplitude (%)	6.2	7.2	6.1	5.2	7.0	14.1	18.4	6.8
	Contractions (Peak to trough)							
Frequency (%)	41.2	47.7	47.3	46.6	40.0	40.5	17.6	43.2
Duration (years)	1.6	1.8	1.7	1.6	1.7	2.1	1.5	1.7
Rate (% per year)	−3.7	−3.5	−3.2	−2.5	−1.8	−3.5	−0.8	−3.0
Amplitude (%)	−5.9	−6.3	−5.4	−4.0	−3.1	−7.4	−1.2	−5.1
Observations	51	151	201	116	100	37	51	701

Table A1.2
The French Business Cycle in GDP per capita, 1300–2000.

	1300–1350	1350–1500	1500–1700	1700–1815	1815–1914	1914–1950	1950–2000	1300–2000
	Expansions (Trough to peak)							
Frequency (%)	54.9	47.0	49.8	50.0	62.0	54.1	96.1	54.8
Duration (years)	1.7	1.7	1.8	2.3	2.2	1.8	23.5	2.1
Rate (% per year)	8.5	7.3	6.0	5.1	4.1	9.1	3.0	5.7
Amplitude (%)	14.5	12.4	10.8	11.7	9.0	16.4	70.5	12.0
	Contractions (Peak to trough)							
Frequency (%)	45.1	53.0	50.2	50.0	38.0	45.9	3.9	45.2
Duration (years)	1.4	2.0	1.8	2.4	1.3	2.0	1.0	1.8
Rate (% per year)	−9.5	−6.2	−5.9	−4.8	−4.2	−8.3	−1.1	−5.9
Amplitude (%)	−13.3	−12.4	−10.6	−11.5	−5.5	−16.6	−1.1	−10.6
Observations	51	151	201	116	100	37	51	701

Table A1.3
The Spanish Business Cycle in GDP per capita, 1300–2000.

	1300–1350	1350–1500	1500–1700	1700–1815	1815–1914	1914–1950	1950–2000	1300–2000
	Expansions (Trough to peak)							
Frequency (%)	52.9	53.6	46.8	50.0	63.0	62.2	90.2	55.5
Duration (years)	3.6	1.8	1.5	1.7	2.9	2.8	9.8	2.1
Rate (% per year)	2.5	5.0	5.1	3.6	3.3	3.7	4.6	4.2
Amplitude (%)	9.0	9.0	7.7	6.1	9.6	10.4	45.1	8.8
	Contractions (Peak to trough)							
Frequency (%)	47.1	46.4	53.2	50.0	37.0	37.8	9.8	44.5
Duration (years)	3.0	1.6	1.7	1.7	1.6	1.6	1.3	1.7
Rate (% per year)	−2.7	−6.1	−4.4	−3.2	−3.6	−5.2	−1.2	−4.3
Amplitude (%)	−8.1	−9.8	−7.5	−5.4	−5.8	−8.3	−1.6	−7.3
Observations	51	151	201	116	100	37	51	701

Table A1.4
The Swedish Business Cycle in GDP per capita, 1300–2000.

	1300–1350	1350–1500	1500–1700	1700–1815	1815–1914	1914–1950	1950–2000	1300–2000
	Expansions (Trough to peak)							
Frequency (%)	42.0	48.3	50.2	45.7	70.0	81.1	88.2	55.3
Duration (years)	4.5	2.6	1.7	1.7	2.6	6.5	11.5	2.4
Rate (% per year)	5.4	4.6	6.7	4.9	2.9	4.1	2.9	4.6
Amplitude (%)	24.3	12.0	11.4	8.3	7.5	26.7	33.4	11.0
	Contractions (Peak to trough)							
Frequency (%)	58.0	51.7	49.8	54.3	30.0	18.9	11.8	44.7
Duration (years)	7.3	2.7	1.7	2.0	1.2	1.8	1.5	2.0
Rate (% per year)	−3.2	−4.0	−6.4	−4.5	−2.6	−5.3	−1.3	−4.6
Amplitude (%)	−23.4	−10.8	−10.9	−9.0	−3.1	−9.5	−2.0	−9.2
Observations	50	151	201	116	100	37	51	700

Table A1.5
The Italian Business Cycle in GDP per capita, 1310–2000.

	1310–1350	1350–1500	1500–1700	1700–1815	1815–1914	1914–1950	1950–2000	1310–2000
	Expansions (Trough to peak)							
Frequency (%)	52.5	47.7	52.7	53.4	63.0	51.4	96.1	56.4

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Table A1.5 (*continued*)

	1310–1350	1350–1500	1500–1700	1700–1815	1815–1914	1914–1950	1950–2000	1310–2000
Duration (years)	2.1	1.8	2.2	2.4	3.7	2.0	23.0	2.6
Rate (% per year)	3.1	5.9	2.9	2.0	1.9	7.0	3.8	3.4
Amplitude (%)	6.5	10.6	6.4	4.8	7.0	14.0	87.4	8.8
Contractions (Peak to trough)								
Frequency (%)	47.5	52.3	47.3	46.6	37.0	48.6	3.9	43.6
Duration (years)	2.0	2.0	2.0	2.0	2.1	2.3	1.0	2.0
Rate (% per year)	−3.3	−5.3	−3.3	−2.3	−2.2	−5.6	−1.5	−3.6
Amplitude (%)	−6.6	−10.6	−6.6	−4.6	−4.6	−12.9	−1.5	−7.2
Observations	40	151	201	116	100	37	51	690

Table A1.6
The Dutch Business Cycle in GDP per capita, 1348–2000.

	1350–1500	1500–1700	1700–1815	1815–1914	1914–1950	1950–2000	1348–2000
Expansions (Trough to peak)							
Frequency (%)	57.0	53.7	56.0	67.0	59.5	90.2	60.3
Duration (years)	2.0	1.7	2.0	2.9	4.0	8.3	2.2
Rate (% per year)	3.4	7.8	4.6	2.3	7.1	3.2	4.8
Amplitude (%)	6.8	13.3	9.2	6.7	28.4	26.6	10.6
Contractions (Peak to trough)							
Frequency (%)	43.0	46.3	44.0	33.0	40.5	9.8	39.7
Duration (years)	1.5	1.5	1.6	1.3	3.0	1.3	1.5
Rate (% per year)	−3.7	−8.7	−5.9	−2.5	−7.7	−1.3	−5.9
Amplitude (%)	−5.6	−13.1	−9.4	−3.3	−23.1	−1.7	−8.9
Observations	151	201	116	100	37	51	652

Table A1.7
The Polish Business Cycle in GDP per capita, 1409–2000.

	1409–1500	1500–1700	1700–1815	1815–1914	1914–1950	1950–2000	1409–2000
Expansions (Trough to peak)							
Frequency (%)	54.9	48.8	42.2	76.0	62.2	80.4	56.2
Duration (years)	5.4	7.3	4.7	9.3	12.0	6.6	7.0
Rate (% per year)	0.8	1.1	1.1	1.9	2.8	4.0	1.7
Amplitude (%)	4.3	8.0	5.2	17.7	33.6	26.4	11.9
Contractions (Peak to trough)							
Frequency (%)	45.1	51.2	57.8	24.0	37.8	19.6	43.8
Duration (years)	6.8	7.4	6.7	3.0	7.0	2.0	5.8
Rate (% per year)	−0.8	−0.9	−1.2	−0.4	−2.1	−4.0	−1.1
Amplitude (%)	−5.4	−6.7	−8.0	−1.2	−14.7	−8.0	−6.4
Observations	91	201	116	100	37	51	591

Table A1.8
The German Business Cycle in GDP per capita, 1500–2000.

	1500–1700	1700–1815	1815–1914	1914–1950	1950–2000	1500–2000
Expansions (Trough to peak)						
Frequency (%)	48.5	59.5	65.0	70.3	92.2	60.2
Duration (years)	2.2	2.6	3.1	4.4	10.8	3.0
Rate (% per year)	1.8	1.4	2.7	7.1	4.1	2.7
Amplitude (%)	4.0	3.6	8.4	31.2	44.3	8.1
Contractions (Peak to trough)						
Frequency (%)	51.5	40.5	35.0	29.7	7.8	39.8
Duration (years)	2.3	1.8	1.7	1.8	1.0	2.0
Rate (% per year)	−1.9	−1.6	−2.2	−16.1	−1.3	−2.6
Amplitude (%)	−4.4	−2.9	−3.7	−29.0	−1.3	−5.2
Observations	200	116	100	37	51	500

Table A1.9
The Portuguese Business Cycle in GDP per capita, 1530–2000.

	1530–1700	1700–1815	1815–1914	1914–1950	1950–2000	1530–2000
Expansions (Trough to peak)						
Frequency (%)	49.4	48.3	47.0	62.2	88.2	53.8
Duration (years)	1.8	1.7	2.5	1.8	9.8	2.2
Rate (% per year)	4.8	4.2	2.5	5.0	4.6	4.3
Amplitude (%)	8.6	7.1	6.3	9.0	45.1	9.5
Contractions (Peak to trough)						
Frequency (%)	50.6	51.7	53.0	37.8	11.8	46.2

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Table A1.9 (*continued*)

	1530–1700	1700–1815	1815–1914	1914–1950	1950–2000	1530–2000
Duration (years)	1.8	1.8	2.8	1.2	1.5	1.9
Rate (% per year)	−4.5	−3.9	−1.7	−4.5	−1.9	−3.6
Amplitude (%)	−8.1	−7.0	−4.8	−5.4	−2.9	−6.8
Observations	170	116	100	37	51	470

Appendix 2: International co-movement, 1300–2000

Tables A2.1 to A2.7 show the correlation of logarithmic growth rates of GDP per capita in European countries for the periods 1300-1350, 1350-1500, 1500-1700, 1700-1815, 1815-1914, 1914-1950, 1950-2000, respectively.

Table A2.1
International co-movement, 1300–1350.

	GBR	FRA	ESP	SWE	ITA
GBR	1				
FRA	0.2*	1			
ESP	−0.1	0.0	1		
SWE	0.2	0.2*	−0.1	1	
ITA	0.3	0.1	0.1	−0.1	1

Notes: This table shows the correlation of logarithmic growth rates of GDP per capita in five economies (Great Britain (GBR), France (FRA), Spain (ESP), Sweden (SWE) and Italy (ITA)) between 1300 and 1350.
* indicates statistical significance at the 10 % level.

Table A2.2
International co-movement, 1350–1500.

	GBR	FRA	ESP	SWE	ITA	NLD	POL
GBR	1						
FRA	−0.1	1					
ESP	−0.1	0.0	1				
SWE	−0.1	−0.1	0.1	1			
ITA	0.0	0.1*	0.0	0.0	1		
NLD	0.3*	0.1*	−0.1*	−0.1*	0.0	1	
POL	0.1	−0.1	0.0	−0.1	−0.1	−0.1	1

Notes: This table shows the correlation of logarithmic growth rates of GDP per capita in seven economies (Great Britain (GBR), France (FRA), Spain (ESP), Sweden (SWE), Italy (ITA), Netherlands (NLD) and Poland (POL)) between 1350 and 1500.
* indicates statistical significance at the 10 % level.

Table A2.3
International co-movement, 1500–1700.

	GBR	FRA	ESP	SWE	ITA	NLD	POL	DEU	PRT
GBR	1								
FRA	0.2*	1							
ESP	0.1*	0.1	1						
SWE	0.1	0.0	0.1	1					
ITA	0.1	0.0	0.0	−0.1	1				
NLD	−0.1*	−0.1*	0.0	0.1	0.0	1			
POL	0.0	−0.1	0.0	0.0	0.0	0.0	1		
DEU	0.2*	0.2*	−0.1	0.0	0.0	0.0	0.0	1	
PRT	0.0	0.2*	−0.1*	0.0	−0.1	−0.1	0.0	0.1	1

Notes: This table shows the correlation of logarithmic growth rates of GDP per capita in nine economies (Great Britain (GBR), France (FRA), Spain (ESP), Sweden (SWE), Italy (ITA), Netherlands (NLD), Poland (POL), Germany (DEU) and Portugal (PRT)) between 1500 and 1700.
* indicates statistical significance at the 10 % level.

Table A2.4
International co-movement, 1700–1815.

	GBR	FRA	ESP	SWE	ITA	NLD	POL	DEU	PRT
GBR	1								
FRA	0.0	1							
ESP	0.2*	−0.1	1						
SWE	0.1	0.1	0.0	1					
ITA	0.0	0.4*	0.0	0.1	1				
NLD	0.0	−0.1	−0.1	0.0	−0.1	1			

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Table A2.4 (*continued*)

	GBR	FRA	ESP	SWE	ITA	NLD	POL	DEU	PRT
POL	0.1	0.2*	0.0	0.0	0.0	0.1	1		
DEU	0.1	0.2*	−0.1	0.2*	0.1	−0.1	0.2*	1	
PRT	0.1	−0.1	0.1	0.0	0.2	0.1	0.1	0.0	1

Notes: This table shows the correlation of logarithmic growth rates of GDP per capita in nine economies (Great Britain (GBR), France (FRA), Spain (ESP), Sweden (SWE), Italy (ITA), Netherlands (NLD), Poland (POL), Germany (DEU) and Portugal (PRT)) between 1700 and 1815.
* indicates statistical significance at the 10 % level.

Table A2.5
International co-movement, 1815–1914.

	GBR	FRA	ESP	SWE	ITA	NLD	POL	DEU	PRT
GBR	1								
FRA	0.1	1							
ESP	−0.1	0.0	1						
SWE	0.1	−0.1	0.2	1					
ITA	−0.1	0.2*	−0.1	0.1	1				
NLD	0.3*	0.3*	0.1	−0.1	0.0	1			
POL	0.0	0.0	0.1	0.0	−0.1	−0.1	1		
DEU	0.2*	0.4*	0.0	0.1	0.3*	0.2*	0.0	1	
PRT	−0.1	0.0	0.0	0.0	0.0	−0.1	0.3*	0.1	1

Notes: This table shows the correlation of logarithmic growth rates of GDP per capita in nine economies (Great Britain (GBR), France (FRA), Spain (ESP), Sweden (SWE), Italy (ITA), Netherlands (NLD), Poland (POL), Germany (DEU) and Portugal (PRT)) between 1815 and 1914.
* indicates statistical significance at the 10 % level.

Table A2.6
International co-movement, 1914–1950.

	GBR	FRA	ESP	SWE	ITA	NLD	POL	DEU	PRT
GBR	1								
FRA	−0.3	1							
ESP	0.1	0.0	1						
SWE	−0.1	0.7*	0.0	1					
ITA	0.0	0.6*	0.1	0.4*	1				
NLD	−0.2	0.8*	−0.1	0.4*	0.7*	1			
POL	0.1	0.2	−0.1	0.2	0.2	0.1	1		
DEU	0.4*	−0.4*	0.0	−0.1	−0.2	−0.5*	0.2	1	
PRT	0.0	0.2	0.3*	0.2	0.2	0.1	0.2	0.0	1

Notes: This table shows the correlation of logarithmic growth rates of GDP per capita in nine economies (Great Britain (GBR), France (FRA), Spain (ESP), Sweden (SWE), Italy (ITA), Netherlands (NLD), Poland (POL), Germany (DEU) and Portugal (PRT)) between 1914 and 1950.
* indicates statistical significance at the 10 % level.

Table A2.7
International co-movement, 1950–2000.

	GBR	FRA	ESP	SWE	ITA	NLD	POL	DEU	PRT
GBR	1								
FRA	0.3*	1							
ESP	0.0	0.4*	1						
SWE	0.4*	0.6*	0.3*	1					
ITA	0.2	0.6*	0.4*	0.4*	1				
NLD	0.4*	0.5*	0.0	0.4*	0.3*	1			
POL	0.4*	0.2	0.1	0.4*	0.1	0.2	1		
DEU	0.1	0.5*	0.0	0.4*	0.6*	0.3*	0.3*	1	
PRT	0.4*	0.6*	0.3*	0.2	0.4*	0.4*	0.1	0.1	1

Notes: This table shows the correlation of logarithmic growth rates of GDP per capita in nine economies (Great Britain (GBR), France (FRA), Spain (ESP), Sweden (SWE), Italy (ITA), Netherlands (NLD), Poland (POL), Germany (DEU) and Portugal (PRT)) between 1950 and 2000.
* indicates statistical significance at the 10 % level.

Appendix 3: Robustness

So far, we have conducted our analysis of business cycles on data for GDP per capita since for many of the countries in our sample, we lack annual data for GDP. This is due to the fact that for these countries, real wages form the basis of the GDP per capita estimates and population data are not available on an annual basis. For five economies, however, we do have annual data for GDP and population as well as GDP per capita, and for these economies we can conduct the analysis on GDP. Here we set out the business cycle facts and analysis of international co-movement for GDP instead of GDP per capita as a check on the robustness of our findings. This is followed by an exercise to check the robustness of our findings to measurement error.

A3.1. Business cycles in GDP

The European business cycle in GDP follows much the same pattern as the business cycle in GDP per capita in a common sample of five economies. In addition, the patterns are also very similar for GDP per capita in both the full sample and the sample of five economies. Table A3.1 shows that in the common sample of five economies: (1) Contractions were roughly as frequent as expansions before the nineteenth century but expansions then increased in frequency to almost 90 per cent by the second half of the twentieth century. (2) The duration of expansions significantly increased from the nineteenth century while contractions decreased over the same period. (3) The rate of growing during expansions showed no trend increase over time, while the rate of shrinking during contractions trended down. (4) The amplitude of expansions increased from the nineteenth century as the amplitude of contractions decreased.

A3.2. Measurement error

An important issue in historical national accounting is measurement error (Feinstein, 1972; Solomou and Weale, 1991; Sefton and Weale, 1995; Feinstein and Thomas, 2002). While there are estimates of the standard errors associated with some national accounts from the nineteenth century onwards, we have less understanding of the likely margins of error further back in time. To assess how measurement error alters the business cycle moments, we run a series of simulations.

The benchmark is the British business cycle between 1815 and 1914 since its properties are typical of the modern business cycle and are well documented (Broadberry et al., 2022, 2023). To the logarithmic growth of GDP per capita for Great Britain between 1815 and 1914, we add random error, compute the business cycle moments, repeat 10,000 times and calculate the average for each business cycle moment. The error has a normal distribution, a mean of zero and a standard deviation equal to the standard deviation of the logarithmic growth of GDP per capita in Great Britain between 1815 and 1914, which was 2.9 per cent.

Table A3.2 displays how the frequency, duration, rate and amplitude of expansions and contractions are affected by measurement error. As the volatility of error rises, the share of expansions and contractions approaches parity as expansions become less frequent and contractions more frequent, the rates of expansion and contraction converge and the amplitude of phases decreases. Table A3.3 shows how international co-movement is altered by measurement error. As the volatility of error rises, the correlations are attenuated.

This exercise suggests that measurement error can affect the business cycle facts. A modern business cycle, measured with error, appears more like a premodern cycle that spends more time in contraction and is less synchronised with other economies. Therefore, measurement error leads to bias in one direction: the observed origin of the modern business cycle is later than the true, unobserved origin. While the simulations have shown the likely sign of the bias, the size is unclear. In the counterfactual, in which the measurement error is equal to the standard deviation of growth, the signal is still discernible through the noise.

Table A3.1
The european business cycle, 1300–2000: GDP and GDP per capita.

	1300-1350	1350-1500	1500-1700	1700-1815	1815-1914	1914-1950	1950-2000	1300-2000
	Expansions (Trough to peak)							
Frequency (%)								
GDP	52.6	54.0	52.4	51.0	76.8	63.8	87.5	59.3
GDP per capita	51.2	53.2	50.4	49.5	67.2	64.9	86.3	56.8
Duration (years)								
GDP	3.5	2.8	2.4	2.5	6.7	5.1	10.1	3.3
GDP per capita	3.4	2.7	2.8	2.4	4.0	5.8	8.6	3.2
Rate (% per year)								
GDP	3.6	3.3	5.3	3.8	3.2	5.2	4.1	4.1
GDP per capita	3.7	3.5	4.8	3.4	2.6	4.3	3.5	3.7
Amplitude (%)								
GDP	12.6	9.2	12.7	9.5	21.4	26.5	41.4	13.5
GDP per capita	12.6	9.5	13.4	8.2	10.4	24.9	30.1	11.8
	Contractions (Peak to trough)							
Frequency (%)								
GDP	47.4	46.0	47.6	49.0	23.2	36.2	12.5	40.7
GDP per capita	48.8	46.8	49.6	50.5	32.8	35.1	13.7	43.2
Duration (years)								
GDP	3.4	2.6	2.3	2.9	1.4	2.9	1.5	2.4
GDP per capita	3.9	2.9	2.8	2.7	1.8	3.1	1.5	2.5
Rate (% per year)								
GDP	-3.8	-3.3	-5.2	-3.6	-1.8	-4.6	-1.2	-4.0
GDP per capita	-3.2	-3.6	-4.7	-3.5	-2.2	-4.8	-1.7	-3.8
Amplitude (%)								
GDP	-12.9	-8.6	-12.0	-10.4	-2.5	-13.3	-1.8	-9.6
GDP per capita	-12.5	-10.4	-13.2	-9.5	-4.0	-14.9	-2.6	-9.5
Observations	152	695	1,005	580	500	185	255	3,345

Notes: This table shows the frequency, duration, rate and amplitude of European business cycles in GDP and GDP per capita between 1300 and 2000 for five economies: Great Britain, Netherlands, Poland, Spain and Sweden.

Table A3.2
Measurement error and the british business cycle, 1815–1914.

	Actual	Counterfactual
	Expansions (Trough to peak)	
Frequency (%)	60.0	59.3
Duration (years)	2.5	2.4
Rate (% per year)	2.8	2.2
Amplitude (%)	7.0	5.3
	Contractions (Peak to trough)	
Frequency (%)	40.0	40.7
Duration (years)	1.7	1.6
Rate (% per year)	−1.8	−1.0
Amplitude (%)	−3.1	−1.6

Notes: This table shows the actual and counterfactual frequency, duration, rate and amplitude of British business cycles between 1815 and 1914 for different levels of measurement error. The simulations are run 10,000 times.

Table A3.3
Measurement error and international co-movement, 1815–1914.

	Actual	Counterfactual
France	0.09	0.06
Spain	−0.08	−0.05
Sweden	0.06	0.04
Italy	−0.11	−0.08
Netherlands	0.30	0.21
Poland	0.04	0.03
Germany	0.22	0.15
Portugal	−0.13	−0.09

Notes: This table shows the actual and counterfactual correlation of logarithmic growth rates of GDP per capita in Great Britain and eight economies between 1815 and 1914. The simulations are run 10,000 times.

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