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2011

University of Kent

School of Economics Discussion Papers

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December 2011

KDPE 1203

BRITISH ECONOMIC GROWTH, 1270-1870: AN OUTPUT-BASED APPROACH

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December 2011

Abstract: This paper reconstructs GDP from the output side for medieval and early modern Britain. In contrast to the long run stagnation of living standards suggested by daily real wage rates, output-based GDP per capita exhibits modest but positive trend growth. One way of reconciling the two series is through variation in the annual number of days worked, but there are also reasons to doubt the representativeness of the sharp rise and fall of daily real wage rates in the late middle ages, which creates the impression of no trend improvement of living standards.

Keywords: Economic Development, Economic Growth, National Income

JEL Classification: O11, O40, E01

Acknowledgements: This paper forms part of the project "Reconstructing the National Income of Britain and Holland, c.1270/1500 to 1850", funded by the Leverhulme Trust, Reference Number F/00215AR. It is also part of the Collaborative Project HI-POD supported by the European Commission's 7th Framework Programme for Research, Contract Number SSH7-CT-2008-225342. We are grateful to Richard Britnell, Ben Dodds, John Hatcher, Leigh Shaw-Taylor, Philip Slavin, Richard Smith, Jan de Vries and seminar/conference participants at Cambridge, Durham, Evanston, LSE, Tokyo, Reading, Utrecht, Venice, Warwick and Yale for helpful comments and suggestions.

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I. INTRODUCTION

The quantitative picture of long run economic development in Europe is based largely on the evidence of real wages. In the case of Britain, the standard source is Phelps Brown and Hopkins (1955; 1956), who showed that there was no trend in the daily real wage rates of building labourers from the late thirteenth century to the middle of the nineteenth century, albeit with quite large swings over sustained periods. This view has recently been supported by Clark (2004, 2005, 2007a), who constructs a new price index, refines the Phelps Brown and Hopkins industrial wage series and adds a wage series for agricultural labourers. In addition, Clark (2010) provides new time series for land rents and capital income to construct a series for GDP from the income side. This new series is dominated by the real wage and hence paints a bleak Malthusian picture of long run stagnation of living standards and productivity.

However, there are good reasons to be sceptical about this interpretation of long run economic history, which seems to fly in the face of other evidence of rising living standards, including the growing diversity of diets (Feinstein, 1995; Woolgar, Serjeantson and Waldron, 2006), the availability of new and cheap consumer goods (Hersh and Voth, 2009), the growing wealth of testators (Overton, Whittle, Dean and Haan, 2004; de Vries, 1994), the virtual elimination of famines (Campbell and Ó Gráda, 2011), the growth of publicly funded welfare provision (Slack, 1990), increasing literacy (Houstan, 1982; Schofield, 1973), the growing diversity of occupations (Goose and Evans, 2000), the growth of urbanization and the transformation of the built environment (de Vries, 1984). Indeed, as Hatcher (2011) has recently pointed out, Phelps Brown and

Hopkins (1956: 296) specifically warned against interpreting their series as a measure of living standards, mentioning on the income side the lack of information on how many days' work the builder was getting and what other resources he had, and on the outlay side lack of information on important costs and the fact that the prices were more wholesale rather than retail. Maddison (2007: 316-319) warns against the pitfalls of inferring trends in GDP per capita from trends in real wages, but his self-styled "guesstimates" of GDP from the output side are no substitute for country-specific output estimates painstakingly reconstructed from the available empirical evidence. The first purpose of this paper is to demonstrate how such a reconstruction is possible in the case of Britain for the period 1270-1870, highlighting the main sources and methods. In the case of Britain, the results show a modest but positive trend rate of growth in per capita GDP between 1270 and 1700, leading to an approximate doubling of incomes. A further doubling of per capita GDP occurred between 1700 and 1870 as growth accelerated during the Industrial Revolution. Since similar records exist for many other European countries and some non-European countries, the output-based approach to GDP estimation developed here holds out the prospect of significantly extending the range of historical national accounting over both time and space.

The second purpose of this paper is to explore the differences between the trends in the real wage and output-based GDP per capita series. The most straightforward way to reconcile the two series is to posit an "industrious revolution", so that annual labour incomes grew as a result of an increase in the number of days worked, despite the stagnation in the daily real wage (de Vries, 1994). However, there are also reasons to

doubt the representativeness of the sharp rise and fall of daily real wage rates during the late medieval period. As noted by Hatcher (2011), if Clark's (2007) fifteenth century daily money wages had been paid to agricultural labourers all year round, husbandmen would have been worse off than labourers and large landowners would have been bankrupt. Workers hired on annual contracts must clearly have been paid a significantly lower daily rate than the casual workers whose wage rates provide the basis for the real wage series. If the "golden age" of the fifteenth century is removed, so is the impression of no trend improvement of living standards.

The paper proceeds as follows. The reconstruction of GDP from the output side is first set out, with the sources and methods for the three main sectors of agriculture, industry and services described in sections II to IV. Section V then explains how the sectoral output series are aggregated to GDP and combined with population to provide a series for GDP per capita. Section VI compares the income and output based measures and explores how they can be reconciled. Section VII concludes. An Appendix provides more detailed discussion of the sources and methods used for the estimation of the annual indices of real output in agriculture, industry and services, as well as aggregate GDP, population and GDP per capita.

II. AGRICULTURAL PRODUCTION

1. Data sources

In reconstructing agricultural output, extensive use has been made of three data sets derived from primary sources: the Medieval Accounts Database assembled by Campbell

(2000; 2007); Overton's Early Modern Probate Inventories Database (Overton, Whittle, Dean and Hann, 2004); and the Modern Farm Accounts Database constructed by Turner, Beckett and Afton (2001). These databases provide crucial information on land use, arable yields and animal stocking densities. This section provides an overview of the sources and methods, but with more detail available in the Appendix.

2. Arable farming in England, 1270-1870

Arable farming output is obtained by multiplying the amount of land sown with each crop by the grain yield for that crop and making deductions for grain used as seed and fodder for working animals. The key magnitudes are derived from the three main datasets as described below. However, there are a number of general issues which arise in going from the sampled information in the databases to the economy-wide totals.

The starting point for the estimation of arable output is the total area under crop, to which the proportions of land sown with each crop in the database samples are applied. Firm estimates of land use only became available in the agricultural returns from 1866, and data from the population census year of 1871 are used here to provide the starting point for the series set out in Table 1 (Parliamentary Papers, 1871). For 1830, the figures come from the tithe files and for 1800, 1750 and 1700 from estimates by contemporaries (Holderness, 1989). Here, the higher figures suggested by Prince's (1989: 41) interpretation of the 1801 Crop Returns have been accepted, while the estimates for 1600 have been inferred by extrapolating backwards from these later figures. For the medieval period, the starting point is the estimate for 1300. Around this time, the population was

close to its medieval peak, so that the arable acreage would also have been at its peak. By quantifying the major changes of land use between 1290 and 1871, and tracking developments at a county level, Broadberry, Campbell and van Leeuwen (2011a) arrive at a new figure for arable land in 1290, which serves as a benchmark for the medieval period. Estimates for other years between 1270 and 1500 are obtained by extrapolation from 1290 on the basis of trends in the cropped acreage on demesnes and tithe data in the non-demesne sector (Campbell, Bartley and Power, 1996; Dodds, 2004; Medieval Accounts Database). Further details are provided in section 2 of the Appendix.

Having obtained estimates of the overall arable acreage in use, the next step is to allocate it between fallow and the major crops sown. This information is taken from the Medieval Accounts Database for the period before 1500, the Early Modern Probate Inventories Database for the period 1550-1750 and from Holderness (1989) and Overton (1996) for the period 1750-1850. For the medieval period, it should be noted that the distribution of crops in the demesne sector is assumed to be representative of the country as a whole. This is broadly consistent with the much smaller amount of evidence on the non-demesne sector (Dodds, 2007; Sapoznik, 2008). The amount of fallow declined from between a third and a half in the medieval period to less than a quarter in the early modern period and to just 3.5 per cent by 1871. Amongst the principal winter-sown crops, wheat remained important throughout the period, but rye and maslin (a mixture of wheat and rye) declined sharply during the modern period. Amongst the spring-sown crops, barley and dredge (a mixture of barley and oats) remained important throughout the period, but oats declined in relative importance. The biggest increase in the use of

arable land was in potatoes and other crops, particularly clover and root crops after 1700 (Overton, 1996: 99-101, 110).

To calculate output from the estimated areas sown with each crop requires information on grain yields per acre, net of seed sown. National average yields per acre, gross of tithe and seed can be obtained from the three main databases, using regression analysis with dummy variables for each farm and for each year, as suggested by Clark (2004). Since the medieval evidence is drawn largely from the seigniorial sector, it is necessary to consider what was happening in the non-demesne sector. Although Postan (1966) believed that yields were higher on the demesnes as a result of access to better land and more capital, Stone (2006: 21) has recently argued that yields were around 11 per cent higher in the non-demesne sector, where incentives were stronger for peasants. Since the direction of the adjustment is unclear, and would anyway be quite small, it has been assumed here that yields on the demesne sector were representative of English agriculture as a whole. From the grain yields gross of seed as well as tithe, it is necessary to subtract grain used as seed to derive the net yields. Further details on grain yields are provided in section 3 of the Appendix.

In addition to making allowance for grain used as seed, calculation of the net output of the arable sector must take account of consumption of oats and pulses by animals working on the farm. This has been calculated on the basis of estimates of the proportions of these crops consumed by horses and oxen in benchmark years, interpolated log-linearly. For oats, the benchmark figures are 70 per cent for 1800 and 50

per cent for 1600 from Overton and Campbell (1999: 201) and 30 per cent for 1300 from Wrigley (2006: 445). For pulses, Allen's (2005) figure of 27 per cent for the post-1700 period was taken from the worksheets underlying Clark, Huberman and Lindert (1995), the higher figure of 50 per cent for the pre-1500 period was based on Campbell (2001: 228-229), and the proportion between 1500 and 1700 was interpolated.

The acreage for each crop is multiplied by the yield and converted from a gross output to a net output basis by the subtraction of seeds and fodder for working animals. The results are shown in Table 2. During the medieval period, output of wheat and rye, the principal bread grains, declined substantially from the late thirteenth century peak, with a sharp fall in line with population following the Black Death of the mid-fourteenth century. The output decline was similarly sharp for oats, which fell out of favour as a crop for human consumption. In place of malted oats, malted dredge (a barley/oats mixture) and malted barley became the preferred brewing grains, and demand for barley remained relatively buoyant. Output of pulses also declined relatively slowly during the medieval period. By the end of the sixteenth century, output of the major grains was back to the peak pre-Black Death level. Output of wheat continued to increase after 1600, while rye declined, reflecting the growing preference for the more expensive bread grain. The output of barley increased markedly in line with the demand for better quality ale brewed from the best barley malt. Output of pulses also grew rapidly during the early modern period, while potatoes became an important crop during the eighteenth century. Output of oats, net of consumption by farm horses, fluctuated more erratically.

3. Pastoral farming in England, 1270-1870

The output of the pastoral sector is derived as the product of the numbers of non-working animals, the proportions producing and the animal yields. For the medieval and early modern periods, estimates of the numbers of non-working animals per 100 sown acres can be obtained from the manorial accounts and probate inventories databases. As with the crop yields, the national average stocking densities are obtained from the observations on individual demesnes and farms. For the medieval period, however, particular care must be taken in moving from the stocking densities on the demesnes to the numbers of animals in the country as a whole.

Conversion of the seigniorial stocking densities into corresponding national densities and numbers of animals is based on four key assumptions. First, because of a negative relationship between farm size and stocking density, drawn from the post-1550 data, the stocking density of cattle was four times higher on non-demesne lands (Overton and Campbell, 1992: 388-389). However, the scale of this effect has been reduced by following Allen (2005) in assuming that holding farm size constant, the density of cattle was one-third lower on non-demesne lands, due to their high unit capital value. Second, again following Allen (2005), mature cattle have been divided into milk and beef animals in the ratio 53 to 47 per cent. Third, swine, a quintessentially peasant animal, are assumed to have been stocked by non-seigniorial producers at four times the density on demesnes, again in line with the negative relationship between farm size and stocking density in the post-1550 period. Fourth, aggregate sheep numbers have been checked for consistency with trends in exports, inferred levels of domestic demand, and the decline in average

fleece weights noted by Stephenson (1988: 380). The demesne sector trend in sheep numbers has been used to represent the trend in agriculture as a whole, but the absolute level has been set at 15 million in 1300, in line with the estimate of Wrigley (2006: 448). This was the number of animals needed to supply the wool export trade as recorded by the customs accounts (Britnell, 2004: 417) and a domestic consumption equivalent of 1.18 square yards per head *per annum*, on the reckoning that domestic production supplied labourers with 1 square yard of woollen cloth, substantial tenants with 2 square yards and landowners with 8 square yards, weighting the different social classes according to the social tables of Campbell (2008). It should be noted that an important constraint on these four key assumptions is the need to obtain consistency between animal numbers in the medieval and early modern periods.

Stocking densities can also be obtained for the early modern period from probate inventories, and are assumed to apply to the whole agricultural sector. These stocking densities are thus simply multiplied with the sown acreage to produce estimates of the numbers of non-working animals. However, stocking densities are unavailable for the modern period, so from 1750 onwards, animal numbers are taken directly from contemporary estimates from John (1989), Mitchell (1988) and Turner (1998) for benchmark years, and interpolated using data on annual sales at Smithfield and the Metropolitan Cattle Market from Mitchell (1988: 708) and Perren (1975: 388). Further details on numbers of non-working animals are provided in section 4 of the Appendix.

To derive pastoral output from animal numbers also requires information on the proportions of animals producing milk, meat and wool. Ninety per cent of cows are

assumed to have produced milk and ninety per cent of sheep to have yielded wool. Meat, however, was produced only by those animals that were slaughtered. Following Holderness (1989: 147), it is assumed that approximately a quarter of the stock of cattle and sheep and around half of all pigs were slaughtered annually in the early modern period. These ratios are also applied to the late medieval period for sheep and pigs, in line with slaughter rates documented by Campbell (1995: 164-167). For cattle, however, slaughter rates were lower in the medieval period because there were few herds kept specifically for beef. By 1850, however, cattle herds were increasingly being kept for the production of beef, so that slaughter rates increased. Similarly, for sheep there was a shift from wool to mutton production in the modern period, simultaneously raising the percentage of animals producing mutton and reducing the percentage producing wool. For pigs, high slaughter rates of 100 per cent were possible because of the large numbers of piglets produced during the year. Further details on the proportions of animals producing are provided in section 4 of the Appendix.

The next step in the calculations involves the estimation of yields of milk, meat and wool per animal, drawn from a number of sources, including Clark (1991), Allen (2005), Stephenson (1988) and Britnell (2004). Data between benchmark years were interpolated using information on the relative prices of pastoral products and the animals from which they were derived. Finally, the information on numbers of animals, percentages of each animal producing and yields per animal can be combined to provide estimates of output in the pastoral farming sector in Table 3.

Further assumptions are needed to derive output estimates for hay and hides. Hay output is derived from the numbers of non-farm horses, on the assumption that each horse consumed 2.4 tons of hay per year (Thompson, 1983). Output of hides is derived from the numbers of animals using assumptions on the percentages of each animal producing and yields per animal from Clark (1991) and Clarkson (1989).

In contrast to the arable sector, where output of all the main products declined with population across the Black Death, output of the main pastoral products remained broadly unchanged during the medieval period, before resuming growth between the mid-fifteenth and mid-sixteenth centuries.

4. Total agricultural output in England, 1270-1870

Multiplying the output volumes by their prices yields the total value of net output. The price data are taken largely from Clark (2004). Output can be valued in both current prices and in constant 1700 prices. Constant price output for the arable and pastoral sectors is shown in Figure 1 in index number form on a logarithmic scale. Table 4 shows the same information in growth rate form, together with the growth rate of total agricultural output.

During the medieval period, arable output exhibited a clear downward trend, particularly as grain consumption fell in line with population across the Black Death. Pastoral output, however, showed greater stability, as the surviving population spent their increased incomes on meat and dairy produce. Agriculture as a whole thus showed only a

modest decline in output. From the mid-sixteenth century, arable and pastoral output both grew, with the pastoral sector at first lagging behind the arable sector, but outpacing it again from the mid-seventeenth century.

The pastoral sector was thus increasing its share of agricultural output in constant prices during the medieval period and from the mid-seventeenth century, but with a setback between the 1450s and the 1650s, which can be seen clearly in Table 5. However, in current price terms the picture is complicated by changes in relative prices. In particular, although the price of pastoral products relative to arable products was fairly stable during the medieval period, it then trended downwards between the 1450s and 1650s, particularly during the "Great Inflation" of the sixteenth century. These relative price changes thus amplified the effects of the slower real growth of the pastoral sector between the 1450s and the 1650s, so that in current prices, the share of the pastoral sector dropped substantially during this period.

However, what is perhaps most striking about Table 5 is the already very high share of the pastoral sector in medieval England, in both current and constant price terms. This meant that although the English people did not have a particularly generous diet if viewed in terms of kilocalories, it was a varied diet, with meat, dairy produce and ale to supplement the less highly processed grain products that made up the bulk of the diet.

It should be noted that there is a gap between 1492 and 1553 as the manorial records come to an end before the probate inventories become available. This gap has

been filled at the level of total agricultural output using the demand function approach of Crafts (1985) and Allen (2000). Agricultural consumption per head is assumed to be a function of its own price, the price of non-agricultural goods and income. Income, own-price and cross-price elasticities are estimated from the data for output (adjusted for net imports), prices and real wages over the period 1301-1492 and 1553-1700, and used to predict the missing values of output between 1492 and 1553, based upon the known values of prices and real wages for this period. The results are discussed in section 5 of the Appendix.

III. INDUSTRIAL PRODUCTION

1. Industrial output in England, 1270-1700

For the period 1270-1700, it is possible to obtain volume measures for most of the key English industries, which can be broken down into three major sectors: metals and mining; textiles and leather; and other industries. The metals and mining sector is based on physical output volumes for a number of important industries. Tin output is available on an annual basis for the whole period from 1301 with relatively few gaps, from Hatcher (1973: 156-159) and Mitchell (1988: 303-304). King (2005) provides data on bar iron production for the period 1490-1700. The output of coal in the 1560s and circa 1700 is taken from Hatcher (1993: 68), interpolated using shipments of coal from north-eastern ports, also taken from Hatcher (1993: 487-495), updating the earlier work of Nef (1932: 380-381).

The textiles and leather sector is based on volume indicators of the key raw material inputs of wool and animal hides. Exports of wool and woollen cloth are given by Carus-Wilson and Coleman (1963) for the period 1280-1554. However, the export of wool is negatively related to the export of cloth, so the production of wool from agriculture minus wool exports is used as an indicator of the woollen textile industry. The output of hides from pastoral agriculture is used to track the output of the leather industry.

Food processing, construction and book production are grouped together as the relatively heterogeneous group of other industries. Food processing is assumed to grow in line with agricultural output. Construction is assumed to grow in line with population, but with an allowance for urbanisation. For the medieval period, however, allowance has been made for church building, using data on the number of cathedral and abbey building projects derived from Morris (1979: 179). Book production is measured by the index of new English language book titles obtained from the English Short Title Catalogue (http://estc.bl.uk/F/?func=file&file_name=login-bl-list).

An index of industrial production is constructed from these individual series using vaue added weights for circa 1700. The weights in Table 6 are derived from Hoffmann (1955), but with a number of modifications, including an allowance for the production of books, as well as the reworking of the weighting scheme by Crafts and Harley (1992). It should be noted, however, that this does not mean that value added shares are assumed to have remained constant over time. Given data on quantity relatives and the value added

shares in the base year, the implied value added shares in other years can be inferred using the quantity relatives (Crafts and Harley, 1992: 706-707, 722). Figure 2 plots the index of industrial production on a logarithmic scale, while Table 7 summarises the same information in growth rate form over fifty year periods, using 10-year averages to capture long run trends. Although there were substantial fluctuations in industrial output during the Middle Ages, there was no trend growth until after the 1480s, which ushered in a period of sustained industrial expansion. Section 6 of the Appendix provides more detail on the component series of the industrial production index for England, 1270-1700.

2. Industrial output in Great Britain, 1700-1870

Industry is the one sector for which data have previously been analysed at annual frequency during the period 1700-1870, so this section can be fairly brief. Crafts (1985) and Harley (1982) pointed out independently that Hoffmann (1955) had overstated the growth rate of industrial output during the Industrial Revolution as a result of inadvertently over-weighting the rapidly growing cotton sector. In addition to changing the weighting scheme, Crafts and Harley (1992) also replaced some of the older series used by Hoffmann (1955), drawing on the latest scholarship. These series have been used here, together with some later additions, the most important of which are the new series of bar iron output from King (2005), Feinstein's (1988: 446) series of investment in total buildings and works for output of the construction industry, and an index of new English language book titles derived from the English Short Title Catalogue and the British Library for the output of the printing industry. However, changes from the Crafts-Harley industrial production index are relatively minor. Output growth accelerated from around

the 1760s to the 1830s before tapering off. Section 7 of the Appendix provides more detail on the component series of the industrial production index for Great Britain, 1700-1870.

IV. SERVICES

1. Services in England, 1270-1700

The service sector has received much less attention from economic historians than agriculture and industry. The approach pioneered by Deane and Cole (1967) to estimate service sector output in eighteenth century Britain is followed here, but with some modifications. For England 1270-1700, services are broken down into commerce, housing and domestic service, and government. However, whereas Deane and Cole assumed that commerce grew in line with industry, in this study use has been made of indicators of international trade and transport, domestic trade and transport, and finance. International trade and transport is measured by data on wool exports, the distances shipped and the growth of the English shipping tonnage, from Carus-Wilson and Coleman (1963), Fisher (1940; 1950) and Davis (1954; 1962), with log-linear interpolation for missing years. Domestic trade and transport is measured by an index of marketed agricultural and industrial output. Changes in the share of output marketed are captured by the cumulative number of new markets established in the period 1270-1490 and the urban share of the population from 1490 to 1700. The data on the growth of the market are taken from Letters (2005), while the urbanization data are derived from the *Cambridge Urban History of Britain* (Dyer, 2000; Sacks and Lynch, 2000). Financial intermediation is measured by the inverse of the velocity of circulation, derived from

Mayhew (2009), building on Cameron's (1967) finding of a declining velocity over the long run. The inverse of velocity is interacted with population as a scaling factor to derive an index of financial sector activity.

Deane and Cole (1967) assumed that housing and domestic service grew in line with population, and the same procedure has been followed here. Real government revenue from O'Brien and Hunt (1999) is available for the whole period from the European State Finance Database at http://www.le.ac.uk/hi/bon/ESFDB/frameset.html

The weights for the main service sectors are shown in Table 8, and are derived from the circa 1700 shares in Crafts (1985: 16). The resulting series for total service sector output is plotted in Figure 2, and the growth rates are shown in Table 7. Total service sector output trended downwards during the medieval period, before picking up strongly after 1500. Section 8 of the Appendix provides more detail on the component series of the service sector output index for England, 1270-1700.

2. Services in Great Britain, 1700-1870

For Great Britain, 1700-1870, the approach adopted here again builds on the work of Deane and Cole (1967) and Crafts (1985), but at an annual frequency. As for the pre-1700 period however, the growth of output in commerce is measured using volume series covering transport, finance and other commerce. The transport index is an unweighted average of shipping tonnage from Mitchell (1988: 534), the length of railways from Mitchell (1988: 541), total investment in waterways and roads from Ginarlis and Pollard

(1988: 217-219) and the number of weekly passenger road services from Bogart (2005: 487). The finance index is based on the number of country banks from Pressnell (1956: 11), interpolated using the drawing accounts of the Bank of England from Mitchell (1988: 658, 665) and Pearson's (2004: 374-375) series on fire insurance. Distribution is a weighted average of the growth of foreign trade from Mitchell (1988) and industry, while other commerce is assumed to grow in line with industry.

The annual index of service sector output thus derived tracks closely the series produced by Crafts (1985) for a number of benchmark years. The trend pattern is of an increase in the growth rate from the 1780s. More detail on the component series of the service sector output index for Great Britain, 1700-1870, is available in section 9 of the Appendix.

V. REAL GDP, POPULATION AND GDP PER CAPITA

1. Weighting scheme for GDP

The next step is to construct an index of real GDP from the above output series for agriculture, industry and services, using an appropriate set of weights. Table 9 sets out the weighting scheme, derived from a reconstruction of nominal GDP by sector. Real output trends from the sectoral series described earlier in the paper are transformed into nominal output trends using sectoral price indices, with absolute levels of GDP in current prices established using an input-output table for 1841 from Horrell, Humphries and Weale (1994).

The agricultural price data are taken largely from Clark (2004), as described in the earlier section on agriculture. For industry, prices are taken from Clark (2006), Beveridge (1939) and Thorold Rogers (1866-1902). The price data for services are based largely on wage rates and housing rents from Clark (2004), although some information on transport prices from Thorold Rogers (1866-1902), Harley (1988) and Bogart (2005), has also been incorporated. For distribution, a weighted average of agricultural and industrial prices has been used. The sectoral price indices are plotted in Figure 3.

Reflating the sectoral output indices with the sectoral price indices and projecting back from the absolute level of nominal GDP by sector in 1841 means that in principle it is possible to obtain current price value added weights for all years. However, in practice these value added weights have been used only for key benchmark years where it is also possible to establish the sectoral shares of employment, which can be used as a cross-check (Broadberry, Campbell and van Leeuwen., 2011b). This also means that the resulting chained index of GDP is produced on the same basis as Feinstein's (1972) series for the post-1870 period, as well as most existing historical national accounting series. The 1841 weights have been used for 1820-1870; 1801 weights, which can be cross-checked against Patrick Colquhoun's (1806) social table, have then been used for 1780-1820; 1759 weights, which can be checked against Joseph Massie's [1760] social table, have been used for 1740-1780; and 1700 weights, which can be cross-checked against Gregory King's [1696] social table, have been used for 1700-1740. The 1700 weights have also been used for England during the immediately preceding period, 1650-1700; 1600 weights, which can be cross-checked against occupational distributions derived

from wills, have been used for the period 1550-1650; 1522 weights, which can be checked against the labor-force shares derived from the Muster Rolls are similarly used for 1450-1550. Finally, 1381 weights, which can be cross-checked with the sectoral labor-force shares established from the 1381 Poll Tax listings, are used for the period 1270-1450. A summary of the sources and methods used in the derivation of sectoral weights is given in section 10 of the Appendix, with further details in Broadberry, Campbell and van Leeuwen (2011b).

2. Real GDP and GDP per capita in England, 1270-1700

Aggregating the time series for real output in agriculture, industry and services using the sectoral value added weights from Table 9 produces the real GDP series for England plotted in Figure 4. This series can then be used to calculate growth rates over 50-year periods, presented in Table 10.

For comparison with real wages, it is necessary to calculate GDP per capita. Although the population of England has been firmly reconstructed for the period since the compulsory registration of births, marriages and deaths, estimates before 1541 are more speculative. For the period after 1541, the data in Table 10 are based on the estimates of Wrigley, Davies, Oeppen and Schofield (1997), interpolated using Wrigley and Schofield (1989). For earlier years, the population estimates are based on data for individual parishes, extending forwards in time the approach of Hallam (1988). The peak medieval population estimate of 4.81 million in 1348 is a little higher than the range of 4.0 to 4.5 million suggested by Overton and Campbell (1996), but still well below the

figure of at least 6 million suggested by Postan (1966) and Smith (1991). As Overton and Campbell (1996) point out, such a high population estimate has implications for other variables such as land use, crop combinations, yields and kilocalorie extraction rates and the share of the population living in towns, which would be hard to square with other evidence. Note the impact of the Black Death, which struck in 1348-49, leading to an immediate sharp collapse in the population, followed by a further decline which continued until the mid-fifteenth century. A summary of the sources and methods used in the derivation of the population estimates is given in section 11 of the Appendix, with further details in Broadberry, Campbell and van Leeuwen (2011c).

Combining the population data with the real GDP series produces the estimates of GDP per capita growth in Table 10. The trend is of modest positive per capita income growth between the 1270s and the 1690s, at an average annual rate of 0.17 per cent. However, the path of growth was episodic. GDP per capita grew substantially during the Black Death crisis of the fourteenth century, and then remained on a plateau between the 1450s and 1650s before resuming significant sustained growth during the second half of the seventeenth century. These trends can also be seen in Figure 4, which plots GDP per capita on a logarithmic scale. Note that although there were some isolated bad years between 1550 and 1650, the trend level of per capita income remained above the level of the pre-Black Death period.

2. Real GDP and GDP per capita in Great Britain, 1700-1870

For the period 1700-1870, estimates of real GDP are provided for the territory of Great Britain. English agriculture is assumed to be representative of developments in Great Britain, so that the addition of Wales and Scotland merely raises the level of production, leaving the trend and annual fluctuations unchanged. The time series for industry and services were collected on a Great Britain basis.

Putting the three main sectors together using the weights from Table 9 produces the annual index of British real GDP shown in Figure 4. Combining the GDP series with the population data from Wrigley, Davies, Oeppen and Schofield (1997) and Mitchell (1988) produces the estimates of per capita income in Figure 4 and Table 10. Between the 1700s and the 1860s, per capita income grew at an annual rate of 0.48 per cent, considerably faster than in England between the 1270s and the 1700s. But as with English per capita GDP before 1700, British growth after 1700 was episodic. Growth between the 1700s and 1830s was slower than during the second half of the seventeenth century, but accelerated sharply from the 1830s, when per capita income growth comfortably exceeded one per cent a year for the first time.

VI. INCOME AND OUTPUT BASED MEASURES

1. Divergent trends in GDP per capita and daily real wages

The output based GDP per capita series shows modest but sustained growth between the late medieval period and the Industrial Revolution. This is in striking contrast to the absence of a positive trend suggested by the daily real wage rate series of Phelps Brown and Hopkins (1956), which despite the disclaimers of its authors, has been used to justify

a bleak picture of long run stagnation in living standards. This pessimistic Malthusian view has recently been supported by Clark (2007b), who in addition to providing a revised real wage series with a similar trend to the Phelps Brown and Hopkins series, adds new time series for land rents and capital income to arrive at a picture of long run stagnation in GDP per capita from the income side (Clark, 2005; 2007a; 2010).

The trend in Clark's GDP per capita series is driven by his real wage series. Since the former is not available on an annual basis, the focus here will be on the latter, which is plotted together with the output based GDP per capita series in Figure 5. The GDP per capita series shows a substantial increase across the Black Death, followed by a plateau from around 1450 to 1650 and then a return to growth culminating in the Industrial Revolution. Although Allen's (2001) real wage series is sometimes seen as presenting a different view of the long run evolution of living standards from that of Clark (2005), if all three series are plotted together with the mean of 1270-1870 set equal to 100, it is clear that both real wage series diverge significantly from the output based GDP per capita series.

There are two main periods of divergence, during the fifteenth century and again during the second half of the eighteenth century. Real wage rates increased more rapidly than GDP per capita between the 1340s and 1450s and then declined between the 1450s and 1650s while GDP per capita remained stable. The peak real wage rates of the mid-fifteenth century were not seen again before the mid-nineteenth century, and hence play an important role in creating the impression of no long run progress in living standards.

During the second half of the eighteenth century, real wages declined while GDP per capita continued to grow steadily.

The divergence during the eighteenth century has recently been analysed by Angelis (2008), who provides a general framework for reconciling real wages and GDP per capita. He starts with the definition of labour's share of income (α) as the product of the daily wage rate (w) and the number of days worked (L) divided by nominal GDP which is the product of real GDP (Y) and the price of GDP (p^Y). The wage bill is thus equal to labour's share of nominal GDP:

$$wL = \alpha p^Y Y \tag{1}$$

Now divide both sides by the consumer price index (p^C) and by population (N) to yield:

$$(w/p^C)(L/N) = \alpha(p^Y/p^C)(Y/N) \tag{2}$$

which can be rearranged to bring the labour supply term to the right hand side and invert the relative price term:

$$(w/p^C) = \frac{(\alpha)(Y/N)}{(L/N)(p^C/p^Y)} \tag{3}$$

This yields an equation for relating changes in real wages (w/p^C) over time to changes in per capita GDP (Y/N), labour's share of income (α), labour supply (L/N) and the price of consumption goods relative to the GDP deflator (p^C/p^Y):

$$\frac{(w/p^C)_1}{(w/p^C)_0} = \frac{(Y/N)_1}{(Y/N)_0}\frac{(\alpha_1)}{(\alpha_0)}\left[\frac{(L/N)_1}{(L/N)_0}\right]^{-1}\left[\frac{(p^C/p^Y)_1}{(p^C/p^Y)_0}\right]^{-1} \tag{4}$$

Angelis (2008: 157) demonstrates that it is possible to explain the slower growth of real wages than GDP per capita during the eighteenth century largely by an increase in the annual number of days worked per person, although part of the divergence was also due to a declining share of labour income in GDP, with relative price changes playing no

significant role. However, Angelis (2008) was unable to comment on the pre-1700 period, for which he lacked data on GDP per capita.

Table 11 conducts a similar exercise for the longer period, using Clark's data on real wages, consumer prices and labour's share of income together with the GDP per capita series from this text. Equation (4) is used to derive a simulated path for labour supply. Since relative prices and labour's share of income changed only modestly, consistency requires a large change in days worked per year, particularly during the period between the 1450s and 1650s when daily real wages fell dramatically and GDP per capita increased. This fits the timing of the "industrious revolution" hypothesised by de Vries (1994) to have occurred after the Reformation, but is the scale of the increase here too large to be credible? To assess that, it is necessary to turn to independent estimates of labour supply.

2. Variations in labour supply

Table 12 sets out the available data on days worked per year. The evidence is firmest for the Industrial Revolution period, where Voth (1998; 2001) uses court records from London and the north of England to infer the decline of the pre-industrial practice of not working on Mondays (known colloquially as St Monday). Clark and van der Werf (1998) infer days worked by comparing wages paid to workers hired on annual contracts and those on daily rates in various parts of England for a period stretching from the second half of the sixteenth century to the late nineteenth century. Their figures are broadly

consistent with those of Voth for the nineteenth century, although Voth's figures suggest a more sudden increase after 1760.

Clark and van der Werf's data also overlap with a set of figures covering the fifteenth and sixteenth centuries derived by Allen and Weisdorf (2011: 721) from a study by Blanchard (1978) of workers who combined farming and lead mining in the Mendips. The total number of days worked is derived as the sum of days worked in agriculture (135) plus the share of the remaining 130 workdays spent in mining. Again there is broad consistency between the two sources in the overlapping years in the second half of the sixteenth century. But perhaps the most interesting finding is the low number of days worked in the fifteenth century and the early sixteenth century, which would be consistent with the notion of an early modern industrious revolution.

3. Problems of interpreting the daily wage rate series

A rather different way of reconciling the real wage and GDP per capita evidence is offered by Hatcher (2011), who argues that the pattern of real wage rates charted by Phelps Brown and Hopkins (1956), Clark (2005; 2007a) and others is unrepresentative of labour incomes more generally. Hatcher argues that the sharp rise in daily real wage rates in the fifteenth century captured by Phelps Brown and Hopkins (19560 and Clark (2005) could not have been earned throughout the year by most workers. Although the wage rates in Figure 5 are for unskilled urban building labourers, Clark (2007a) claims a similar pattern for agricultural labourers. But here, Hatcher (2011) shows convincingly that the rates paid to casual labourers were much higher than those paid to agricultural

workers on long contracts (*famuli*) and were only available for short periods during the peak season. He shows further that if husbandmen had paid these wages throughout the year they would have been worse off than the labourers, while large landowners would have been bankrupt! Since this inversion of the income distribution clearly did not occur during the fifteenth century, Hatcher concludes that Clark's real wage rates are "unreal". Blanchard's (1978) evidence on the small number of days worked by lead miners in the Mendips at the beginning of the sixteenth century would also be consistent with Hatcher's analysis.

With the current state of research, neither way of reconciling the real wage rate and output based GDP per capita evidence can be ruled out. There could have been a large scale industrious revolution as suggested by de Vries (1994) or the fifteenth century "golden age" of nominal and real wages may be exaggerated, as suggested by Hatcher (2011). But what does seem safe to conclude is that it would be dangerous to take the trend of the daily real wage rates currently in use as representative of annual living standards without further corroboration, as noted by the producers of the first such series (Phelps Brown and Hopkins, 1956: 296). That is why it is so important for researchers to supplement the daily real wage data with output based GDP per capita estimates, to build up a more complete picture of long run growth. This paper has made a start for the important case of Britain, the first country to achieve modern economic growth. Similar records exist for a number of other European and Asian societies, where research is now under way to estimate GDP per capita from the output side (van Zanden and van

Leeuwen, 2011; Malanima, 2011; Álvarez-Nogal and Prados de la Escosura, 2011; Broadberry and Gupta, 2011; Bassino, Broadberry, Fukao, Gupta and Takashima, 2011).

VII. CONCLUSIONS

This paper has provided output-based estimates of GDP per capita for Britain over the period 1270-1870, to place alongside daily real wage rates, which have hitherto been the main source of quantitative evidence on living standards over the long run. Although the British economy is particularly well endowed with statistical information over this long period, and there is an unusually large secondary literature on which to draw, similar primary source materials exist for other European and non-European countries, including the Netherlands, Italy, Spain, India and Japan.

The results suggest an incremental process of growth and development in contrast to the long run stagnation showed by daily real wage rates. One possible way of reconciling the two types of evidence is through an increase in the number of days worked per year, as suggested by proponents of an "industrious revolution", such as de Vries (1994). However, an alternative interpretation suggested by Hatcher (2011) is that the late medieval "golden age" of real wage rates compiled by researchers such as Phelps Brown and Hopkins (1956) and Clark (2005; 2007a), which gives the impression of no progress between the fifteenth and the nineteenth centuries, is not representative of the earnings of most workers. At this stage, neither interpretation can be ruled out.

TABLE 1: English arable land use (millions of acres)

	Wheat	Rye/ Maslin	Barley/ Dredge	Oats	Pulses	Potatoes	Other crops	Total sown	Fallow arable	Total arable
1270	2.21	0.72	1.23	2.94	0.29	0.00	0.00	7.40	5.13	12.52
1300	2.68	0.60	1.27	3.16	0.45	0.00	0.00	8.16	4.56	12.72
1380	1.83	0.36	1.22	1.87	0.47	0.00	0.00	5.75	3.89	9.64
1420	1.61	0.32	1.17	1.66	0.45	0.00	0.00	5.21	3.53	8.75
1450	1.53	0.31	1.15	1.59	0.44	0.00	0.00	5.03	3.41	8.44
1500	1.58	0.37	1.19	1.56	0.47	0.00	0.10	5.26	3.24	8.50
1600	1.85	0.77	1.44	1.32	0.61	0.00	0.72	6.72	2.16	8.87
1650	2.00	0.39	1.86	1.13	1.02	0.00	1.36	7.74	1.88	9.63
1700	1.99	0.42	1.82	1.15	0.98	0.00	1.30	7.64	1.91	9.56
1750	1.95	0.06	1.50	1.82	0.98	0.08	2.53	8.92	1.59	10.51
1800	2.51	0.06	1.46	1.97	0.83	0.17	2.90	9.91	1.28	11.19
1830	2.12	0.06	1.81	1.27	0.63	0.26	4.46	10.62	1.30	11.91
1871	3.31	0.06	1.96	1.45	0.90	0.39	5.28	13.35	0.48	13.84

Sources and notes: Overton and Campbell (1996: Tables III, V); Campbell, Bartley and Power (1996); Medieval Accounts Database; Early Modern Probate Inventory Database; Holderness (1989); Overton (1996). Further details available in Part 2 of the Appendix and Broadberry, Campbell and van Leeuwen (2011a).

TABLE 2: English arable output net of seed and animal consumption in million bushels (10-year averages)

	Wheat	Rye	Barley	Oats	Pulses	Potatoes
1270s	18.85	8.94	14.44	20.45	0.44	NA
1300s	20.88	5.95	14.91	19.12	1.43	NA
1350s	12.02	2.72	10.91	8.93	0.95	NA
1400s	10.35	2.02	12.56	7.29	0.98	NA
1450s	7.69	2.80	9.69	8.58	0.82	NA
1550s	17.08	3.83	11.82	8.14	1.74	NA
1600s	20.70	7.85	18.59	8.44	4.01	NA
1650s	27.01	3.70	33.50	6.14	6.53	NA
1700s	27.94	6.70	35.20	5.70	8.25	1.27
1750s	31.48	1.51	39.67	13.03	9.03	13.56
1800s	46.32	1.36	42.67	14.06	11.07	26.70
1850s	73.69	1.09	58.23	15.93	9.57	44.79
1860s	86.07	0.98	57.00	16.33	11.42	47.72

Sources and notes: Derived from Manorial Accounts Database, Probate Inventories Database and Modern Farm Accounts Database as described in the text. Data reported as decadal averages.

TABLE 3: Output in English pastoral farming (10-year averages)

Years	Milk (m.gals)	Beef (m. lb)	Veal (m. lb)	Mutton (m. lb)	Pork (m. lb)	Wool (m. lb)	Hides (m. lb)	Hay (m. tons)
1270s	42.09	10.57	1.98	81.33	26.13	20.84	6.29	0.12
1300s	54.45	13.72	2.63	90.49	30.82	20.89	7.34	0.11
1350s	51.46	13.52	2.56	94.49	21.33	24.82	7.36	0.12
1400s	45.25	12.39	2.32	75.11	12.38	15.13	6.32	0.10
1450s	44.92	12.83	2.37	83.90	14.06	13.11	6.59	0.09
1550s	63.94	19.85	3.58	79.32	31.39	14.08	7.54	0.15
1600s	58.56	19.06	3.40	157.49	33.51	28.34	9.90	0.24
1650s	72.52	24.83	4.35	130.85	31.14	23.95	10.51	0.29
1700s	59.10	21.16	3.67	211.92	39.93	39.09	13.12	0.34
1750s	163.19	62.94	10.50	217.12	84.40	34.12	21.73	0.55
1800s	279.75	115.99	18.54	422.49	170.63	56.62	38.50	1.37
1850s	434.05	192.64	28.28	616.27	297.43	71.66	53.08	1.93
1860s	492.79	217.85	31.99	713.12	293.05	83.36	58.34	1.94

Sources and notes: Derived from Manorial Accounts Database, Probate Inventories Database and Modern Farm Accounts Database as described in the text. Data reported as decadal averages.

TABLE 4: Output growth in English agriculture in constant 1700 prices

Years	Arable sector (% *per annum*)	Pastoral sector (% *per annum*)	Total agriculture (% *per annum*)
1270s – 1300s	0.12	0.40	0.24
1300s – 1340s	-0.19	-0.04	-0.12
1340s – 1400s	-0.87	-0.42	-0.66
1400s – 1450s	-0.37	0.03	-0.16
1450s – 1470s	-0.38	0.00	-0.16
1470s – 1550s	0.72	0.18	0.45
1550s – 1600s	0.63	0.72	0.69
1600s – 1650s	0.34	-0.04	0.21
1650s – 1700s	0.24	0.47	0.33
1700s – 1750s	0.29	0.90	0.55
1750s – 1800s	0.52	1.31	0.93
1800s – 1830s	0.98	0.63	0.77
1830s – 1860s	0.58	1.08	0.85
1270s – 1340s	-0.05	0.14	0.03
1270s – 1700s	0.08	0.13	0.11
1270s – 1860s	0.21	0.37	0.29
1700s – 1860s	0.55	1.02	0.77

Sources and notes: Derived from Medieval Accounts Database; Early Modern Probate Inventories Database; Modern Farm Accounts Database as described in the text. The growth rates are calculated on decadal averages.

TABLE 5: Output shares in English agriculture, 10-year averages (%)

	Current prices		Constant 1700 prices	
	Arable	Pastoral	Arable	Pastoral
1270s	60.1	39.9	69.2	30.8
1300s	51.2	48.8	66.4	33.6
1350s	48.8	51.2	53.3	46.7
1400s	46.3	53.7	57.5	42.5
1450s	38.4	61.6	53.1	46.9
1550s	58.1	41.9	60.5	39.5
1600s	58.1	41.9	58.8	41.2
1650s	64.5	35.5	64.0	36.0
1700s	59.7	40.3	61.5	38.5
1750s	57.8	42.2	54.6	45.4
1800s	48.5	51.5	45.3	54.7
1850s	44.8	55.2	44.2	55.8
1860s	40.0	60.0	44.3	55.7

Sources and notes: Derived from Medieval Accounts Database; Early Modern Probate Inventories Database; Modern Farm Accounts Database as described in the text.

TABLE 6: English industrial output weights, circa 1700

	%
Tin	1.7
Iron	11.8
Coal	11.4
METALS & MINING	24.9
Woollens	26.6
Leather	14.8
TEXTILES & LEATHER	41.4
Food	21.3
Books	3.6
Construction	8.8
OTHER INDUSTRY	33.7
TOTAL INDUSTRY	100.0

Sources and notes: Derived from Hoffmann (1955); Crafts and Harley (1992: 728).

TABLE 7: annual output growth in agriculture, industry, services, and GDP, England (1270-1700) and Great Britain (1700-1870), (in constant 1700 prices)

Period 1270s-1690s = England 1700s-1860s = Britain	agriculture % p.a.	industry % p.a.	services % p.a.	GDP % p.a.
1270s – 1300s	0.24	0.05	0.39	0.22
1300s – 1340s	-0.12	0.26	0.12	0.07
1340s – 1400s	-0.66	-0.66	-1.15	-0.79
1400s – 1450s	-0.16	-0.27	-0.21	-0.21
1450s – 1480s	0.10	0.32	0.30	0.23
1480s – 1550s	0.42	0.61	0.48	0.56
1550s – 1600s	0.69	1.12	0.82	0.80
1600s – 1650s	0.21	0.35	0.93	0.41
1650s – 1690s	0.41	0.89	0.55	0.61
1700s – 1760s	0.68	0.58	0.58	0.61
1760s – 1780s	0.70	1.04	0.87	0.83
1780s – 1800s	0.95	2.01	1.89	1.62
1800s – 1830s	0.75	2.97	1.73	1.85
1830s – 1860s	0.85	2.81	2.61	2.34
1270s – 1690s	0.12	0.30	0.22	0.21
1700s – 1830s	0.75	1.41	1.09	1.08
1700s – 1860s	0.77	1.68	1.38	1.32

Sources and notes: Derived as described in the text. The growth rates are calculated on decadal averages.

TABLE 8: English service sector weights, circa 1700

	%
Commerce	37.2
Of which:	
Finance	5.0
Domestic trade and transport	21.5
International trade and transport	10.7
Housing and domestic	46.6
Government	16.2
Total	100.0

Sources and notes: Derived from Crafts (1985: 16).

TABLE 9: Sectoral shares in current price GDP, 1270-1870 (%)

Year	Region	Agriculture	Industry	Services	Total
1381	England	45.5	28.8	25.7	100.0
1522	England	39.7	38.7	21.6	100.0
1600	England	41.1	36.2	22.7	100.0
1700	England & Britain	26.7	41.3	32.0	100.0
1759	Britain	29.7	35.2	35.1	100.0
1801	Britain	31.3	32.7	36.0	100.0
1841	Britain	22.1	36.4	41.5	100.0

Sources and notes: Derived from reconstruction of current price GDP by sector. Real output trends are transformed into current price trends using sectoral price deflators, with absolute levels of GDP in current prices established using Horrell, Humphries and Weale's (1994) input-output table for 1841; For England, 1381 weights are used for 1270-1450; 1522 weights for 1450-1550; 1600 weights for 1550-1650; and 1700 weights for 1650-1700. For Great Britain, 1700 weights are used for the period 1700-1740, 1759 weights for 1740-1780, 1801 weights for 1780-1820 and 1841 weights for 1820-1870.

TABLE 10: England (1270-1700) and Great Britain (1700-1870): percentage annual growth in population, GDP, and per capita GDP

Period 1270s-1690s = England 1700s-1860s = Britain	population % p.a.	GDP % p.a.	per capita GDP % p.a.
1270s – 1300s	0.23	0.22	-0.02
1300s – 1340s	-0.02	0.07	0.09
1340s – 1400s	-1.33	-0.79	0.54
1400s – 1450s	-0.14	-0.21	-0.07
1450s – 1480s	0.29	0.23	-0.07
1480s – 1550s	0.54	0.56	0.03
1550s – 1600s	0.67	0.80	0.12
1600s – 1650s	0.45	0.41	-0.04
1650s – 1690s	-0.08	0.61	0.69
1700s – 1760s	0.34	0.61	0.27
1760s – 1780s	0.74	0.83	0.10
1780s – 1800s	1.09	1.62	0.54
1800s – 1830s	1.44	1.85	0.42
1830s – 1860s	1.17	2.34	1.17
1270s – 1690s	0.04	0.21	0.17
1700s – 1830s	0.76	1.08	0.32
1700s – 1860s	0.84	1.32	0.48

Sources and notes: Derived as described in the text. The growth rates are calculated on decadal averages.

TABLE 11: Explaining the divergence between GDP per capita and real wages (1700=100)

	Percentage change over the period					
	1300s–1340s	1340s–1450s	1450s–1650s	1650s–1750s	1750s–1800s	1800s–1860s
Real wage (w/p^C)	5.5	75.0	-50.4	15.2	-3.6	59.7
GDP per capita (Y/N)	2.8	30.6	4.2	48.3	19.6	46.5
Labour's share (α)	-5.1	15.3	-8.5	-1.7	-0.2	12.1
Relative prices (p^C/p^Y)	4.4	-6.4	8.0	-0.7	9.2	1.6
Simulated labour supply (L/N)	-11.5	-8.0	78.0	27.4	13.4	1.2

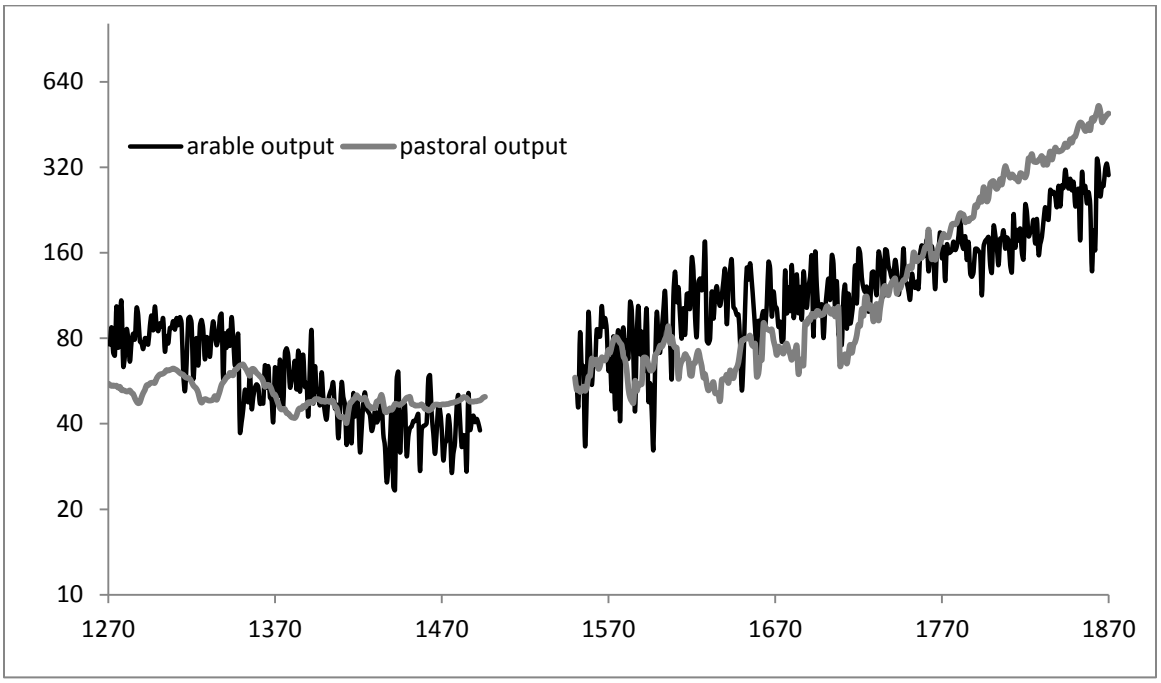
Sources and notes: Real wage: Clark (2006); GDP per capita: this text; Labour's share: Clark (2010); Relative prices: Clark (2006) and this text. The growth rates are calculated on decadal averages.

TABLE 12: Estimates of annual days worked per person

Period	Blanchard/Allen and Weisdorf	Clark and van der Werf	Voth
1433	165		
1536	180		
1560-1599		257	
1578	260		
1584	210		
1598	259		
1600-1649		266	
1650-1699		276	
1685		312	
1700-1732		286	
1733-1736		295	
1760			258
1771		280	
1800			333
1830			336
1867-1869		293-311	
1870		318	

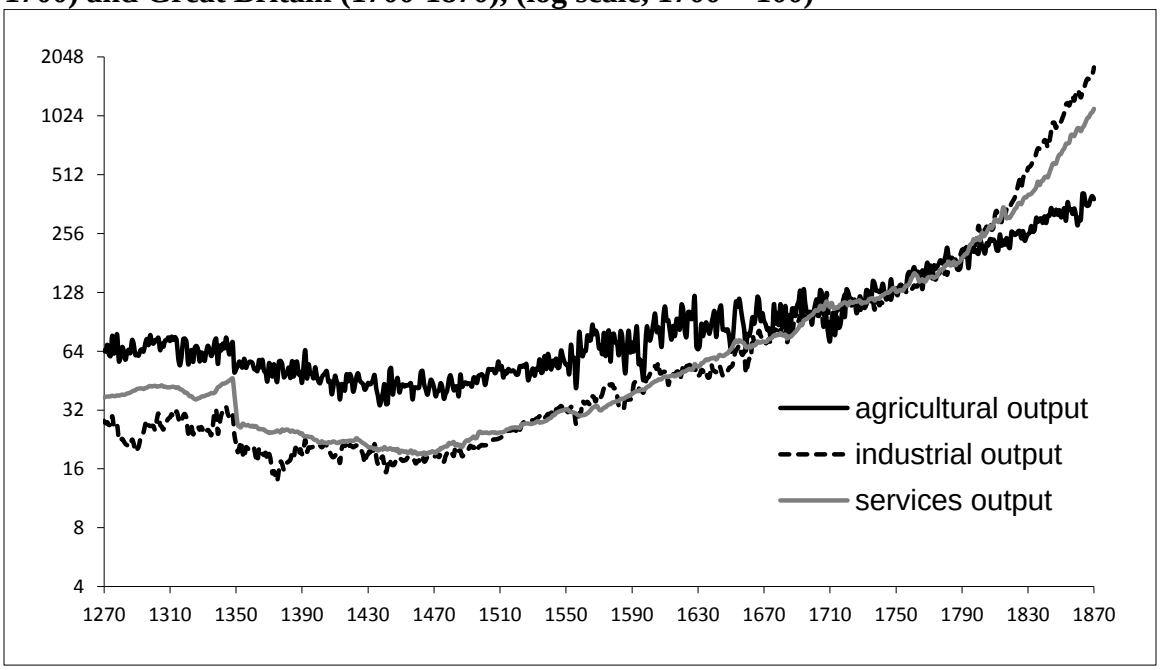
Sources and notes: 1433-1598: derived by Allen and Weisdorf (2011: 721) from Blanchard (1978: 24) as the number of days worked in agriculture (135) plus the share of the remaining130 workdays spent in mining; 1560-1599 to 1870: Clark and van der Werf (1998: 838); 1760-1830: Voth (2001: 1078).

FIGURE 1: Indexed output in English arable and pastoral agriculture (log scale, 1700=100)



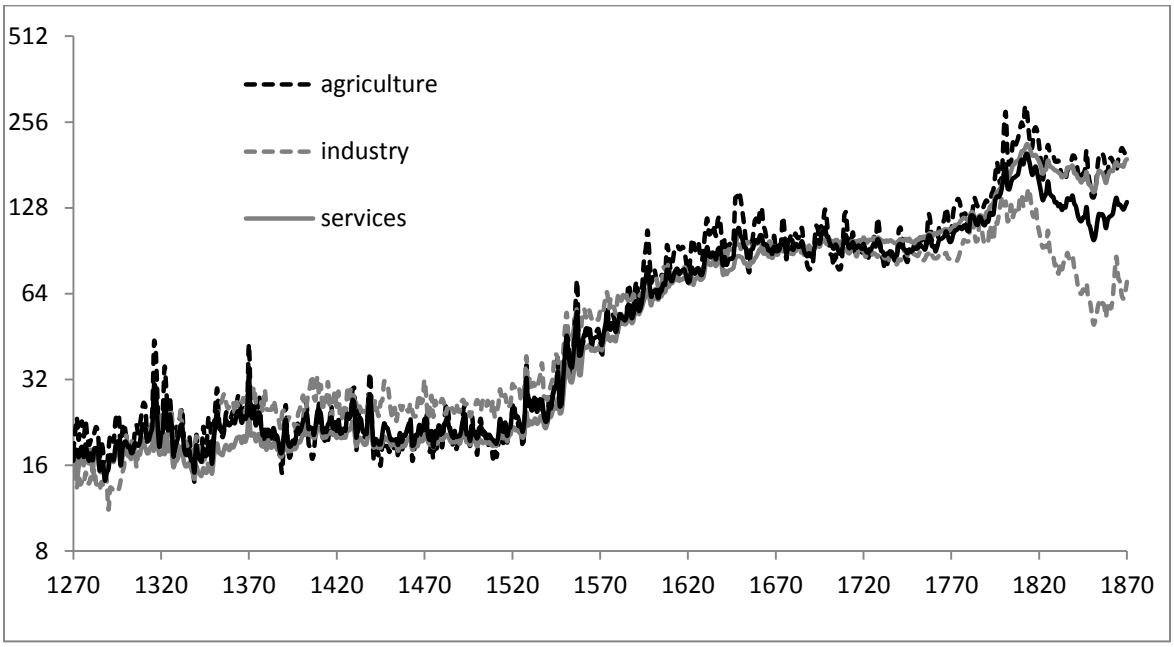
Sources and notes: See Tables 1-2.

FIGURE 2: Indexed output of agriculture, industry and services, England (1270-1700) and Great Britain (1700-1870), (log scale, 1700 = 100)



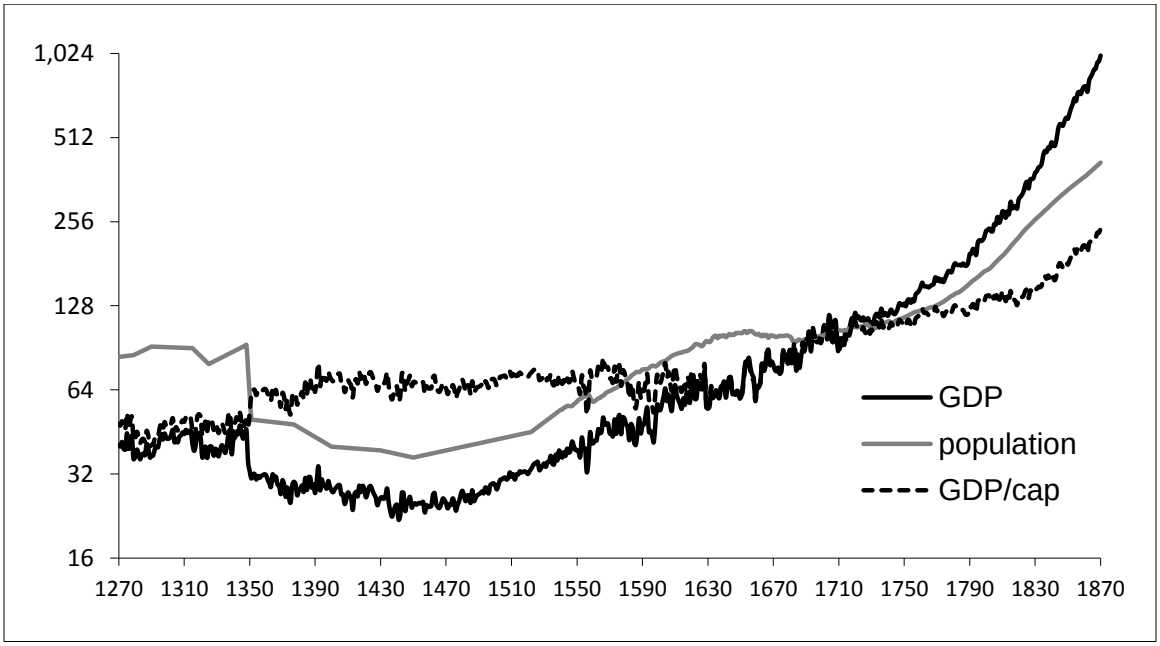
Sources and notes: See Tables 4 and 7.

FIGURE 3: Aggregate and sectoral price indices, England (1270-1700), Great Britain (1700-1870), (log scale, 1700=100)



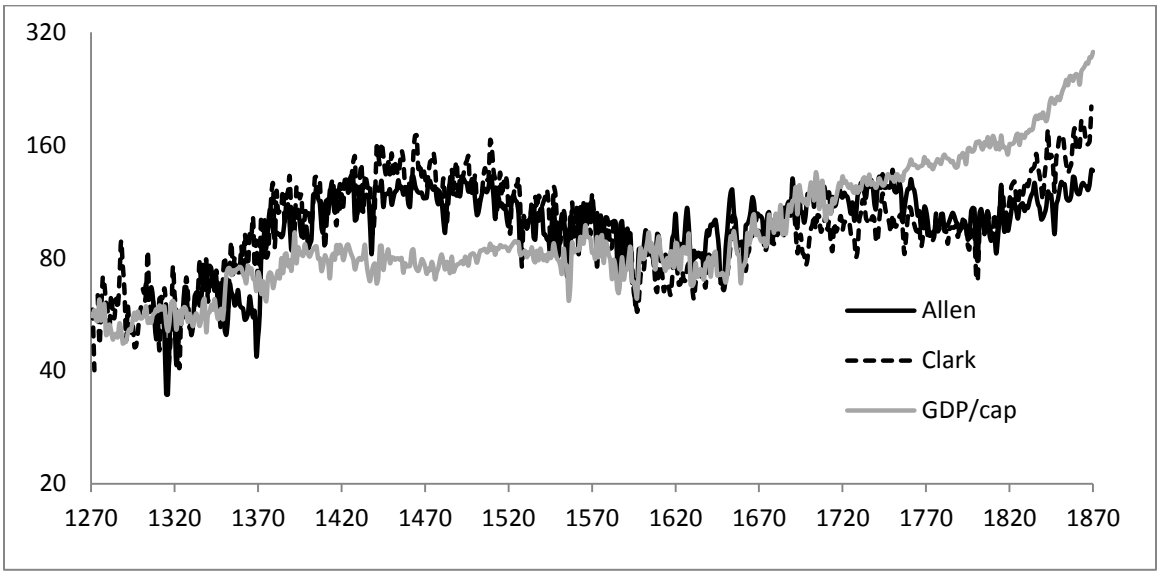
Sources and notes: Derived from Clark (2004; 2006), Beveridge (1939); Thorold Rogers (1886-1902) as described in the text.

FIGURE 4: Indexed GDP, population, and per capita GDP, England (1270-1700) and Great Britain (1700-1870): (log scale, 1700 = 100)



Sources and notes: See Table 10.

FIGURE 5: Indexed daily real wage rates of unskilled building workers and GDP per capita, (log scale, mean of 1270-1870 = 100)



Sources and notes: Clark (2005); Allen (2001); see Table 10.

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