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Abstract: Annual estimates of GDP constructed from the output side are used to analyse British business cycles between 1270 and 1870. After c.1670 the scale of recessions tended to diminish as the economy grew, diversified and became more resilient. Until c.1730, business cycles were driven largely by agricultural fluctuations, but shocks to industry and commerce became more important over time as the structure of the economy changed. A number of severe recessions can be identified, associated with harvest failures, disease outbreaks, wars and disruptions to commerce. Monetary and financial factors also played a role in some of these severe recessions.

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I. Introduction

Throughout history the short-term fluctuations in economic output encompassed by the concept of the business cycle were an unavoidable fact of life. Even economies that were growing strongly, such as the Dutch economy during its sixteenth- and seventeenth-century golden age and the British economy during its eighteenth- and nineteenth-century industrial revolution, sustained significant, if transitory, setbacks. That, in both cases, net growth nonetheless occurred in the medium and long terms is because these reversals were relatively short lived, recovery from them was strong, and there were more years of expansion than there were of contraction. Yet prevailing economic circumstances were not always so favourable, and repeated recessions, especially, when they were deep and prolonged, could offset the gains achieved during the good years and entrap economies in a state of stasis or, worse, push them into prolonged contraction. Each crisis also often came at a heavy price, in terms of bankruptcies, evictions, unemployment, squeezed living standards, impoverishment and, often, heightened mortality. They highlight the vulnerabilities of societies, expose where resilience was deficient, are rich in human interest and for these reasons have long attracted scholarly attention.

Prices, real wage rates, harvests, trade statistics, criminal cases, and mortality rates have all been deployed by historians to shed valuable light upon aspects of these downturns but, even when used in combination, the picture revealed is incomplete (Campbell, 2009 & 2010). For instance, Hoskins (1964 & 1968) used data on the price of wheat in an effort to identify years of good and bad harvests in England for the periods 1480-1619 and 1620-1759. Apart from some methodological shortcomings of this work, and the misplaced assumption that prices provide a straightforward proxy for yields, it would take a large leap of faith to move from Hoskins's cycle for wheat to grain output in its entirety, the output of all agricultural products (including those from the pastoral sector), let alone the output of the economy as a whole. Of course, Hoskins was not attempting to identify business cycles; his aims were far more modest. To have done so would have required an altogether more comprehensive range of data, along the lines of those advocated by the 1946 report of the National Bureau of Economic Research (NBER) (Burns & Mitchell, 1946). The NBER methodology was that employed by Gayer, Rostow and Schwartz (1953) and Rostow (1972) to derive a chronology of British business cycles for the nineteenth century, and then by Ashton (1959) to derive a corresponding chronology for eighteenth-century England. Identification of peak and trough years entailed checking a large number of time series for

different parts of the economy and then establishing turning points in 'general business activity' as a 'consensus of statistical data rather than turning-points in any particular magnitude such as national income' (Matthews, 1954: 2). This was painstaking work but there are inconsistencies between the two chronologies during the overlap period between them and neither matches well with the results obtained when the starting point is a national income series.

Since the business cycle can be defined as the downward and upward movement of gross domestic product (GDP) around its long-term growth trend, it follows that the most useful reconstructions are those derived from annual estimates of GDP. GDP has the merit of encompassing all components of economic output — agriculture, industry and services — rather than a single sector, or segment of a sector, whose behaviour is unlikely to be representative of the performance of the economy as a whole. Such estimates are now available for a number of countries extending back for periods spanning much of the second millennium (Campbell, 2013; Broadberry, Guan & Li, 2018). Those for Holland, for example, begin in the mid-fourteenth century but are most robust from the late-fifteenth century, when they highlight the 'high instability of the economy' with trend growth, at times, 'overshadowed by enormous swings in all sectors of the economy' (van Zanden & van Leeuwen, 2012: 123).

Utilising GDP estimates to analyse business cycles within a growth framework is a distinctive feature of modern macroeconomics (Long & Plosser, 1983; Lucas, 1987; Plosser, 1989). The aim of this paper is therefore to adopt this approach to derive a new chronology of short-run business cycles for England from 1270 to 1700 and then Great Britain from 1700 to 1870, as set out in Figures 6, 8, 9 and 10, Tables 3-5 and Appendix 1. It represents both an empirical and methodological improvement upon the older method of deriving business-cycle chronologies from the visual identification of turning points in unfiltered time series.

II. The historical national accounts for England and Great Britain, 1270-1870

Business cycles derived from annual estimates of GDP are only as good as the historical national accounts upon which they are based. To create the GDP series used here, the respective outputs of agriculture, industry and services have been estimated separately and then combined using value-added weights for a number of benchmark years. A detailed description of how each sectoral-output series has been reconstructed, including the sources upon which they are based and the weightings and methodologies employed, is given in *British Economic Growth 1270-1870* (Broadberry & others, 2015 [henceforth *BEG*]). In this

section, therefore, attention is drawn to those aspects of these accounts that are material to the identification of short-term business cycles. Figures 1 and 2 report the overall trends in nominal and real GDP, the price deflator used to derive one from the other, and the indexed trends of population and GDP per head.

Figures 1 and 2 about here

The price index is derived from information on the prices of the main goods and services provided in the English economy and built up by sector, as discussed in detail in *BEG*. This includes an agricultural price index that will be used in Section IV, below, to harmonise the amplitude of business cycle fluctuations between sub-periods with different agricultural datasets. These results relate to England from 1270 to 1700 and Great Britain thereafter and are index linked relative to their respective values in the year 1700. It is clear that most of the increase in nominal GDP before 1700 resulted from the six-fold increase in the price level that occurred over these centuries, the bulk of it during the sixteenth-century price revolution: whereas nominal GDP increased by a factor of 14.84 from 1270-1700, real GDP increased by a lesser factor of 2.46. Thereafter, there was only a modest increase in the price level, with a period of substantial inflation during the French and Napoleonic Wars followed by a sharp post-war deflation and then return to stability. Hence after 1700 most of the increase in nominal GDP was the result of real growth.

Because of the change of geographical scale in 1700 from England to Great Britain it makes sense to treat the periods before and after 1700 separately. There is another potentially important break around 1720 in the main source of information for the agricultural sector, when the modern farm-accounts database collected by Turner, Beckett and Afton (2001) comes on stream, containing a strong time-series element for a sample of farms, in contrast to the one-off observations for individual farms utilised for the period from c.1550 to c.1720. This qualitative change in the sources of the agricultural data coincides with a general improvement in the completeness of the information available for all three main output sectors. The GDP estimates for 1720-1870 are therefore particularly robust.

The GDP estimates are most volatile between c.1550 and c.1720 when the information used to estimate agricultural output comes from the early modern probate-inventories database assembled by Overton (Overton & Campbell, 1999; Overton & others, 2004). In contrast to the situation before 1490 and after 1720, there are no continuous runs of data for individual farms, each of which is documented just once, following the occupying farmer's

death. Crop yields can be inferred from the probate inventories but the number of observations for individual years is often in single figures; with a larger sample size the volatility of the annual observations would undoubtedly be lower. The geographical coverage of this dataset is also less representative than those for the preceding and succeeding periods. For the late-medieval period, the quality and quantity of the available agricultural information is significantly better. The main data source is the manorial-accounts database assembled by Campbell (2000; 2007), which provides time series for cropped areas, crop yields, animal yields and animal stocking densities on a large sample of seigniorial demesnes scattered across southern England, the best of them characterised by long runs of observations.

Between the mid-fifteenth century, when the manorial-accounts database effectively ends, and the mid-sixteenth century, when the probate inventories database begins, is a statistical dark age when there is a paucity of firm statistical data, particularly for agriculture. To bridge this gap the output series for the years 1451-1550 have been interpolated using a demand function (*BEG*: 122-4). This results in agricultural output estimates which are conspicuously less volatile than those obtained when agricultural output is estimated directly (Table 1). Such discontinuities in the character of the underlying data from which the agricultural output estimates have been constructed present a significant empirical challenge to valid comparison of the absolute amplitude of business cycles *between* the sub-periods 1271-1450, 1451-1550, 1551-1720 and 1721-1870. A first step to making such comparisons is to harmonise the magnitude of deviations between sub periods, as proposed in Section IV, below.

It should be noted that the harmonisation of the GDP series has been done in such a way as to preserve the original dating of the peaks and troughs of the business cycle. This is important because there are good reasons for thinking that the timing of the peaks and troughs in agriculture are accurate, since they have been checked against the historical record. In particular, Stratton (1978) provides a year-by year account based on archival documentation, classifying harvests in a way that takes account of regional variation and also noting serious outbreaks of diseases affecting livestock, such as sheep scab and rinderpest. Further, since the harmonisation has been conducted on the cyclical component of output after de-trending, the trend growth rate remains unaltered. The original “unharmonised” series from *BEG* for agricultural output and its component parts can therefore continue to be used as a reliable guide to growth trends and the timing of peaks and troughs, although

caution should be exercised when assessing the amplitude of short run fluctuations which are prone to exaggeration, especially during the period c.1550 to c.1720.

III. Annual growth rates and the character of GDP growth, 1270-1870

One method of throwing the boom years with rapid positive growth and slump years with high rates of negative growth into relief is to calculate the annual log growth rate of real GDP. The method is simple to calculate but has the drawback that it tends to amplify the magnitude of the cyclical fluctuations by failing to make any allowance for periods of trend growth or decline. Here, therefore, the annual growth rate of GDP has been averaged per decade and used to highlight the broad variations and trends in growth rates that occurred across the 600 years from 1270 to 1870 (Figure 3). Whether the economy was on balance expanding or contracting was obviously material to the impact of individual business cycles.

Figure 3 about here

The most extended period of predominantly negative average growth rates of GDP was from the 1310s to the 1370s. Negative growth rates prevailed both during the decades of peak population pressure and low GDP per head that preceded the Black Death and afterwards (Figures 2 & 3), when the massive mortality-induced reduction in population forced a drastic curtailment of gross output. Shedding excess population nevertheless delivered windfall gains in output per head, hence the paradox of rising GDP per head at a time of predominantly negative GDP growth. That prevailing tendency towards negative GDP growth persisted until well into the middle years of the fifteenth century (Hatcher, 1996), with only the 1380s and 1410s bucking the trend.

At some time during the final decades of the fifteenth century this long era of stagnant population and predominantly negative annual growth rates drew to an end and the economy began to expand once again, achieving this without any significant erosion of GDP per head. As negative growth loosened its grip, output and population rose together without significantly depressing GDP per head (Figures 1 and 2). It is therefore unfortunate that there is not better documentation for this pivotal period that would enable the annual growth rates of GDP to be brought into sharper focus. By the time that a new documentary age dawns in the 1550s the population was already growing strongly again and beginning to weigh upon GDP per head. For the next hundred years mean annual growth rates of GDP per decade fluctuated between positive and negative (Figure 3). The 1580s stand out as a difficult decade and negative growth dogged the first half of the seventeenth century, up to and including the thinly

documented decades of the Civil War and the Commonwealth in the 1640s and 1650s. The Restoration of 1660 was, however, followed by positive growth, stronger, on average, than anything experienced during the previous 400 years. Nevertheless, onset of sustained growth of GDP, population and GDP per head was postponed until the 1680s, from which point, with the conspicuous exception of the 1720s, all three series were rising strongly (Figure 2). Eighteenth and nineteenth-century business cycles were therefore superimposed upon this powerfully rising trend. From the 1820s, as GDP per head surpassed all previous levels, the average annual growth rate of GDP per decade was consistently above 2 per cent (Figures 2 and 3).

Figure 4 about here

Calculating growth rates of GDP has the further merit that it facilitates a breakdown of the business cycle into the components associated with agriculture, industry and services (Hills & others, 2010) and therefore helps identify the dominant determinants of the individual cycles and reveal the extent to which this changed over time. Figure 4 provides an overview for the whole period of the contributions of the three sectors to the annual growth rate of GDP averaged by decade. In the 1270s, when the GDP estimates begin, and for the next 400 years, agriculture was plainly the dominant influence upon growth rates. Occasionally, however, as in the 1380s and 1570s, falling output in agriculture was offset by expanding output in industry. The contributions of industry and services became increasingly prominent over the course of the seventeenth century, to the extent that by the end of that century their combined contributions to growth typically matched or exceeded those of agriculture. The 1750s was the last decade when agriculture's contribution to growth narrowly exceeded that of the other two sectors. From that point, as changes in economic structure advanced apace, the performances of industry and services became the main drivers of the growth of GDP and from the 1840s services were at least as important a source of growth as industry. By this point, of course, the country had completed its long transition from an overwhelming reliance upon agriculture to a modern economy in which growth was sustained and the industrial and, increasingly, the service sectors were the main generators of income.

IV. Defining business cycles using the Hodrick-Prescott filter, 1270-1870

An alternative way to make the real GDP series stationary and extract a short-term cyclical component is to apply the Hodrick-Prescott (1997) filter. This is the method preferred by many economists and is therefore that used to derive the chronology of business cycles presented

in this paper and tabulated in Appendix 1. The basic idea is to decompose a time series variable (y_t) into a growth component (g_t) and a cyclical component ($c_t = y_t - g_t$) in such a way as to make the growth component more sensitive to long-term than to short-term fluctuations. This is done by setting the growth component to minimise:

$$\sum_{t=1}^{T}(y_t - g_t)^2 + \lambda \sum_{t=1}^{T}[(g_t - g_{t-1}) - (g_{t-1} - g_{t-2})]^2 \qquad (1)$$

The first term is the sum of squared deviations of the variable from the growth component, and hence penalises short term fluctuations, while the second term is λ times the sum of squares of the growth component's second difference, and hence penalises variations in the growth component. The larger the value of the smoothing parameter λ, the higher the penalty for variations in the growth component. The cyclical component of the log of the GDP index obtained by setting λ equal to 100, the value recommended by Backus and Kehoe (1992), is graphed in Figure 5.

Figures 5 and 6 about here

Straightforward application of this method yields a chronology of business cycles (Figure 5) whose varying absolute amplitude is powerfully influenced by the changing character of the underlying agricultural data discussed in Section II, above. Although agriculture is the sector where the problem of excess volatility in the data is most pronounced, all sectors are affected because of the importance of wool textiles, leather and food processing for industry and the role of merchants responsible for marketing these products in the service sector. Using the unadjusted cyclical component of GDP therefore poses a particular challenge for the analysis and discussion of business cycles across the whole period 1270-1870. For the analysis of short-term variations in GDP what is needed is to 'harmonise' the cyclical component of GDP, whilst maintaining the same trend as the raw GDP series, with the same peaks and troughs, but more stable in amplitude. To achieve this, the volatility of the annual cyclical component of GDP has been harmonised across the sub-periods 1271-1450, 1451-1550, 1551-1720 and 1721-1870 utilising corresponding data on the volatility of prices. Real agricultural prices (the agricultural price index divided by the GDP deflator), of course, have the merit of being available on a more consistent and representative basis over these 600 years than the information available on agricultural output. Their changing cyclical behaviour is therefore taken as a proxy for genuine changes in the amplitude of the cyclical component of GDP between these four main periods.

Tables 1 and 2 about here

The mean absolute deviations of the real agricultural price series, the unadjusted cyclical component of GDP (derived using the Hodrick-Prescott filter), and the harmonised cyclical component of GDP are reported in Table 1 (columns A, B & E) for each of the four sub-periods. Note that in the case of real agricultural prices (column A) the trend of deviations declines sequentially from a maximum of 5.88 per cent 1271-1450 to a minimum of 4.51 per cent 1821-70. In contrast, mean absolute deviations of the unadjusted cyclical component of GDP (column B) fluctuate according to the changing character of the underlying agricultural data (Figure 5). They are highest during the probate inventory era of 1551-1720, but much lower 1451-1550 when the agricultural estimates are derived using a demand function, and lower still 1721-1870 when runs of farm accounts come on stream and agriculture accounted for a smaller share of GDP. The changing ratio of the unadjusted cyclical component of GDP deviations to the price deviations is given in column C. The ratio for individual sub periods ranges from 0.38 in 1451-1550 to 1.03 in 1551-1720. Since the amplitude of GDP fluctuations during the final period of 1721-1870 is broadly in line with the amplitude of fluctuations during the period 1451-1550 (when the demand-based agricultutural output estimates already incorporate information on prices) (Table 1), the amplitudes of all four sub periods have been harmonised on the ratio of 0.43 for 1721-1870. The ratios for each sub-period relative to the ratio of 0.43 for the 1721-1870 period then provide the weightings (column D) used to harmonise the deviations of the cyclical component of GDP between each period (column E).

Figure 7 about here

The harmonised cyclical component of GDP series graphed in Figure 6 and tabulated in Appendix 1 can be compared with the unadjusted cyclical component of GDP series graphed in Figure 5. Note that the mean absolute deviations of the harmonised cyclical component of GDP, like those of real agricultural prices, decline sequentially over time (Table 1). This, however, is something of an illusion. Tabulating the mean deviation of the harmonised cyclical component of GDP over shorter sub-periods of 50 years (Table 2) reveals that mean absolute deviations fluctuated around 2.5 ±0.3 per cent until 1670 and only sank decisively below that level thereafter, to minima of less than 2.0 per cent in 1721-70 and 1821-70 (Figure 7 implies that there may have been a further quietening of business-cycle activity in the period 1871-1913). Such temporal fluctuations in the amplitude of the cyclical component of GDP deviations are, of course, to be expected. The exogenous shocks of the weather and disease which periodically hit economic output so hard were inconsistent in their

frequency and intensity. Also, slowly but surely the structure of the economy was changing and, as it developed and grew, becoming more resilient to these kinds of setback.

The situation in the troubled mid-fourteenth century is instructive. The years 1321-70 are exceptionally well-documented and consequently the annual GDP estimates are particularly robust. At a time when GDP per head was close to its historical minimum (Figure 2) and dependence upon agriculture dominant, the hazards of extreme weather, livestock disease, escalating warfare and repeated bouts of plague dealt successive heavy blows to the economy. The mean absolute deviation of the harmonised cyclical component of GDP for these eventful 50 years is 2.81 per cent (Table 2). Booms and slumps when deviations from trend were at least ±3 per cent occurred in two out of five years, and deviations in excess of ±6 per cent occurred in six of the fifty years, notably 1339 and 1350-51 (negative) and 1344 and 1347-48 (positive). There were also exceptional booms and slumps when for two consecutive years the deviation from trend exceeded ±3%, as was the case during the recovery years of 1337-8, 1344-5 and 1347-8 and, most conspicuously, the crisis years of 1349-52, when heavy plague mortality dealt a body blow to economic output.

If 1321-1370 represents one extreme, the half century from 1821 to 1870 represents the other. Again, the GDP estimates for these years are well documented and robust. By then national income had grown enormously, the dependence upon agriculture had substantially diminished, and GDP per head had grown fivefold. With a larger, stronger and more diversified economy, in which risks were spread more widely, the mean absolute deviation of the harmonised cyclical component of GDP, at 1.83 per cent, is a third smaller (Table 2). The sole example of a boom or bust with a deviation from trend in excess of ±6 per cent occurred in 1862, when civil war in America brought a cotton famine to Lancashire and the resultant slump in manufacturing output and associated commercial activities hit GDP hard. The earlier recession of 1842-3 — sparked by an industrial contraction in construction and metals — looks worse than it was because of the contrast it provides to the booms of 1835-6 and 1844-6, when Britain's emerging export staple industries of cotton, coal and iron were all thriving. In all these respects, the amplitude of these mid-nineteenth-century business cycles was substantially smaller than that of their mid-fourteenth-century counterparts. This modest but real calming of business cycle activity is consistent with the transformation of economic activity which had occurred over the intervening centuries.

When did the genuine reduction in the amplitude of business cycles that occurred between the mid-fourteenth and the mid-nineteenth centuries take place? On the evidence

of Table 2, the mean absolute deviation of the harmonised cyclical component of GDP was little different during the troubled middle decades of the sevententh century from what it had been three centuries earlier. On this measure, there was clear continuity between late-medieval and early modern business cycles. By 1671-1720, however, that continuity had been broken, as the mean absolute deviation of the harmonised cyclical component of GDP decreased to 2.03 per cent. This is consistent with the clear evidence that by the late-seventeenth century the economy had grown in scale, diversity and dynamism (*BEG*: 406-13). By 1721-70 business-cycle behaviour had calmed further, with a reduction in average amplitude to less than 2.0 per cent. Volatility increased somewhat during the inflationary era of the French Wars but from the 1820s it quietened once again and was back to the levels of the mid-eighteenth-century. Thus, it was between 1671 and 1770, as the economy embarked upon the transition to modern economic growth and when the newly established Bank of England began to perform an increasingly influential role in the nation's financial affairs, that the behaviour of British business cycles underwent a significant moderation. The economy still oscillated between boom and bust but violent oscillations were largely a thing of the past.

V. English business cycles, 1270-1700

The short-term ebb and flow of economic activity was an abiding feature of the period 1270-1700. Business cycles typically averaged 3 to 4 years from peak to peak and their amplitude was often large, with peaks and troughs in the range ± 5 percent and, very occasionally, in excess of ±7.5 per cent. Such variation is to be expected of a relatively underdeveloped economy in which agriculture, whose annual output was intrinsically unstable, bullked large: it accounted for 45.5 per cent of GDP in 1381 and was still contributing 26.7 per cent of GDP in 1700 (*BEG*: 194-5). Agricultural fluctuations driven by extreme weather and occasional outbreaks of livestock disease feature prominently in discussions of the period (Campbell, 2010 & 2016) and throughout this period, as Figure 4 shows, such fluctuations were the predominant driver of the business cycle.

At the start of the chronology, following the bumper harvest year of 1275 (one of the best on record), the recession of 1279-80 shows up as the first of many of an agricultural origin. Its cause was a devastating national outbreak of sheep scab which depressed wool yields and prices, with adverse consequences for industrial output and commercial services along with pastoral agriculture (Stratton, 1978; Stephenson, 1988; Carus-Wilson & Coleman, 1962; Slavin, 2016). Recovery from livestock diseases took time and so the sheep-scab

panzootic cast a long shadow, especially when reinforced by the poor harvest of 1283. As a result, the 1280s stand out as a generally depressed decade, relieved only by the good harvest of 1287, and problems rumbled on into the 1290s.

Figures 8 and 9 and Table 3 and 4 about here

Four centuries later, the economy remained prey to harsh weather and dismal harvests, with shortfalls in agricultural output depressing GDP in 1684, 1686 and 1693. Between the 1280s and 1680s the chronology of business cycles is punctuated by similar harvest-related recessions. In the fourteenth century, the notorious famine years beginning in 1315, when harvests failed for three consecutive years across much of northern Europe, followed by a devastating outbreak of cattle plague — probably rinderpest — and then further serious harvest failures in 1321 and 1324, mark an extended but intermittent episode of crisis, comprising a series of short and quite distinctive component elements, including a notable respite in 1318-19. In the mid-fifteenth century, as the Little Ice Age entered its extended first phase and agriculture faced the challenge of some seriously adverse weather conditions (Campbell, 2016: 335-49), 1436-7, 1441-2 and 1445, all stand out as years when the negative effects of inclement weather and dismal harvests, compounded by a poor showing by industry, were widely felt. In the sixteenth century the conspicuously deep recession of 1556-7 arose from a particularly severe back-to-back harvest failure. In its immediate wake mortality rates rose and marriage and birth rates fell, as was characteristic of a serious subsistence crisis (Campbell, 2009: 46-7; Hoyle, 2017: 147). Better known is the extended crisis of 1594-7, although less for its obvious demographic impact than because the government responded to the pressing social problems it created by enacting in 1601 what has become known as the Elizabethan Poor Law (Campbell, 2009: 46-7; Smith, 2015; Hoyle, 2017: 147, 150). In the seventeenth century, 1629-30 was bad and agriculturally-related difficulties returned at the end of the Civil War decade of the 1640s (Coates, 2004; Cunningham, 1907). Unfortunately, record keeping was one of the many casualties of the Civil War and ensuing Commonwealth, so the GDP estimates are less robust for these years. Parish registers were also less scrupulously maintained. Hindle (2008) believes that deficiencies in burial registration may have led Wrigley and Schofield (1989) to underestimate the seriousness of the subsistence crisis that unfolded from 1647 as harsh weather exacerbated the problems created by the contested political and military situations (Parker, 2013). Conversely, because of similar data deficiencies the recession of 1659 — the final

year of the Commonwealth when the country was in political disarray — looks worse than it probably was (Figure 9).

War, on occasion, greatly compounded these weather-related problems. Thus, between 1315 and 1322 a spate of deliberately destructive Scottish hit-and-run raids on the north of England had an enduring if regionally circumscribed impact upon output (Campbell, 2010). Edward III's declaration of war against France in 1337, which initiated the Hundred Years War (1337-1453), had far graver consequences for the national economy. The recession that followed in 1339, when an embargo was placed on wool exports, is one of the deepest and sharpest on record (Figure 8). The harmonised cyclical component of GDP fell from +5.1 per cent above trend in 1338 to -7.8 per cent below trend in 1339 and the financial and commercial repercussions of Edward's actions were felt far beyond England's shores. Within a year, however, the crisis had passed and within another three years GDP had largely recovered. In 1415 the newly crowned Henry V repeated his martial great-grandfather's actions but at far less damaging cost to the national economy (Ormrod, 2013).

By the sixteenth century the costs of warfare had escalated and In the 1590s the domestic problems created by the run of bad harvests were greatly aggravated by the costs of the Nine Years' War simultaneously being waged by England in Ireland. The final conquest of Ireland cost the country dearly, otherwise, as Nef (1942) points out, from 1540 to 1640 England was less affected by warfare than continental Europe, where fighting was almost uninterrupted. Spain's attempted English invasion of 1588 had failed and in 1603 the ancient conflict with Scotland was finally extinguished when Scotland's James VI ascended to the English throne. War nevertheless continued to be a contributor to the business cycle both through the direct effects of government spending and the indirect effects of the disruption to trade and industry. The English Civil War of 1642-51 had an understandably depressing effect upon most branches of economic activity and the years from 1645 to 1651 were a time of more-or-less continuous recession (Figure 9). After the Civil War, and in defence of its commercial interests, England became engaged in a number of wars driven by commercial rivalry, notably the Anglo-Dutch Wars of 1652-54, 1665-67 and 1672-74 (Ormrod, 2003), although it was only the costly and fruitless Third Anglo-Dutch War that seems to have been accompanied by a downturn in the business cycle.

The possibility that periodic scarcities of money may have depressed economic activity, until the problem was dramatically resolved by the influx of New World silver in the sixteenth century, is a view championed by several historians. Nightingale (1990: 560), for

instance, argues that a drop in the output of the English mints between 1370 and 1400 depressed the price level and was accompanied by a reduction of credit, with negative consequences for the volume of real economic activity. Yet this is not easily reconciled with the positive annual GDP growth rates which, on average, prevailed throughout the 1380s and early 1390s and the obvious boom years of 1384, 1386 and 1392 (Figures 3 & 8). Spufford (1988: 362) has advanced a similar case with respect to the more serious reduction in mint output of the 1440s and 1450s, which occurred across almost the whole of Europe as well as in England. He believes that shortages of money exercised a singularly depressing effect on both prices and real output. Nevertheless, although there was no net positive GDP growth over these two decades, nor was there any clear synchronicity between years of recession and the years when mint output was lowest (Figure 8 and Table 3; Mayhew, 2013).

Monetary factors have also been linked to the five-year contraction of 1547-52, via the debasement of the coinage, culminating in the Great Tudor Debasement of 1542-1551 (Challis, 1967). However, whilst the debasement undoubtedly added a specifically English element to the Great Inflation of the sixteenth century, caused primarily by the flow of New World bullion into Europe, its effects on real economic activity are much harder to demonstrate. Upon closer examination, this contraction had little to do with the impact upon commerce and industry of the preceding debasement (Challis, 1967; Gould, 1970) and much more with what was happening in agriculture. The Great Tudor Debasement does not therefore provide an early example of a financial crisis leading to a severe recession.

The single greatest recession of them all, however, was caused not by extreme weather, war, commercial dislocation or problems of money supply, although all were elements of the crisis that unfolded (Campbell, 2016: 267-89), but by the massive mortality precipitated in 1348-9 by the first wave of the Second Plague Pandemic. Within the space of two years the Black Death dramatically curtailed economic output by dealing devastating blows to the supply of labour and demand for goods and services.The harmonised cyclical component of GDP collapsed from +11.0 per cent above trend in 1348 to –3.9 per cent below trend in 1349, –6.1 per cent in 1350 and then –7.6 per cent in 1351. In fact, the harmonised cyclical component of GDP remained negative for an unprecedented and unparalleled eight consecutive years. No subsequent recession would ever be as deep and prolonged. For the next 25 years each repeat visitation of plague — in 1360-2, 1369 and 1374-5 — brought a return of recession, although never again on the same scale. Meanwhile, persistently poor harvests inhibited any full recovery of agricultural productivity (Campbell, 2011). Over these

years, therefore, real GDP continued its downward slide, not arrested until the 1380s (Figures 1 and 3). In fact, the 1380s were the best decade for annual growth rates in almost a hundred years (Figure 3) and 1392 saw the strongest positive GDP growth since 1275.

Plague remained a fact of demographic life for the next 300 years and its persistence was one of the reasons why there was no renewal of demographically-driven output growth until the final decades of the fifteenth century (Figures 1 and 2). In fact, the fifteenth century was almost as prone to recession as the fourteenth (Hatcher, 1996). International trade was at a low ebb, as European access to oriental commerce was increasingly obstructed, and, with populations still much reduced, demand within Europe remained slack. With no scarcity of per capita resources and improved GDP per head, workers appear to have seized the opportunity to shorten the working year (*BEG*: 263-5; Humphries & Weisdorf, 2019). From the sixteenth century, however, with the return of population growth, daily wage rates fell back and wage-earners could only maintain these material gains by working harder. By the end of the seventeenth century plague had finally disappeared and industry and services were advancing apace and accounted for, respectively, 41.3 and 32.0 per cent of GDP (*BEG*: 194). From the 1680s annual GDP growth rates became increasingly positive as GDP per head finally rose above its earlier ceiling and began the sustained upward rise that would continue to 1870 and beyond (Figures 2 and 3). At the same time, the amplitude of business cycles started to subside (Table 2). This is a reminder that in England's case the turning point from stasis to growth occurred in the late seventeenth century and not, as was for long believed, in the eighteenth century.[1] As growth took hold, and in a further departure from the past, the boom phases of business cycles became more prominent than the slumps.

VI British business cycles, 1700-1870

From 1700 the business-cycle chronology relates to the whole of Britain rather than just England. Each cycle still typically lasted for 3 to 4 years from peak to peak and their *relative* amplitudes still reflected the magnitude of the risks to which the economy was exposed. In the opening decades of the eighteenth century these included some years of conspicuously bad weather (notably 1706 and, following the bitter winter of 1708-09, 1710) and commercial

[1] The growth boom between 1650 and 1700 was not yet modern economic growth, however, as this requires increasing population and GDP per head as well as positive GDP growth (Kuznets, 1966). With population declining during the second half of the seventeenh century century, the onset of modern economic growth was delayed until around 1700.

disruptions arising from the War of the Spanish Succession (1701-1714).[2] When economic downturns occurred, setbacks to industry and commerce were an increasingly prominent component of them. In contrast to the situation before 1670 (Table 2), there was nonetheless a genuine tendency for the extremes of boom and slump to abate. The British economy, after all, was growing and thereby becoming stronger and more resilient. In the process, it was diversifying and achieving a more even balance between agriculture, industry and services and each sector was itself becoming internally more diverse, all of which tended to spread risks and reduce the impact of negative shocks. Productivity advances within agriculture also helped moderate the variability of output within the sector which, historically, had always been the greatest single source of GDP volatility (Campbell & Ó Gráda, 2011). This reduction in agriculture's output share and improvement in its performance meant, in effect, that the economy was becoming cushioned against the buffetings of extreme weather.

Figure 10 and Table 5 about here

The 1720s were an exception. The decade began with the 9 months of speculative madness known as the South Sea Bubble, when shares in the South Sea Company rose from little more than £100 at the beginning of 1720 to around £1,000 by August of the same year, before crashing back to £150 by the end of September (Temin & Voth, 2004: 1,658). This is an early and extreme example of asset price inflation followed by a crash. The harmonised cycical component of real GDP reached a peak in 1720, followed by a trough in 1721, although this was not particularly severe. Later in the decade, the advent of harsh weather and the outbreak of disease, together, resulted in the harmonised cyclical component of GDP being below trend in five of the six years between 1725 and 1731, precipitating the worst mortality crisis of the eighteenth century (Campbell, 2009: 45, 47). Between them, but for almost the last time, these two old enemies of economic output made a bad situation a great deal worse. Thereafter, although the exogenous shocks of disease and extreme weather continued periodically to damage output, the recessions that resulted were never as severe as in the past and recovery from them was stronger. The net balance was now almost always in favour of growth (Figure 4). The eighteenth and nineteenth centuries had no counterpart to the fourteenth-century plagues, capable of throwing output trends into reverse for a generation or more at a time. Even potato blight, which in 1845

[2] Note that the negative effects of the Great Frost of 1709 are not as dramatic in the harmonised series as in the original series from *BEG*.

spread from England to Ireland with devastating and lasting consequences, scarcely dented British GDP as it occurred when the country was on the crest of an economic wave (Figures 4 & 10).

As the threats posed to economic output by the weather and disease receded, so those presented by political, financial and commercial disruptions came to the fore. The extended period spanned by the French Wars proved particularly challenging as manifest in the heightened variability of annual growth rates at that time (Table 2). Apart from the diffculty of maintaining international commerce amidst armed conflict on land and at sea, the economy was exposed to a prolonged bout of inflation. In 1797 the Bank of England was faced simultaneously by an external drain on its gold reserves to finance war expenditure overseas and an internal drain caused by a run on the country banks by depositors fearful of a French invasion. It responded by suspending specie payments (Bordo & White, 1991: 311). By 1813, sterling had depreciated from par by 38.2 per cent, but thereafter appreciated as the British government retained credibility through an appropriate mix of fiscal and financial policies (Silberling, 1924: 227; Bordo & White, 1991: 310-14). From 1815, following the outbreak of peace, that meant allowing a sudden deflation to enable the resumption of convertibility. The latter was accompanied by real economic hardship as the economy experienced a slump, with the cyclical component of real GDP falling progressively from 1816 to 1823. On this occasion the shadow cast over the economy by these financial and commercial readjustments was deeper than that cast by the volcanic dust veil then enveloping the globe following the explosive eruption of Mount Tambora in April 1815 (Post, 1977; Oppenheimer, 2011: 295-319). For once, bad weather and poor harvests were the lesser part of these serious economic difficulties. The living standards of the poor were squeezed hard and in 1819 protests arising from these cumulative difficulties were harshly suppressed (Reid, 1989).

The role played by the Bank of England in shaping the financial context within which this recession unfolded was something new and the shape of things to come. In this respect the post-Napoleonic War slump looks decidedly modern. Subsequently, as sustained economic growth took hold, the increasingly sophisticated role of money, finance and credit created new vulnerabilities which, when exposed, had serious consequences for the real economy. Thus, the worst slump of the nineteenth century occurred in 1862 when the American Civil War disrupted the supply of raw cotton to Lancashire textile manufacturers, with profound knock-on effects for the economy as a whole (Henderson, 1969) (Figures 3 &

10). By contrast, the collapse of the discount house Overend, Gurney and Company in 1866 was followed by only a short slump in 1867, as the Bank of England intervened to act as a lender of last resort (Schneider, 2022). This was a decisive point in the Bank's evolution towards its role as a modern central bank.

VII Conclusions

The starting point of this paper, as in all modern studies of the business cycle, is provided by national estimates of GDP constructed from the output side and capable of disaggregation into the separate outputs of agriculture, industry and services. The results are therefore founded upon a more comprehensive range of variables than previous historical studies of business cycles. The cycles themselves have been identified by applying the Hodrick-Prescott filter to extract the cyclical component from the real GDP series. This is the method favoured by many economists and widely employed in their analyses of contemporary datasets. To ensure broad comparability of business cycles across the period 1270-1870, differences in the amplitude of business cycles between sub-periods characterised by different agricultural datasets have been harmonised using information on the variability of prices. No previous historical study has investigated business cycles in this way across such a long and economically transformative period of history.

Throughout the pre-industrial centuries it was variations in agricultural output that were the single most influential driver of business cycles. This reflects the facts that until the mid-seventeenth century agriculture was the single largest contributor to GDP and, at the same time, it was the sector whose annual output was most exposed to the varying effects of the weather and the sporadic devastations of livestock disease. In 1321 a sharp recession occurred when a nationwide outbreak of cattle plague was closely followed by bad weather and harvest failure. On this occasion, the scale and duration of the recession reflected the already straitened economic circumstances prevailing when the shortfall in output occurred. Context was therefore important, as was very much the case of the harvest failures that coincided with the final years of the Civil War and ensuing Commonwealth as well as those that followed the South Sea Bubble. Through their influence upon harvests, weather conditions, therefore, clearly impacted directly upon economic activity in the short-term and were responsible for some of the biggest of the observed recessions, although the post-recession bounce back, as in the case of 1318-19, was sometimes equally striking. With time, however, these influences faded, as industry and services accounted for a larger share of

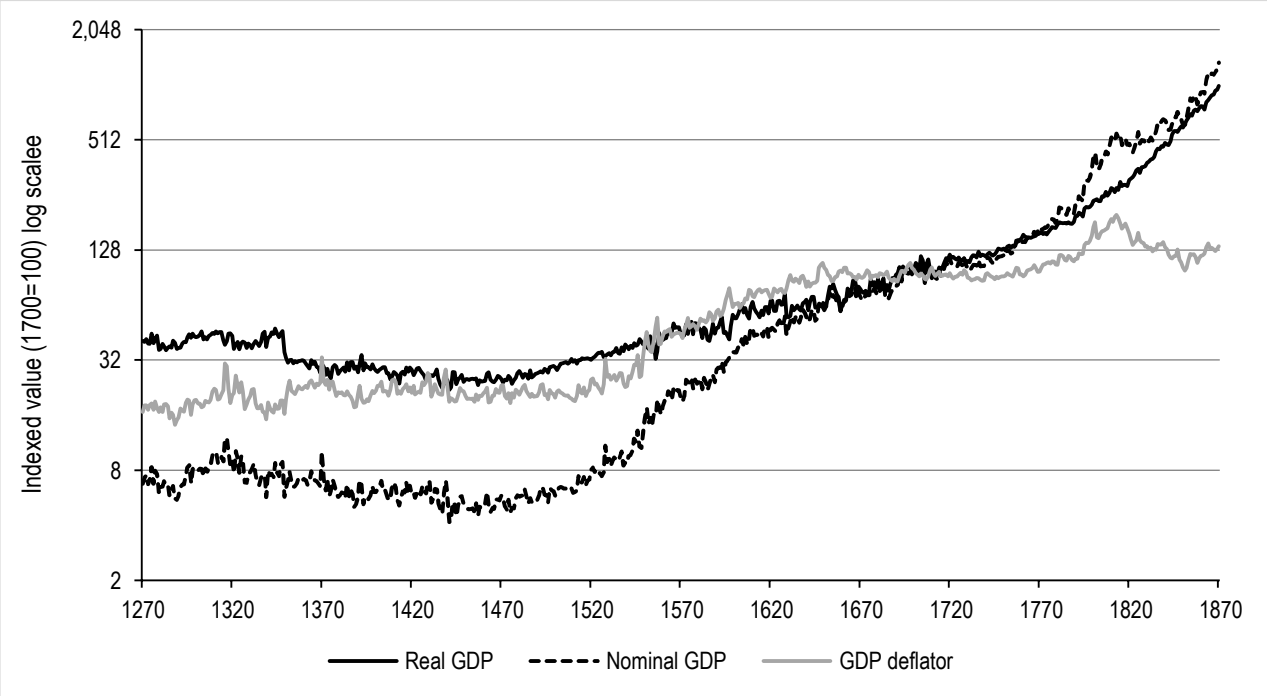
output and as the adoption of a raft of technological improvements diminished the variability of agricultural output (Overton, 1996). These changes in the structure of the economy as it developed and grew, more particularly after 1670 than before, are evident in the emergence of industry and commerce as increasingly important drivers of business cycles. From the mid-eighteenth century their influence became paramount and as their contributions to GDP grew apace, so the influence of agriculture upon business cycles faded into insignificance.

War was a recurrent source of disruption, particularly when it interrupted and dislocated trade, as it did in 1339 when Edward III manipulated the wool export trade to political advantage, and again, over 500 years later, in 1862 when the American Civil War starved the Lancashire cotton industry of its essential raw material. In both cases, and there were numbers of others, significant slumps resulted. Although there were over 180 short-term business cycles over the course of these six centuries, no two of them were ever exactly the same in their causes, course or consequences. The one constant was their existence. That some were more severe, serious or significant than others is self-evident but how should that importance be judged? The worst recessions might be deep, as was the case in 1339, 1413, 1457, or 1556-7, but then often followed by a swift bounce back. Or they might be long drawn out, lasting 5 years or more with scarcely any let up, as from 1279-86, 1304-8, 1594-8, 1612-16, 1645-51, 1658-62, 1670-5, 1737-46, 1784-9, 1816-23, and 1861-5. The worst of all combined both features. The Black Death recession that began in 1349 lasted for eight years and over its course witnessed a contraction of harmonised GDP by nearly 30 per cent. Judged in these terms, the Black Death recession was the most severe on record. It was also the most anomalous, for during no other recession did such a dramatic upturn in real wage rates and GDP per head occur. Its uniqueness sprang from the sheer scale of the precipitating demographic shock and long postponement of any recovery. In these respects, the event would never be repeated.

In the long run what mattered was the extent to which the boom stages of each business cycle offset the slumps and the speed with which recovery from recession took place. Although in the earlier centuries there were always short episodes when net growth prevailed, the balance did not shift decisively in favour of growth until the end of the seventeenth century. That it did indicates that a fundamental change was taking place in the character of business cycles as, at much the same time, the transition began to modern economic growth. Later business cycles look increasingly modern, in the sense that developments in industry and commerce were their principal drivers, financial relationships

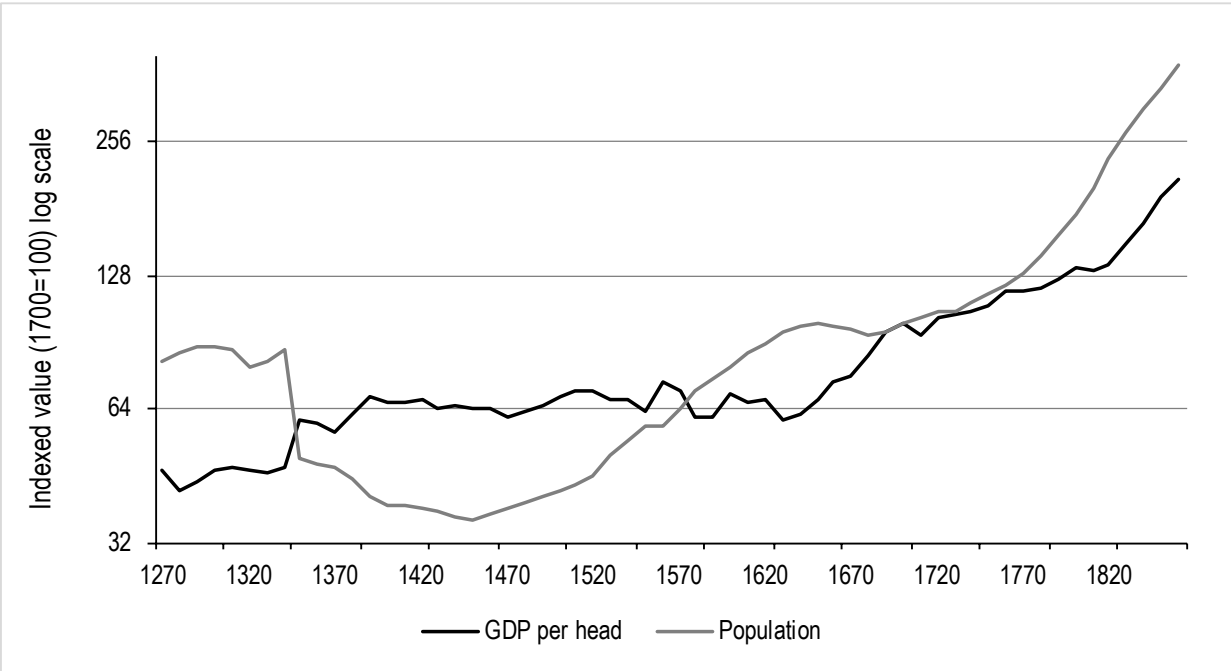
were material to outcomes, the Bank of England was playing an increasingly influential role and their amplitude was significantly reduced.

FIGURE 1: Real and nominal GDP and price deflator: England 1270-1700 and Great Britain 1700-1870 (1700=100, log scale)



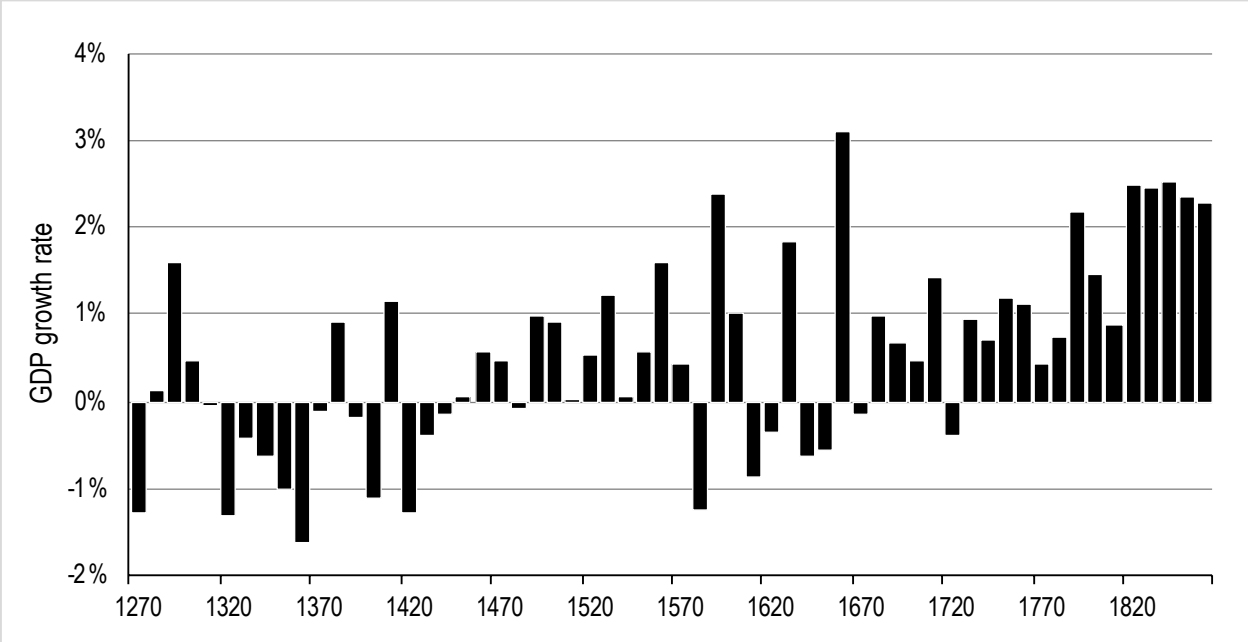
Source: derived from *BEG*.

FIGURE 2: Population and GDP per head, decadal averages: England 1270-1700 and Great Britain 1700-1870 (1700=100, log scale)



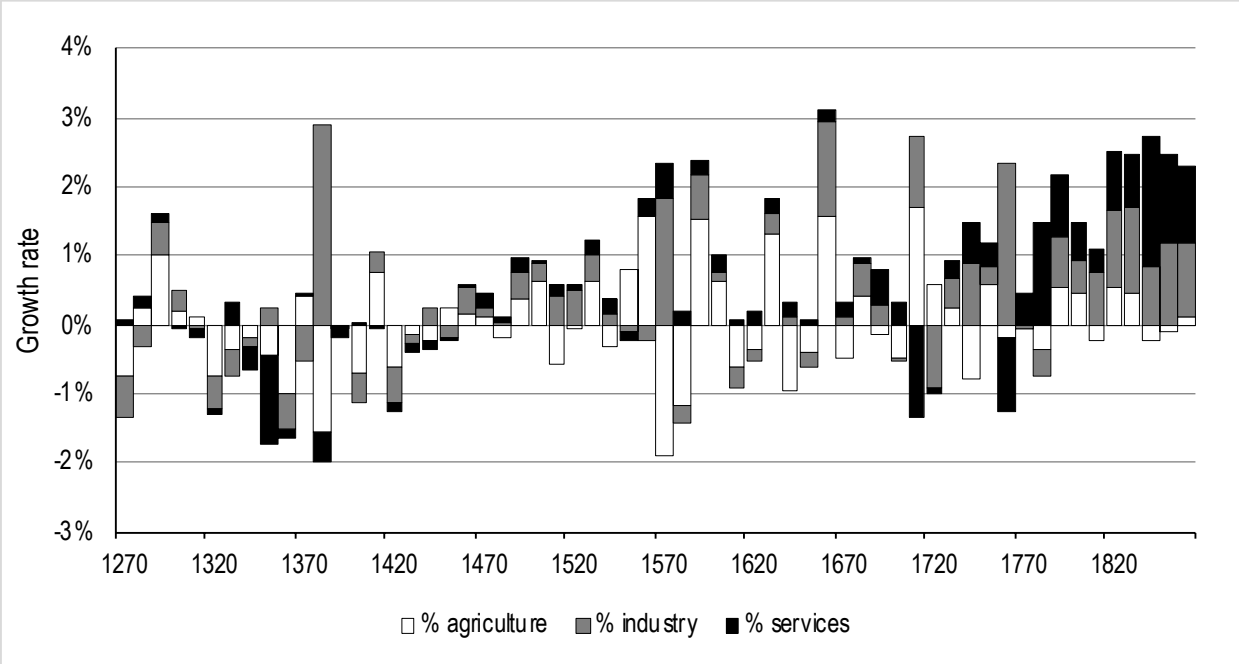
Source: derived from *BEG*.

FIGURE 3: Mean annual % GDP growth per decade: England 1270-1700 and Great Britain 1700-1870



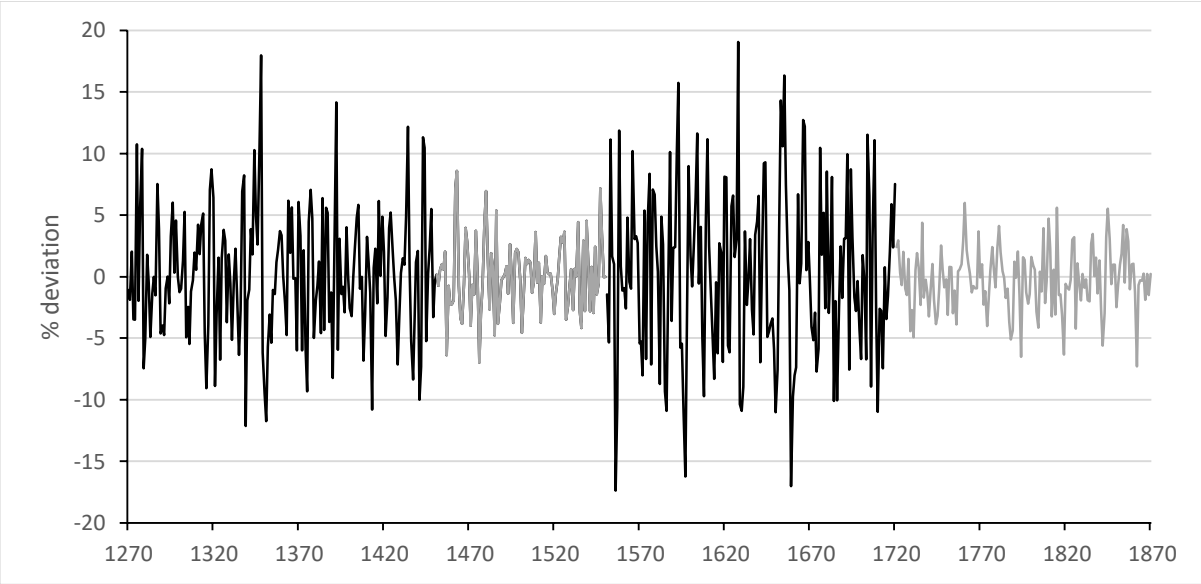
Source: derived from *BEG*.

FIGURE 4: Mean percentage contributions per decade of agriculture, industry and services to annual output growth: England 1270-1700 and Great Britain 1700-1870



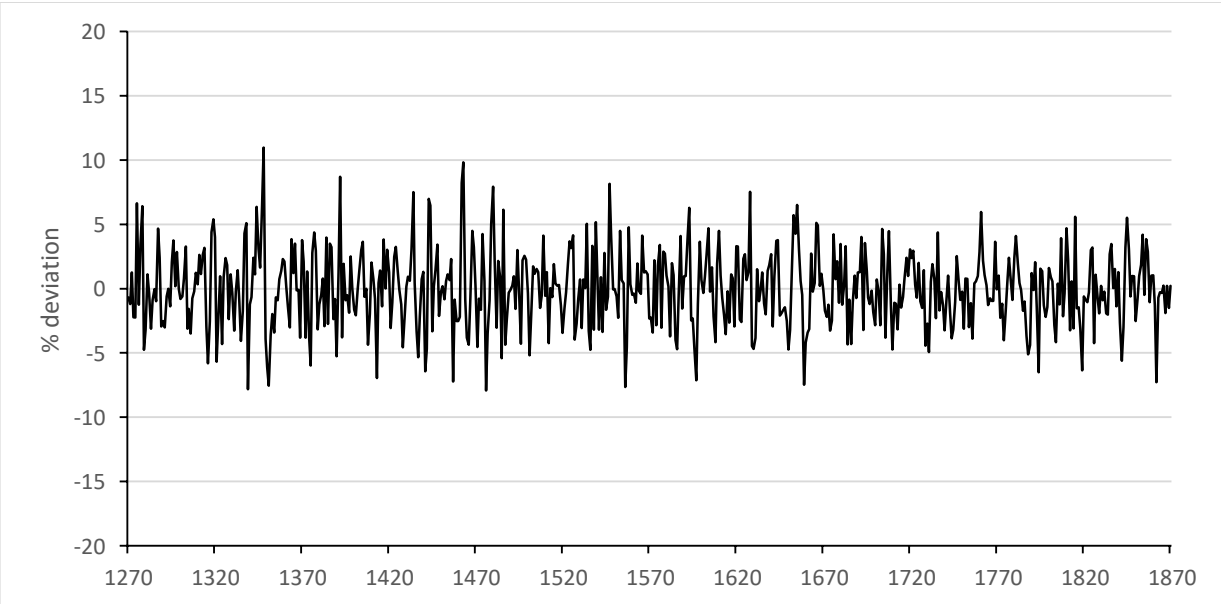
Source: derived from *BEG*.

FIGURE 5: Unadjusted cyclical component of GDP: England 1270-1450, 1451-1550, 1551-1700 and Great Britain 1700-1720 and 1721-1870



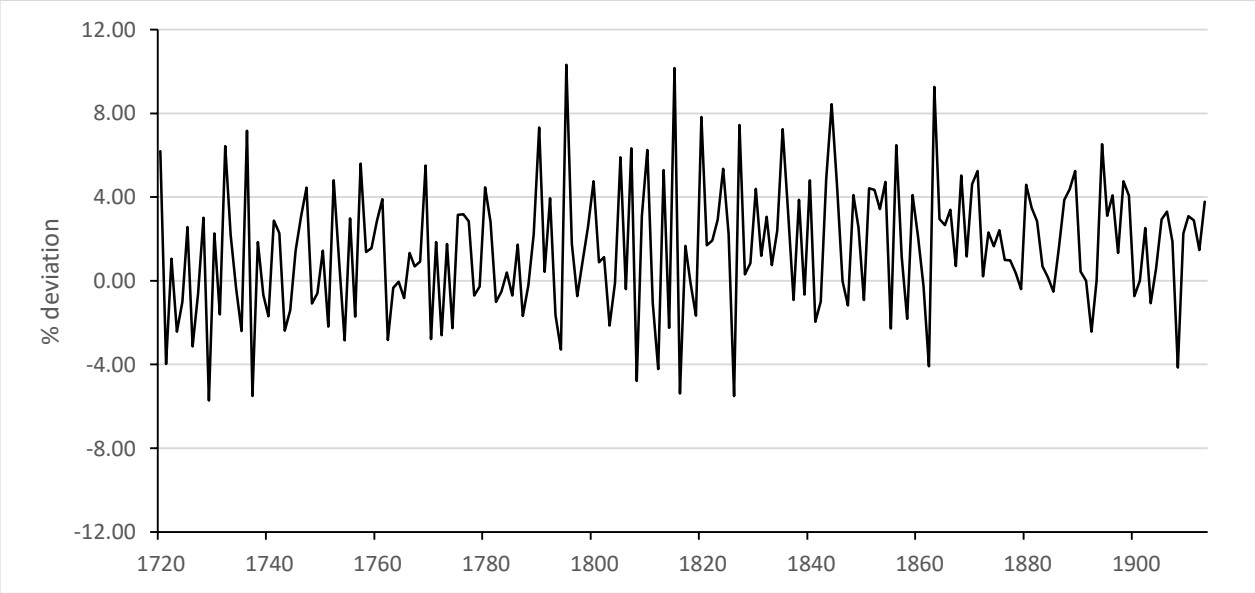
Source: derived from *BEG* using Hodrick-Prescott filter, without harmonisation of cyclical component.

FIGURE 6: Harmonised cyclical component of GDP: England 1270-1700 and Great Britain 1700-1870



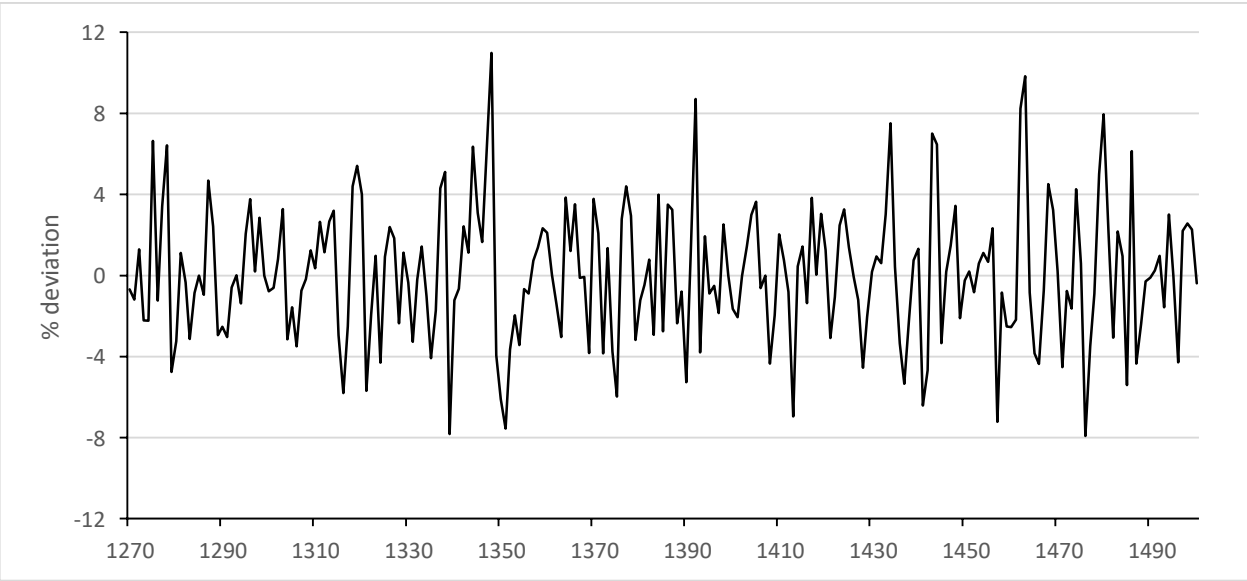
Source: derived from *BEG* using Hodrick-Prescott filter, with harmonisation of cyclical component.

FIGURE 7: Annual log growth rates of GDP: Great Britain 1720-1870 and United Kingdom 1870-1913



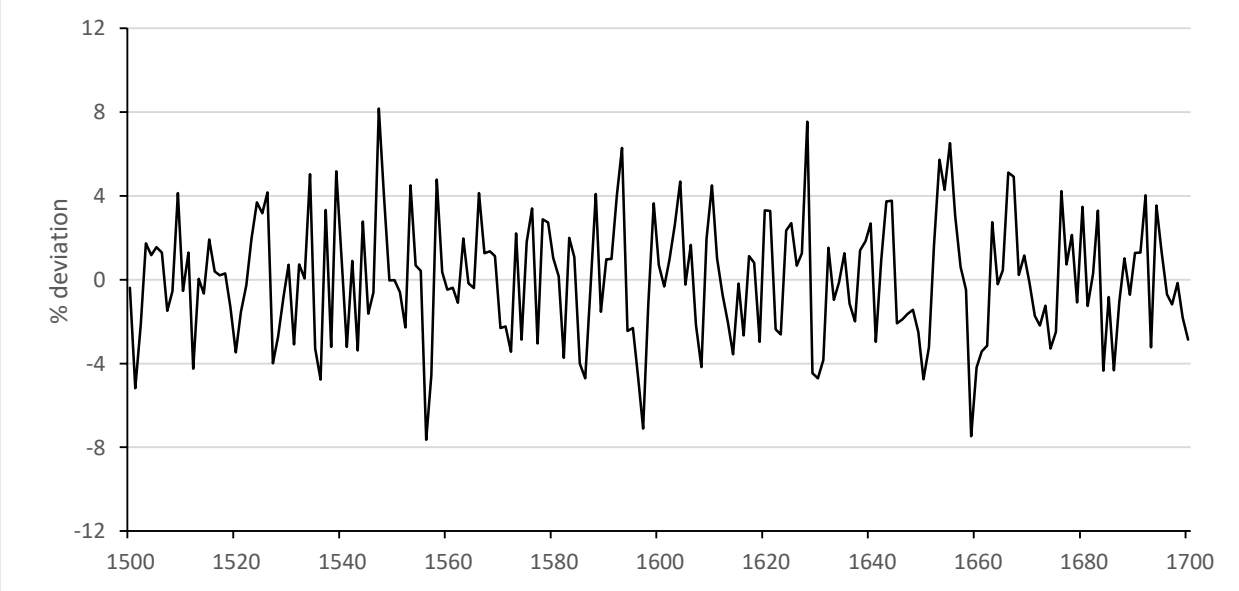
Source: GB data for 1720-1870 from *BEG*, UK data for 1870-1913 from Feinstein (1972).

FIGURE 8: Business-cycle chronology: England 1270-1500.



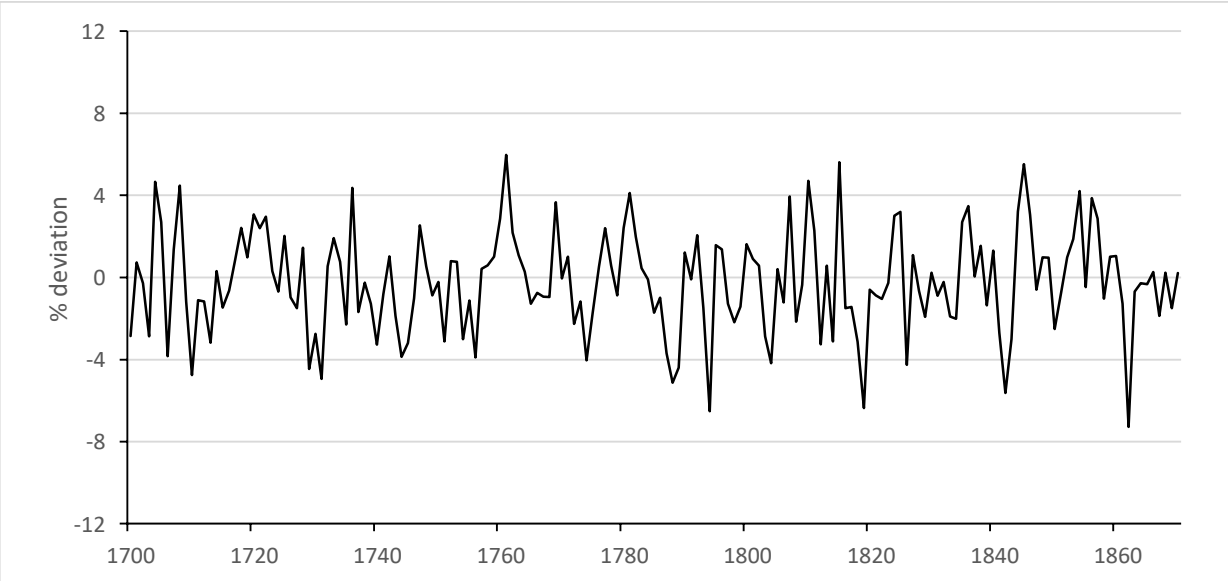
Source: derived from *BEG* using Hodrick-Prescott filter, with harmonisation of cyclical component.

FIGURE 9: Business-cycle chronology: England 1470-1700.



Source: derived from *BEG* using Hodrick-Prescott filter, with harmonisation of cyclical component.

FIGURE 10: Business-cycle chronology: Great Britain 1700-1870



Source: derived from *BEG* using harmonised GDP data.

TABLE 1: Harmonising the amplitude of English and British business cycles, 1271-1870.

Period	(A)	(B)	(C)	(D)	(E)
	MAD of real agricultural price change (%)	MAD of unadjusted cyclical component of GDP (%)	Ratio (B) / (A)	Ratio (E) / (B)	MAD of harmonised cyclical component of GDP (%)
1271-1450	5.88	4.02	0.68	0.63	2.53
1451-1550	5.77	2.19	0.38	1.14	2.49
1551-1720	5.46	5.65	1.03	0.42	2.35
1721-1870	4.51	1.95	0.43	1.00	1.95

Notes: MAD = mean absolute deviations. The ratios given in Column D are those of the sub-period ratios given in Column C to the ratio of 0.43 for 1721-1870.

Source: derived from *BEG* using data on real GDP and real agricultural prices (the agricultural price index divided by the GDP deflator).

TABLE 2: The varying amplitude of English and British business cycles, 1271-1870

Period	MAD of harmonised cyclical component of GDP (%)	Period	MAD of harmonised cyclical component of GDP (%)
1271-1320	2.35	1571-1620	2.46
1321-1370	2.81	1621-1670	2.64
1371-1420	2.40	1671-1720	2.03
1421-1470	2.72	1721-1770	1.81
1471-1520	2.30	1771-1820	2.14
1521-1570	2.34	1821-1870	1.83

Notes: MAD = mean absolute deviations.

Source: derived from Appendix 1.

TABLE 3: English business-cycle chronology, 1270-1500.

Peak	Trough	Peak	Trough	Peak	Trough
1272	1274	1348	1351	1419	1421
1275	1276	1353	1354	1424	1428
1278	1279	1355	1356	1431	1432
1281	1283	1359	1363	1434	1437
1285	1286	1364	1365	1440	1441
1287	1289	1366	1367	1443	1445
1290	1291	1368	1369	1448	1449
1293	1294	1370	1372	1451	1452
1296	1297	1373	1375	1454	1455
1298	1300	1377	1379	1456	1457
1303	1304	1382	1383	1458	1460
1305	1306	1384	1385	1463	1466
1309	1310	1386	1388	1468	1471
1311	1312	1389	1390	1472	1473
1314	1316	1392	1393	1474	1476
1319	1321	1394	1395	1480	1482
1323	1324	1396	1397	1483	1485
1326	1328	1398	1401	1486	1487
1329	1331	1405	1406	1492	1493
1333	1335	1407	1408	1494	1496
1338	1339	1410	1413	1498	1501
1342	1343	1415	1416		
1344	1346	1417	1418		

Note: based on the harmonised cyclical component of GDP derived using the Hodrick-Prescott filter (λ=100).

Source: derived from Appendix 1.

TABLE 4: English business-cycle chronology, 1500-1700.

Peak	Trough	Peak	Trough	Peak	Trough
1498	1501	1561	1562	1632	1633
1503	1504	1563	1565	1635	1637
1505	1507	1566	1567	1640	1641
1509	1510	1568	1570	1644	1645
1511	1512	1571	1572	1648	1650
1513	1514	1573	1574	1653	1654
1515	1517	1576	1577	1655	1659
1518	1520	1578	1582	1663	1664
1524	1525	1583	1586	1666	1668
1526	1527	1588	1589	1669	1672
1530	1531	1593	1594	1673	1674
1532	1533	1595	1597	1676	1677
1534	1536	1599	1601	1678	1679
1537	1538	1604	1605	1680	1681
1539	1541	1606	1608	1683	1684
1542	1543	1610	1614	1685	1686
1544	1545	1615	1616	1688	1689
1547	1549	1617	1619	1692	1693
1550	1552	1620	1623	1694	1697
1553	1556	1625	1626	1698	1699
1558	1560	1628	1630		

Note: based on the harmonised cyclical component of GDP derived using the Hodrick-Prescott filter (λ=100).

Source: derived from Appendix 1.

TABLE 5: British business-cycle chronology, 1700-1870.

Peak	Trough	Peak	Trough	Peak	Trough
1701	1703	1755	1756	1817	1819
1704	1706	1761	1765	1820	1822
1708	1710	1766	1768	1825	1826
1711	1713	1769	1770	1827	1829
1714	1715	1771	1772	1830	1831
1718	1719	1773	1774	1832	1834
1720	1721	1777	1779	1836	1837
1722	1724	1781	1785	1838	1839
1725	1727	1786	1788	1840	1842
1728	1729	1790	1791	1845	1847
1730	1731	1792	1794	1848	1850
1733	1735	1795	1798	1854	1855
1736	1737	1800	1804	1856	1858
1738	1740	1805	1806	1860	1862
1742	1744	1807	1808	1864	1865
1747	1749	1810	1812	1866	1867
1750	1751	1813	1814	1868	1869
1752	1754	1815	1816	1870	

Note: based on the harmonised cyclical component of GDP derived using the Hodrick-Prescott filter (λ=100).

Source: derived from Appendix 1.

APPENDIX 1: Business cycle chronology, England 1270-1700 and Great Britain 1700-1870, based on the harmonised cyclical component of GDP derived using the Hodrick-Prescott filter (λ=100).

Year	Cyclical comp^t	Year	Cyclical comp^t	Year	Cyclical comp^t	Year	Cyclical comp^t	Year	Cyclical comp^t
1270	-0.68%	1320	4.00%	1370	3.79%	1420	1.26%	1470	0.22%
1271	-1.19%	1321	-5.69%	1371	2.08%	1421	-3.09%	1471	-4.54%
1272	1.28%	1322	-1.93%	1372	-3.83%	1422	-1.07%	1472	-0.76%
1273	-2.21%	1323	0.97%	1373	1.35%	1423	2.48%	1473	-1.64%
1274	-2.24%	1324	-4.32%	1374	-3.76%	1424	3.26%	1474	4.25%
1275	6.64%	1325	0.93%	1375	-5.98%	1425	1.39%	1475	0.59%
1276	-1.24%	1326	2.39%	1376	2.79%	1426	-0.07%	1476	-7.92%
1277	3.43%	1327	1.84%	1377	4.39%	1427	-1.21%	1477	-3.49%
1278	6.42%	1328	-2.36%	1378	2.95%	1428	-4.57%	1478	-0.91%
1279	-4.77%	1329	1.13%	1379	-3.17%	1429	-2.05%	1479	4.99%
1280	-3.23%	1330	-0.35%	1380	-1.22%	1430	0.18%	1480	7.95%
1281	1.12%	1331	-3.27%	1381	-0.47%	1431	0.94%	1481	2.19%
1282	-0.34%	1332	-0.20%	1382	0.79%	1432	0.61%	1482	-3.06%
1283	-3.13%	1333	1.43%	1383	-2.92%	1433	3.03%	1483	2.17%
1284	-0.86%	1334	-1.02%	1384	3.98%	1434	7.50%	1484	0.95%
1285	-0.01%	1335	-4.07%	1385	-2.76%	1435	0.44%	1485	-5.41%
1286	-0.96%	1336	-1.73%	1386	3.50%	1436	-3.35%	1486	6.14%
1287	4.68%	1337	4.31%	1387	3.24%	1437	-5.35%	1487	-4.37%
1288	2.43%	1338	5.11%	1388	-2.35%	1438	-2.10%	1488	-2.39%
1289	-2.95%	1339	-7.83%	1389	-0.80%	1439	0.75%	1489	-0.30%
1290	-2.53%	1340	-1.23%	1390	-5.28%	1440	1.31%	1490	-0.10%
1291	-3.03%	1341	-0.66%	1391	1.25%	1441	-6.43%	1491	0.25%
1292	-0.60%	1342	2.42%	1392	8.70%	1442	-4.69%	1492	0.97%
1293	0.00%	1343	1.13%	1393	-3.80%	1443	6.99%	1493	-1.56%
1294	-1.37%	1344	6.36%	1394	1.93%	1444	6.46%	1494	3.00%
1295	2.06%	1345	3.09%	1395	-0.89%	1445	-3.34%	1495	-0.02%
1296	3.76%	1346	1.64%	1396	-0.51%	1446	0.19%	1496	-4.29%
1297	0.20%	1347	6.46%	1397	-1.86%	1447	1.47%	1497	2.21%
1298	2.85%	1348	10.97%	1398	2.51%	1448	3.43%	1498	2.57%
1299	-0.01%	1349	-3.94%	1399	0.01%	1449	-2.10%	1499	2.27%
1300	-0.79%	1350	-6.11%	1400	-1.64%	1450	-0.24%	1500	-0.38%
1301	-0.61%	1351	-7.56%	1401	-2.05%	1451	0.20%	1501	-5.18%
1302	0.81%	1352	-3.65%	1402	-0.02%	1452	-0.82%	1502	-2.14%
1303	3.28%	1353	-1.96%	1403	1.43%	1453	0.59%	1503	1.73%
1304	-3.14%	1354	-3.42%	1404	3.00%	1454	1.12%	1504	1.17%
1305	-1.56%	1355	-0.67%	1405	3.64%	1455	0.67%	1505	1.55%
1306	-3.50%	1356	-0.89%	1406	-0.61%	1456	2.32%	1506	1.29%
1307	-0.75%	1357	0.74%	1407	-0.01%	1457	-7.24%	1507	-1.49%
1308	-0.19%	1358	1.38%	1408	-4.36%	1458	-0.84%	1508	-0.55%
1309	1.24%	1359	2.32%	1409	-1.97%	1459	-2.52%	1509	4.14%
1310	0.35%	1360	2.10%	1410	2.03%	1460	-2.54%	1510	-0.55%
1311	2.64%	1361	0.04%	1411	0.75%	1461	-2.18%	1511	1.29%
1312	1.15%	1362	-1.42%	1412	-0.80%	1462	8.23%	1512	-4.24%
1313	2.66%	1363	-3.03%	1413	-6.96%	1463	9.83%	1513	0.05%
1314	3.20%	1364	3.85%	1414	0.45%	1464	-0.84%	1514	-0.65%
1315	-2.95%	1365	1.21%	1415	1.43%	1465	-3.84%	1515	1.92%
1316	-5.82%	1366	3.51%	1416	-1.36%	1466	-4.37%	1516	0.40%
1317	-2.50%	1367	-0.11%	1417	3.82%	1467	-0.73%	1517	0.22%
1318	4.40%	1368	-0.07%	1418	0.04%	1468	4.51%	1518	0.30%
1319	5.41%	1369	-3.83%	1419	3.04%	1469	3.23%	1519	-1.29%

Year	Cyclical $comp^t$	Year	Cyclical $comp^t$	Year	Cyclical $comp^t$	Year	Cyclical $comp^t$	Year	Cyclical $comp^t$
1520	-3.47%	1570	-2.31%	1620	3.31%	1670	-0.13%	1720	3.07%
1521	-1.54%	1571	-2.23%	1621	3.28%	1671	-1.72%	1721	2.40%
1522	-0.26%	1572	-3.43%	1622	-2.38%	1672	-2.19%	1722	2.96%
1523	1.95%	1573	2.20%	1623	-2.62%	1673	-1.23%	1723	0.30%
1524	3.69%	1574	-2.85%	1624	2.35%	1674	-3.29%	1724	-0.69%
1525	3.17%	1575	1.80%	1625	2.70%	1675	-2.49%	1725	2.02%
1526	4.17%	1576	3.40%	1626	0.66%	1676	4.23%	1726	-0.97%
1527	-3.98%	1577	-3.05%	1627	1.26%	1677	0.74%	1727	-1.49%
1528	-2.73%	1578	2.89%	1628	7.54%	1678	2.14%	1728	1.45%
1529	-0.83%	1579	2.73%	1629	-4.47%	1679	-1.08%	1729	-4.45%
1530	0.71%	1580	1.03%	1630	-4.70%	1680	3.48%	1730	-2.74%
1531	-3.09%	1581	0.17%	1631	-3.84%	1681	-1.25%	1731	-4.95%
1532	0.72%	1582	-3.74%	1632	1.52%	1682	0.29%	1732	0.54%
1533	0.06%	1583	2.00%	1633	-0.96%	1683	3.30%	1733	1.92%
1534	5.04%	1584	1.08%	1634	-0.12%	1684	-4.35%	1734	0.77%
1535	-3.29%	1585	-4.00%	1635	1.26%	1685	-0.84%	1735	-2.29%
1536	-4.76%	1586	-4.71%	1636	-1.14%	1686	-4.33%	1736	4.37%
1537	3.32%	1587	-0.53%	1637	-1.99%	1687	-1.05%	1737	-1.69%
1538	-3.21%	1588	4.10%	1638	1.40%	1688	1.02%	1738	-0.25%
1539	5.17%	1589	-1.53%	1639	1.85%	1689	-0.72%	1739	-1.27%
1540	0.90%	1590	0.97%	1640	2.69%	1690	1.27%	1740	-3.27%
1541	-3.21%	1591	0.99%	1641	-2.97%	1691	1.29%	1741	-0.81%
1542	0.89%	1592	4.04%	1642	0.95%	1692	4.03%	1742	1.03%
1543	-3.38%	1593	6.28%	1643	3.74%	1693	-3.23%	1743	-1.87%
1544	2.78%	1594	-2.45%	1644	3.77%	1694	3.55%	1744	-3.87%
1545	-1.63%	1595	-2.32%	1645	-2.08%	1695	1.34%	1745	-3.20%
1546	-0.61%	1596	-4.62%	1646	-1.90%	1696	-0.70%	1746	-1.02%
1547	8.16%	1597	-7.12%	1647	-1.64%	1697	-1.18%	1747	2.55%
1548	4.01%	1598	-1.23%	1648	-1.44%	1698	-0.15%	1748	0.55%
1549	-0.04%	1599	3.65%	1649	-2.51%	1699	-1.81%	1749	-0.87%
1550	-0.01%	1600	0.71%	1650	-4.76%	1700	-2.86%	1750	-0.21%
1551	-0.61%	1601	-0.33%	1651	-3.23%	1701	0.73%	1751	-3.12%
1552	-2.27%	1602	0.94%	1652	1.64%	1702	-0.28%	1752	0.79%
1553	4.50%	1603	2.62%	1653	5.73%	1703	-2.87%	1753	0.77%
1554	0.68%	1604	4.69%	1654	4.29%	1704	4.66%	1754	-3.01%
1555	0.42%	1605	-0.23%	1655	6.51%	1705	2.70%	1755	-1.12%
1556	-7.66%	1606	1.67%	1656	3.05%	1706	-3.83%	1756	-3.90%
1557	-4.58%	1607	-2.15%	1657	0.60%	1707	1.36%	1757	0.42%
1558	4.78%	1608	-4.18%	1658	-0.47%	1708	4.48%	1758	0.59%
1559	0.36%	1609	1.95%	1659	-7.49%	1709	-1.19%	1759	1.01%
1560	-0.47%	1610	4.51%	1660	-4.19%	1710	-4.75%	1760	2.87%
1561	-0.38%	1611	1.02%	1661	-3.43%	1711	-1.10%	1761	5.98%
1562	-1.10%	1612	-0.70%	1662	-3.15%	1712	-1.17%	1762	2.18%
1563	1.97%	1613	-2.05%	1663	2.74%	1713	-3.18%	1763	1.07%
1564	-0.18%	1614	-3.56%	1664	-0.22%	1714	0.32%	1764	0.29%
1565	-0.40%	1615	-0.19%	1665	0.45%	1715	-1.46%	1765	-1.27%
1566	4.13%	1616	-2.66%	1666	5.12%	1716	-0.64%	1766	-0.75%
1567	1.27%	1617	1.13%	1667	4.92%	1717	0.86%	1767	-0.93%
1568	1.36%	1618	0.81%	1668	0.22%	1718	2.41%	1768	-0.94%
1569	1.13%	1619	-2.96%	1669	1.16%	1719	0.98%	1769	3.67%

Year	Cyclical $comp^t$	Year	Cyclical $comp^t$	Year	Cyclical $comp^t$	Year	Cyclical $comp^t$	Year	Cyclical $comp^t$
1770	-0.05%	1790	1.21%	1810	4.71%	1830	0.23%	1850	-2.51%
1771	1.01%	1791	-0.09%	1811	2.27%	1831	-0.89%	1851	-0.75%
1772	-2.26%	1792	2.05%	1812	-3.26%	1832	-0.23%	1852	0.98%
1773	-1.18%	1793	-1.48%	1813	0.57%	1833	-1.90%	1853	1.87%
1774	-4.04%	1794	-6.52%	1814	-3.11%	1834	-2.02%	1854	4.21%
1775	-1.75%	1795	1.58%	1815	5.61%	1835	2.69%	1855	-0.47%
1776	0.52%	1796	1.37%	1816	-1.50%	1836	3.48%	1856	3.86%
1777	2.40%	1797	-1.28%	1817	-1.43%	1837	0.05%	1857	2.87%
1778	0.58%	1798	-2.18%	1818	-3.13%	1838	1.54%	1858	-1.03%
1779	-0.87%	1799	-1.42%	1819	-6.36%	1839	-1.36%	1859	1.02%
1780	2.41%	1800	1.61%	1820	-0.59%	1840	1.30%	1860	1.04%
1781	4.11%	1801	0.90%	1821	-0.87%	1841	-2.70%	1861	-1.29%
1782	1.98%	1802	0.57%	1822	-1.04%	1842	-5.62%	1862	-7.29%
1783	0.45%	1803	-2.86%	1823	-0.27%	1843	-3.01%	1863	-0.68%
1784	-0.09%	1804	-4.18%	1824	3.01%	1844	3.22%	1864	-0.28%
1785	-1.71%	1805	0.41%	1825	3.20%	1845	5.52%	1865	-0.33%
1786	-0.98%	1806	-1.21%	1826	-4.25%	1846	3.05%	1866	0.26%
1787	-3.70%	1807	3.94%	1827	1.08%	1847	-0.59%	1867	-1.88%
1788	-5.13%	1808	-2.15%	1828	-0.66%	1848	0.99%	1868	0.23%
1789	-4.39%	1809	-0.36%	1829	-1.92%	1849	0.97%	1869	-1.49%
								1870	0.22%

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