BRITISH ECONOMIC GROWTH, 1300-1850: SOME PRELIMINARY ESTIMATES

Stephen Broadberry, University of Warwick, S.N.Broadberry@warwick.ac.uk
Bruce Campbell, Queen's University Belfast, b.m.campbell@qub.ac.uk
Alexander Klein, University of Warwick, A.Klein.1@warwick.ac.uk
Mark Overton, University of Exeter, M.Overton@Exeter.ac.uk
Bas van Leeuwen, University of Warwick, bas.vanleeuwen1@googlemail.com

8 September 2009
File: BritishGDPLongRun2a.doc

Abstract: We provide annual estimates of GDP for England between 1300 and 1700 and for Great Britain between 1700 and 1850, constructed from the output side. The GDP data are combined with population estimates to calculate GDP per capita. We find English per capita income growth of 0.13 per cent per annum between 1300 and 1700, although growth was episodic, with the strongest growth during the Black Death crisis of the fourteenth century and in the second half of the seventeenth century. For the period 1700-1850, we find British per capita income growth of 0.26 per cent, broadly in line with the widely accepted Crafts/Harley estimates. This modest trend growth in per capita income since 1300 suggests that, working back from the present, living standards in the late medieval period were well above "bare bones subsistence". This can be reconciled with modest levels of kilocalorie consumption per head because of the very large share of pastoral production in agriculture.

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.

I. INTRODUCTION

This paper forms part of a project to reconstruct the national income of Britain and Holland between the late thirteenth century and the mid-nineteenth century. Here, we present preliminary estimates of British GDP constructed from the output side. For the period before 1700, we work only with estimates for England, but for the period 1700-1850 our estimates are for the territory of Great Britain, including Wales and Scotland as well as England.

For agriculture, we build on the pathbreaking study of Overton and Campbell (1996), which tracked long run trends in agricultural output and labour productivity, but was restricted to estimates for a small number of benchmark years. To provide annual estimates, we rely heavily on three data sets assembled for the medieval, early modern and modern periods. For the medieval period, we analyse the Medieval Accounts Database assembled by Campbell (2000; 2007), drawing upon the archival labours of a number of other historians, including David Farmer, John Langdon and Jan Titow. The information on arable yields and animal stocking densities is taken largely from manorial accounts, but is supplemented by information on the non-manorial sector from tithes. For the early modern period, we use the probate inventory database assembled by Overton, Whittle, Dean and Hann (2004), which provides indirect estimates of arable yields and animal stocking densities from the valuation of the assets left by farmers. From the early eighteenth century on, we make use of the database on farm accounts assembled by Turner, Beckett and Afton (2001).

For industry and services, for the period after 1700 we build on the pioneering approach of Deane and Cole (1967), as modified by Crafts and Harley (1992). Gross output indicators for the major sectors have been assembled and weighted using value added shares. For the period before 1700, a similar procedure has been used, drawing on as many sources as possible for the output indicators and assembling new sectoral weights at the key benchmark years of 1377 and 1522, as well as the more familiar 1688 benchmark based ultimately on the work of Gregory King [1696].

For the period between 1300 and 1700, we find English per capita income growth of 0.13 per cent per annum on average. This cumulates to an increase in per capita incomes of nearly two-thirds, although growth was episodic rather than continuous, with the strongest growth occurring during the Black Death crisis of the fourteenth century and in the second half of the seventeenth century. For the period 1700-1850, we find British per capita income growth of 0.26 per cent per annum, broadly in line with the widely accepted Crafts/Harley estimates. Again, growth was episodic, with periods of faster growth occurring 1780-1801 and 1830-1850. This modest trend growth in per capita income since 1300 suggests that, working back from the present, living standards in the late medieval period were well above what Allen (2009: 36-41) calls "bare bones subsistence". This can be reconciled with modest levels of kilocalorie consumption per head because of the very large share of pastoral production in agriculture. This meant that a large share of the English population were already in a position during the late Middle Ages to afford what Allen calls the "respectable lifestyle", with a more varied diet

including meat, dairy produce and ale, as well as the less highly processed grain products that comprised the bulk of the bare bones subsistence diet.

Our estimates of GDP are built up primarily from the output side. However, the national accounting perspective suggests a number of tests which can be conducted to demonstrate consistency, drawing on income from the income and expenditure sides. In particular, we check consistency with the real wage estimates which have been used frequently by economic historians to draw conclusions about long run living standards (Clark, 2005; Allen, 2001). Second, we also consider per capita consumption of kilocalories, to check the sustainability of the population (Overton and Campbell, 1996).

The paper proceeds as follows. Sections II to IV describe the procedures for estimating output in agriculture, industry and services, respectively. Section V then aggregates the sectoral outputs into real GDP for England during the period 1300-1700 and Great Britain during 1700-1850, and combines these series with data on population to derive estimates of GDP per capita. In section VI, we compare the long run evolution of per capita GDP derived from the output side with real wages and examine the per capita consumption of kilocalories in the light of Allen's (2009) distinction between bare bones subsistence and respectable lifestyle baskets. Section VII places British economic growth in a wider European context, while section VIII concludes.

II. AGRICULTURAL PRODUCTION

1. Arable farming in England, 1250-1850

The starting point for any estimate of the output of the arable sector is the total area under crop, which is set out in Table 1. For most benchmark years, the data differ slightly from Overton and Campbell (1996), as a result of the incorporation of subsequent scholarship. Firm estimates of land use only became available in the agricultural returns of 1871, which therefore provides the starting point for the series. For 1830, the figures come from the tithe files and for 1800, 1750 and 1700 from estimates by contemporaries (Holderness, 1989). Here, we have accepted the higher figures suggested by Prince's (1989: 41) interpretation of the 1801 Crop Returns, 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 attained its medieval peak, so that the arable acreage would also have been at its peak. Contrary to the claims of Clark (2007a: 124), it is unlikely that the arable acreage in 1300 could have been much above the level of 1800. Estimates for 1420, 1380 and 1250 are obtained by extrapolation from 1300 on the basis of trends in the cropped acreage on demesnes and tithe data in the non-demesne sector (Campbell *et al*., 1996; Dodds, 2004; Medieval Accounts Database).

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 1500-1750 and from Holderness (1989) and Overton (1996) for the period 1750-1850. For the medieval period, it should be noted that we assume the distribution of crops in the demesne sector 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 (Sapoznik, 2008; Dodds, 2007).

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. Information on the crop distribution is taken from data that are intrinsically local and of uneven geographical coverage, so that a system of regional weightings is essential to ensure a reliable national total. Each region's share of the national sown acreage is taken from the 1801 crop returns, but within each region, the breakdown of crops varies over time in line with the information in the databases. 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 early 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. Weighted national average yields per acre, gross of tithe and seed can be obtained from the manorial accounts for the medieval period, the probate inventories for the early modern period and the farm accounts for the modern period. Each dataset has been divided into seven regional groupings and separate chronologies have been constructed for each region before being

combined into a single weighted master chronology for the country as a whole. Due to the discontinuous nature of much of the data, the chronologies are derived using regression analysis with dummy variables for each farm and for each year, as suggested by Clark (2004). Since our evidence is drawn from the seigniorial sector, we need to consider what was happening in the non-demesne sector. Although Postan (1966) clearly 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, we have assumed that yields on the demesne sector were representative of English agriculture as a whole.

Wheat yields gross of seed as well as tithe are shown in Figure 1 for wheat, for illustrative purposes. From these gross yields it is necessary to subtract grain used as seed to derive the net yields shown in Table 2 for all the major crops. There are some differences between crops, but the different datasets appear to tell a consistent story, with yields declining during the late medieval period from around 1300, picking up again during the early modern period from the mid-sixteenth century, and growing more rapidly during the modern period from the early eighteenth century. The data exhibit a high degree of short run volatility, which has been smoothed out in Figure 1 with an eleven-year moving average.

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. For the medieval and early modern periods, estimates of the numbers of working animals per 100 sown acres can be obtained from the medieval accounts and probate inventory databases. For the early modern period, these stocking densities are assumed to apply to the whole agricultural sector and hence are simply multiplied with the sown acreage to produce estimates of the numbers of working animals. However, for the medieval period, the demesne stocking densities have been converted into the numbers of horses and oxen on all lands using Wrigley's (2006: 449) assumption that the stocking density of animals on non-seigniorial holdings was three-quarters that on the demesnes. In making these estimates, allowance has been made for both the declining share of demesne acreage and the lesser quantities of fodder consumed by immature animals. As with the crop yields, a regional weighting scheme is needed to derive the stocking densities for the country as a whole from the observations on individual demesnes and farms. For the modern period, direct estimates of animal numbers are taken from Mitchell (1988), Turner (1998) and Allen (2005), since data on stocking densities are unavailable.

Figure 2 sets out the numbers of mature working animals in England. There was a gradual process of substitution of horses for oxen as working animals, beginning in the medieval period. By the nineteenth century, the use of oxen had more or less died out. Using assumptions about consumption of oats and pulses by mature and immature animals, it is possible to derive estimates of farm animal consumption, which are then

subtracted from gross output to derive arable output net of seed and animal consumption in Table 3.

During the medieval period, output of wheat and rye, the principal bread grains, declined substantially from the peak of the late thirteenth century, with a sharp fall in line with population following the Black Death of the mid-fourteenth century. The output decline was even sharper 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 buoyant. Output of pulses also held up well 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. This reflected the growing preference for the more expensive bread grain. The output of barley also 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.

2. Pastoral farming in England, 1250-1850

The starting point for deriving the numbers of non-working animals is again the stocking densities. As with the working animals, particular care must be taken for the medieval period 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, following Allen (2005), it has been assumed that due to their high unit capital value, the density of cattle was one-third lower on the non-demesne lands. However, we have also made an allowance for the negative relationship between farm size and stocking density, drawn from the post-1550 data. Second, again following Allen (2005), mature cattle have been divided into milk and beef animals in the ratio 53 to 47 percent. Third, swine, a quintessentially peasant animal, are assumed to have been stocked at double the density by non-seigniorial producers (Wrigley, 2006). Fourth, aggregate sheep numbers are assumed to have been stationary in the long term, in contrast to their dynamic growth in the seigniorial sector. This is consistent with trends in exports, inferred levels of domestic demand, and the decline in average fleece weights noted by Stephenson (1988: 380).

Stocking densities can also be obtained for the early modern period from probate inventories, but are unavailable for the modern period. For 1750 onwards, animal numbers are taken directly from contemporary estimates from John (1989), Mitchell (1988) and Turner (1998), and interpolated using data on annual sales at Smithfield Market from Mitchell (1988: 708). Non-working animal numbers for the whole period 1250-1850 are shown in Figure 3.

Calculating the output of the pastoral sector is more speculative than the equivalent calculation for the arable sector, since the percentages of animals producing

specific products and the yields per animal have attracted less attention from historians than crop yields. Until more systematic work is done on the sources, the estimates advanced here are necessarily provisional.

Table 4 sets out the numbers of non-working animals, with cattle divided between milk and beef herds and calves. The proportions of animals assumed to have been producing milk, meat and wool are set out in Table 5. A high proportion of cows are assumed to have produced milk and a high proportion 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 during the medieval and early modern periods, but with a shift from wool to mutton and an increase in the proportion of pigs slaughtered in the modern period. These basic assumptions have been qualified with additional information from Clark (1991) and Ecclestone (1996).

The next step in the calculations involves the estimation of yields of milk, meat and wool per animal. Table 6 sets out our preferred estimates, drawn from a number of sources, including Clark (1991), Allen (2005), Stephenson (1988) and Britnell (2004). Finally, Table 7 combines the information on numbers of animals, percentages of each animal producing and yields per animal to provide estimates of output in the pastoral farming sector.

Further assumptions are needed to derive output estimates for hay, hides and skins, and dairy products. 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 (Allen, 2005). Output of hides and skins is derived from the numbers of working and non-working animals using assumptions on the percentages of each animal producing and yields per animal from Clark (1991), Clarkson (1989) and Ecclestone (1996). In the dairy sector, output is split between cheese, butter and fresh milk using data from Biddick (1989) and Holderness (1989).

3. Total agricultural output in England, 1250-1850

Multiplying the output volumes by their prices yields the total value of net output. The price data are taken largely from Clark (2004), who synthesises the published data of Beveridge (1939), Thorold Rogers (1866-1902: volumes 1-30) and the multi-volume *Agrarian History of England and Wales*, as well as integrating new archival material, principally from the unpublished papers of William Beveridge and David Farmer. To this, have been added the prices of hides from Thorold Rogers (1866-1902) and of rye from Farmer (1988; 1991), as well as direct estimates from the Early Modern Probate Inventories Database. Output can be valued in both current prices and in constant 1700 prices.

Figure 4 plots arable, pastoral and total agricultural output in constant prices on a logarithmic scale, while Table 8 summarises the same information in growth rate form, using 5-year averages. During the medieval period, arable output exhibited a clear

downward trend, while pastoral output showed greater stability. Agriculture as a whole thus showed 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 from the early seventeenth century.

As a result of these trends, the pastoral sector increased its share of output during the medieval period and again from the early seventeenth century. Between the mid-fifteenth century and the early seventeenth century, however, the share of the pastoral sector in agricultural output declined. These trends can be seen in Table 9, which shows the current price shares of individual products, as well as the arable and pastoral sectors as a whole. However, it should be noted that the trends are complicated by movements in relative prices. In particular, although the price of pastoral products relative to arable products was relatively stable during the medieval period, it declined after about 1500, thus muting the effects of the differential real growth between the pastoral and arable sectors noted above.

What is perhaps most striking about Table 9 is the already very high share of the pastoral sector in medieval England. 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.

III. INDUSTRIAL PRODUCTION

1. Industrial output in England, 1300-1700

For the period before 1700, it is possible to obtain volume measures of some of the key industries, including woollen textiles, iron, coal, tin and books. 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 we use the production of wool from agriculture minus wool exports as an indicator of the woollen textile industry. 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 Newcastle, taken from Nef (1932: 380-381). Book production is measured by the index of new English language book titles obtained from the English Short Title Catalogue (http://www.rlg.org/estc.html). Tin output is available on an annual basis for the whole period from 1300 with relatively few gaps, from Hatcher (1973: 156-159) and Mitchell (1988: 303-304). Food processing is assumed to grow in line with agricultural output, but with an allowance for urban growth to reflect the higher proportion of processed foods in the urban diet. Similarly, building is assumed to grow in line with population, but with an allowance for urbanisation.

We provide an index of industrial production using the weighting scheme shown in Table 10. The weights for circa 1700 are derived Hoffmann (1955), but with a number of modifications, including an allowance for the printing industry. Table 11 presents data on industrial growth rates over fifty year periods. There was a sharp increase in the growth rate of the industrial sector after 1500 which can be seen clearly in Figure 5, which is plotted on a logarithmic scale.

2. Industrial output in Great Britain, 1700-1850

Industry is the one sector for which data have previously been analysed at annual frequency during the period 1700-1850, building on the pioneering work of Hoffmann (1955). However, as Crafts (1985) and Harley (1982) pointed out independently, Hoffmann (1955) inadvertently overstated the growth rate of industrial output during the Industrial Revolution as a result of his weighting procedures. The problem is that a few industrial branches, most notably cotton and iron, grew much more rapidly than the rest of industry, and these branches are included in Hoffmann's data set. However, the available time series cover only 56 per cent of industrial output, and the weights of these industries are increased proportionally to achieve 100 per cent coverage of industrial output. But this means that the unrepresentative, rapidly growing branches of cotton and iron effectively have their weights doubled. Harley (1982) and Crafts *et al.* (1989) propose that only the weights of industries other than cotton and iron should be increased to arrive at 100 per cent coverage.

In addition to changing the weighting scheme, Harley (1982) and Crafts *et al.* (1989) also replaced some of the older series used by Hoffmann (1955), drawing on the latest scholarship. We use these series, 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 building 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.

Figure 6 presents our series for industrial output, together with the "revised best guess" series of Crafts and Harley (1992) and Hoffmann's (1955) original index for contrast. The biggest difference is between the Hoffmann index and the other two indices, as a result of the excessive weight given to cotton textiles and iron in the former. Our series shows slightly slower growth than the Crafts-Harley index during the early eighteenth century, largely as a result of the inclusion of new series, particularly King's (2005) data for the iron industry. From the mid-eighteenth century onwards, differences between the two series are relatively minor, and essentially confirm the picture originally presented in Crafts *et al.* (1989). Output growth accelerated from around 1740 to 1840 before tapering off. Again, there is quite a substantial cyclical dimension to industrial output. Table 12 presents the annual growth rates of industrial output over the conventional sub-periods calculated using both the raw annual data and 5 year averages, together with the Crafts-Harley estimates for comparison.

IV. SERVICES

1. Services in England, 1300-1700

The service sector has received much less attention from economic historians than agriculture and industry. Here, we follow the approach used by Deane and Cole (1967) to estimate service sector output in eighteenth century Britain. For England 1300-1700, we break down services into government, commerce, and housing and other services. For government, we use an 11-year moving average of real government revenue from O'Brien and Hunt (1999), which is available for the whole period from the European

State Finance Database at http://www.le.ac.uk/hi/bon/ESFDB/frameset.html. We follow Deane and Cole in assuming that commerce grew in line with industry, while housing and other services are assumed to grow in line with population, but with an allowance for the growing urban share.

The weights for services are shown in Table 13, and are taken from the 1688 shares in Crafts (1985: 16). The resulting series for total service sector output are plotted in Figure 7, and the growth rates presented in Table 14. Total service sector output trended slightly downwards during the medieval period, before picking up strongly after 1500. These trends are graphed here in Figure 7.

2. Services in Great Britain, 1700-1850

For Great Britain, 1700-1850, we again follow the approach of Deane and Cole (1967), who provided estimates for benchmark years. Here, however, we provide data at an annual frequency. Also, we take account of the downwards revision by Crafts (1985) of Deane and Cole's estimates of service sector growth, particularly for the early nineteenth century. For the eighteenth century Deane and Cole (1967: 76-78) assumed that "commerce" grew at the same rate as industry, that "rent and miscellaneous services" increased in line with population, and that "government and defence" could be measured by real public expenditure. Crafts (1985: 35-37) made only minor changes here. For the nineteenth century, however, Deane and Cole (1967: 166) derived estimates of income in "trade and transport", "domestic and personal", "housing", "government, professional and other services" and deflated them by the Rousseaux price index. Crafts (1985: 31)

showed that this produces an implausibly high rate of growth for commerce, and assumed instead that commerce grew in line with national income, thus introducing an element of iteration into the estimates. Crafts (1985: 35-37) used employment growth for domestic and personal services and new estimates of the housing stock for housing. He also revised the growth rate of government using new data on employment growth.

Our estimates are broadly consistent with those of Crafts (1985), but make a few changes to reflect the need for annual data. The most important difference is in commerce, where we measure the growth of output using volume series covering transport, finance and other commerce. This produces results which are not far out of line with the Deane and Cole (1967) assumption for the eighteenth century, that commerce grew in line with industry. This also avoids the iterative element in the Crafts (1985) assumption that commerce grew in line with national income during 1801-31, and ensures consistency of treatment throughout the whole period.

For government, we use civil government and defence expenditure throughout the whole period, deflated using the Schumpeter-Gilboy and Rousseaux price indices from Mitchell (1988: 719-723). For housing, we use the stock estimates of Feinstein (1988: 389), using a regression relationship between housing stock and population to fill in gaps. Output of domestic and personal services is assumed to rise in line with population throughout the whole period, following Deane and Cole (1967) and Crafts (1985). This inevitably produces a relatively stable path for output in domestic and personal services, which is consistent with most assessments of this sector.

Our annual index of service sector output is plotted in Figure 8. The trend pattern is of an increase in the growth rate from around 1780. As is usually the case, fluctuations in services were milder than in industry or agriculture. Table 15 presents the annual growth rates of services output over the conventional sub-periods calculated using both the raw annual data and 5 year averages, together with the Crafts-Harley estimates for comparison. Our estimates are clearly very similar to those of Crafts and Harley (1992).

V. REAL GDP, POPULATION AND GDP PER CAPITA

1. Real GDP and GDP per capita in England, 1300-1700

The next step is to construct an index of real GDP for England over the period 1300-1700 from the above series for agriculture, industry and services, using an appropriate set of weights. Table 16 sets out the weighting scheme, with the weights for the period 1300-1450 derived from the Poll Tax Returns for 1381, the weights for 1450-1650 from the Muster Rolls for 1522, and the weights for 1650-1700 taken from Crafts (1985) and based on the original estimates of Gregory King [1696]. The 1381 and 1522 weights incorporate information on relative wages in agriculture and non-agriculture as well as occupational shares from the Poll Tax Returns and Muster Rolls. The resulting series, plotted in Figure 9, can be used to calculate growth rates over 50-year periods, presented in Table 17. English GDP trended down during the medieval period between 1300 and 1500, before showing positive growth between 1500 and 1700. Over the whole period 1300-1700, the English economy averaged a growth rate of 0.15 per cent per annum.

Ultimately, we are interested in what happened to GDP per capita, the most widely accepted indicator of material living standards over the long run. Although the population of England has been firmly reconstructed by Wrigley and Schofield (1989) and Wrigley *et al.* (1997) 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 18 are based on the estimates of Wrigley *et al.* (1997), interpolated using Wrigley and Schofield (1989). For earlier years, our estimates are based on regression analysis using data for individual parishes, along similar lines to Clark (2007a). It should be noted that our population estimate of 4.72 million in for 1300, although slightly higher than suggested by Overton and Campbell (1996), is still well below the figure of 6 million suggested by Smith (1991). However, 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. We shall return to this issue in the section on consumption. Note the impact of the Black Death, which struck in 1348-49, sharply accelerating a population decline that was already underway in the early fourteenth century.

Combining the population data with the real GDP series produces our estimates of GDP per capita growth in Table 19. The trend is of modest positive per capita income growth between 1300 and1700, at an average annual rate of 0.13 per cent. However, the path of growth was episodic. We find that GDP per capita grew substantially during the Black Death crisis of the fourteenth century, then fell back during the sixteenth century

before resuming growth during the second half of the seventeenth century. These trends can also be seen in Figure 12, which plots GDP per capita on both linear and logarithmic scales.

Per capita income growth before the Industrial Revolution thus appears to be confined largely to periods of falling population. This may at first sight appear to confirm the Malthusian interpretation of writers such as Postan (1972) and Clark (2007b). However, we would argue that the Malthusian label is inappropriate for pre-industrial England, for the following reasons. First, although population was above the medieval peak by 1700, per capita incomes were more than two-thirds higher. The economy was able to support a larger population with less people working in agriculture, freeing up others to produce the industrial goods and services demanded in a more urbanised society. Second, the high share of the pastoral sector meant that living standards for the majority were "respectable" in 1300, and remained so throughout the period, although it must be emphasised that there was a sizeable minority of people at the bottom of the income distribution who were living at bare bones subsistence. Allen (2009: 50) suggests that this group represented 18.3 per cent of the population in 1688. Third, moving beyond the GDP measures, it should not be forgotten that wider choices were opening up for more people between 1300 and 1700 in many areas, including consumption, occupation and geographical mobility. Fourth, the risk of famine diminished over time with the provision of a system of welfare to protect the vulnerable at the bottom of the income distribution.

2. Real GDP and GDP per capita in Great Britain, 1700-1850

For the period 1700-1850, our estimates of real GDP are for the territory of Great Britain. We have assumed that British agriculture can be represented by developments in England, 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 refer to the territory of Great Britain. We present our weights in Table 20. For the period 1700-1800, we use the weights from Crafts (1985: 16-17), based on the social tables of Gregory King [1696]. For the period 1800-1850, we have used the input-output table of Horrell *et al.* (1994).

Putting the three main sectors together using the weights from Table 20, we arrive at the annual index of British real GDP shown in Figure 11. Our series shows much the same pattern of trend growth acceleration as the Crafts-Harley data, although the growth rate during the period 1801-1830 is somewhat lower in our series, as a result of the lower growth rate in agriculture at this time. This can be seen clearly in Table 21, which presents the annual growth rates of aggregate output over the conventional sub-periods calculated using both the raw annual data and 5 year averages, together with the Crafts-Harley estimates for comparison. Figure 13 shows clearly that the fastest growth was in industry and the slowest growth in agriculture, with services exhibiting an intermediate growth rate.

To see what happened to per capita incomes, it is necessary to provide estimates of the total population of Great Britain. From 1801 onwards, annual data on the

population of England, Wales and Scotland are available from Mitchell (1988: 9). For the period before 1801, the population of England has been reconstructed firmly by Wrigley and Schofield (1989) and Wrigley *et al.* (1997). Since less information is available for Wales and Scotland, we assume that the ratio of the population of Wales to England remained the same for the period 1700-1801. For Scotland, we have population estimates for 1700 and 1750 (Schofield, 1994: 93). Other years are interpolated using the population of England.

Combining the GDP series with the population data produces our estimates of per capita income in Figure 12. Table 22 presents the same material in growth rate form. The main findings are that per capita income growth accelerated considerably between 1780 and 1801, then slowed down between 1801 and 1830, before accelerating again after 1830.

VI. CROSS-CHECKING THE OUTPUT ESTIMATES

1. Consumption and output

One way of assessing the credibility of the output estimates is to see what they imply about the level and sufficiency of consumption per head. Table 23 assesses the supply of kilocalories available per head of the population. Livi-Bacci (1991) believes that for a population to have been adequately fed required an average food intake of 2,000 kilocalories *per capita* per day, although for a largely agrarian economy such as medieval England, it is reasonable to assume that some of the kilocalories requirements could have been met from home-raised vegetables and poultry, together with wild nuts, berries, fish

and game. We should thus be looking for the main arable crops and pastoral products of the agricultural sector to produce around 1500 kilocalories per person per day to meet the subsistence needs of the population. The figures in Table 23 are 20-year averages, to abstract from short run fluctuations.

The estimates suggest that agricultural output was more than sufficient to meet society's needs after the Black Death, but was significantly less so in 1300. The picture of English society in the half century before the Black Death that emerges from this table is one of an economy under pressure. Note also that it is hard to see how a population much above the 4.61 million (estimated here over a 20 year period centred on 1300) could have been sustained, given the grain yields and the levels of land use underpinning the output estimates. Even allowing for a 10% higher arable production in the non-demesne-sector, as suggested by Stone (2006), would not change the picture dramatically, as can be seen in the final column.

One issue which is apparent from Table 23 and from the very high share of the pastoral sector highlighted in Table 9, is that a lot of land was devoted to producing relatively expensive kilocalories. Thus the medieval English population does not seem particularly well off if living standards are assessed in terms of kilocalories. However, the diet was highly varied, with a large proportion of the population able to consume meat, dairy produce and ale. This is in striking contrast to a Malthusian economy, with real wages driven down to bare bones subsistence, where the bulk of the population would be

deriving the majority of their kilocalories from grains with little processing (Allen, 2009: 35-37).

The return to population growth in the fifteenth and sixteenth centuries put the diet under pressure again, but it should be noted that the pastoral sector continued to supply a significant share of kilocalories. By the mid-eighteenth century, per capita consumption of kilocalories from grain production, supplemented by potatoes and grain imports as well as pastoral products, was again above sufficiency.

2. Income and output based measures

An alternative way to assess the credibility of our output estimates is to compare them with the long-established estimates of real wages. Phelps Brown and Hopkins (1981) produced long time series of daily real wages for skilled and unskilled building workers, which apparently painted a picture of Malthusian fluctuations but long run stationarity of material living standards over the period 1300-1850. Subsequent refinements by Allen (2001) present a more subtle picture, with the real wage gains following the Black Death being maintained in Britain and Holland, but eaten away by subsequent population growth in the rest of Europe. Clark (2005) continues to show a substantial decline in British real wages from their medieval peak before recovery from the mid-seventeenth century.

Figure 13 charts our per capita GDP estimates together with the Allen and Clark real wage series for unskilled building workers. In common with Allen (2001), we find

per capita GDP in 1700 substantially higher than in 1300. However, we also find a long period of declining living standards between the mid-fifteenth century and the mid-seventeenth century, which is more in line with the findings of Clark (2005) for this period.

How should we interpret this increase of per capita income of around two-thirds between 1300 and 1700? We have seen in Table 23 that there was little gain in food consumption per capita over this period, at least measured in terms of kilocalories. The gains in material living standards should thus be seen as arriving more through the consumption of industrial goods and services. This shows up in the path of average wealth at death and the growing urbanisation of the British economy. Overton (2006) uses data on probate inventory totals for Cornwall, Hertfordshire, Kent, Lincolnshire and Worcestershire to show that between 1550 and 1750, median wealth increased from £11.31 to £22.35 in constant prices. Furthermore, looking at sub-periods, Overton finds a decrease in per capita wealth between 1550 and 1620, when GDP per capita also had a slightly negative trend. Malanima (2009) suggests an urbanisation ratio for England rising from 4.0 per cent in 1300 to 13.2 per cent by 1700 and 43.0 per cent by 1870, using settlements of at least 10,000 as the cut-off.

VII. BRITAIN IN A EUROPEAN PERSPECTIVE

This paper on British GDP over the long run is part of a project to reconstruct the historical national accounts of Britain and Holland. In addition, estimates of GDP per capita are now available for a number of other European countries before 1850. Table 24

thus puts the British experience into a wider European perspective, projecting backwards from Maddison's (2003) widely accepted estimates of GDP per capita in 1850, expressed in 1990 international dollars. Projecting back from Maddison's figure for Britain, we arrive at a figure of more than $900 in 1300, well above Madidson's figure of $400 in 1000. This figure of $400, or a little more than a dollar a day, is usually taken as the measure of bare bones subsistence, and is observed for many poor countries in the twentieth century. Estimates for other European countries also suggest late medieval living standards well above $400. In some case, such as Italy, this may be explained by high levels of urbanisation. For western Europe as a whole, however, it is explained by mixed agriculture with a large pastoral sector.

The large share of pastoral agriculture had a number of important implications for future growth. First, this was a high value added agriculture, even if it did not produce many more kilocalories per head than arable agriculture. Second, this was a highly capital intensive agriculture, with animals making up a large share of the capital stock. Third, this was an agriculture which was highly intensive in the use of non-human energy. In these respects, Western Europe already looked very different from Asia long before what Pomeranz (2000) calls the Great Divergence of the industrial revolution period. Broadberry and Gupta (2006) point out that during the early modern period European wages were significantly above Asian wages, if compared at the exchange rate (the silver wage) rather than the amount of grain they could purchase (the grain wage). This was taken to suggest a higher European productivity in traded goods and services, so that although European consumers could enjoy more industrial goods and services, they did

not necessarily enjoy more agricultural goods. Yet even if European and Asian consumption baskets were broadly similar in terms of the kilocalories they contained, it now looks as though Europeans (especially those able to afford the 'respectability basket") consumed more agricultural value-added than many Asians because of the greater direct and indirect contribution made by animals to the contents of that basket.

VIII. CONCLUSIONS

This paper provides the first annual estimates of GDP for England between 1300 and 1700 and for Great Britain between 1700 and 1850, constructed from the output side. For agriculture, the estimates rest on a detailed reconstruction of arable and pastoral farming, built up from manorial records during the modern period, probate inventories during the early modern period and farm accounts during the modern period. For industry and services, indices of gross output are assembled for the major sectors and combined with value added weights. The GDP data are then combined with population estimates to calculate GDP per capita. Estimates of nominal GDP are also provided by combining the volume series with price indices.

Our results suggest English per capita income growth of 0.13 per cent per annum between 1300 and 1700, with the strongest growth after the Black Death and in the second half of the seventeenth century. For the period 1700-1850, we find British per capita income growth of 0.26 per cent, broadly in line with the widely accepted estimates of Crafts and Harley (1992). This modest trend growth in per capita income before the Industrial Revolution suggests that, working back form the present, living standards in

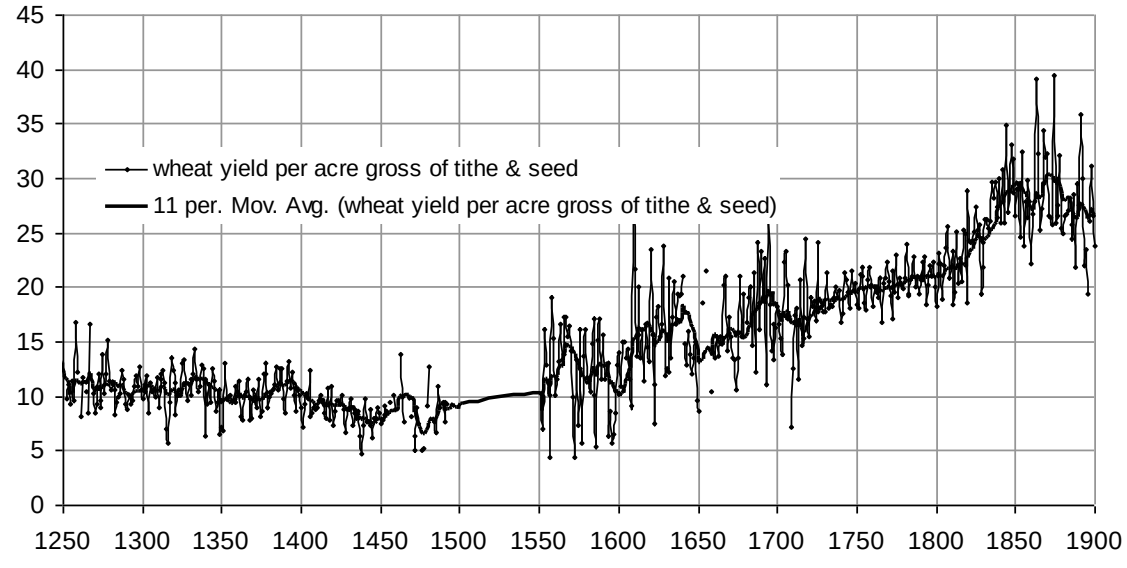
the late medieval period were well above “bare bones subsistence”. This can be reconciled with modest levels of kilocalorie consumption per head because of the very large share of pastoral production in agriculture. Contrary to the claims of the California School, Western Europe was on a very different path of development from Asia long before the Great Divergence, characterized by high value added, capital intensive and non-human energy intensive production.

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
1250	1.84	0.69	1.10	2.60	0.21	0.00	0.00	6.44	4.83	11.27
1300	2.43	0.55	1.15	2.87	0.40	0.00	0.00	7.40	4.13	11.52
1380	1.66	0.33	1.11	1.70	0.43	0.00	0.00	5.21	3.52	8.73
1420	1.48	0.29	1.10	1.54	0.42	0.00	0.00	4.85	3.49	8.34
1450	1.50	0.30	1.12	1.56	0.43	0.00	0.00	4.92	3.32	8.24
1500	1.56	0.38	1.17	1.52	0.46	0.00	0.12	5.20	3.14	8.34
1600	1.85	0.77	1.44	1.32	0.61	0.00	0.73	6.72	2.16	8.87
1650	2.04	0.40	1.89	1.15	1.03	0.00	1.37	7.87	1.92	9.79
1700	2.02	0.43	1.84	1.16	0.99	0.00	1.30	7.76	1.94	9.70
1750	1.98	0.06	1.52	1.84	0.99	0.09	2.65	9.06	1.62	10.67
1800	2.63	0.06	1.49	2.08	0.84	0.17	3.13	10.23	1.29	11.52
1830	3.40	0.06	2.00	1.60	0.60	0.29	5.20	12.86	1.33	14.19
1871	3.32	0.06	1.96	1.45	0.90	0.39	5.66	13.35	0.48	13.83

Sources: Overton and Campbell (1996: Tables III, V); Campbell, Bartley and Power (1996); Medieval Accounts Database; Early Modern Probate Inventory Database; Holderness (1989); Overton (1996).

FIGURE 1: English weighted national average wheat yields per acre, gross of tithe and seed (bushels)



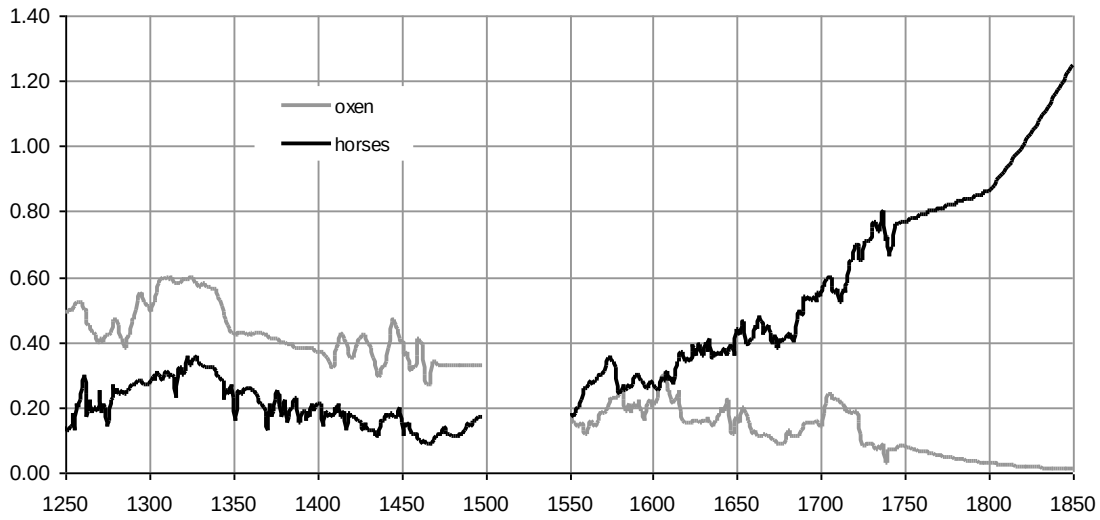
Sources: Medieval Accounts Database, the Early Modern Probate Inventories Database and the Modern Farm Accounts Database.

TABLE 2: English mean yields per acre gross of tithes, net of seeds (bushels)

	Wheat	Rye	Barley	Oats	Pulses
1250-1299	8.29	11.93	10.63	7.05	6.64
1300-1349	8.08	10.34	10.00	6.36	5.93
1350-1399	7.76	9.36	10.03	7.00	5.59
1400-1449	6.29	9.86	8.36	7.17	5.59
1450-1499	6.35	10.05	7.66	6.21	4.03
1550-1599	9.50	7.83	9.89	8.62	7.32
1600-1649	13.16	12.93	13.73	12.28	8.18
1650-1699	14.08	14.63	14.75	12.25	10.87
1700-1749	15.57	15.53	17.32	17.82	13.54
1750-1799	18.10	17.87	21.64	21.11	12.29
1800-1849	22.59	19.52	26.09	27.95	16.51
1850-1899	25.31	26.18	23.84	30.26	16.03

Sources and notes: Gross Yield per acre taken from the Medieval Accounts Database, the Early Modern Probate Inventories Database and the Modern Farm Accounts Database. Seed sown per acre from the Medieval and Modern Databases. Pulses for the modern period and all seeds sown for the early modern period are taken from Overton and Campbell (1996), Allen (2005).

FIGURE 2: Working animals in England (mlns)



Sources: Derived from the Medieval Accounts Database; the Early Modern Probate Inventories Database; the Modern Farm Accounts Database; Allen (1998); John (1989); Mitchell (1988); Turner (1998).

TABLE 3: English arable output net of seed and animal consumption (million bushels)

	Wheat	Rye	Barley	Oats	Pulses	Potatoes
1250-1299	18.48	6.74	12.03	16.83	1.10	NA
1300-1349	19.78	5.72	11.50	14.52	1.19	NA
1350-1399	13.16	3.17	11.09	9.35	1.18	NA
1400-1449	9.65	3.08	9.42	8.58	1.22	NA
1450-1499	9.65	3.49	8.74	7.05	0.89	NA
1550-1599	16.67	5.05	13.46	6.51	2.46	NA
1600-1649	25.77	7.20	23.31	7.99	4.35	NA
1650-1699	28.35	6.48	27.12	5.04	7.53	NA
1700-1749	30.16	4.24	27.53	12.71	10.02	5.79
1750-1799	42.57	1.08	32.66	24.03	8.17	17.49
1800-1849	62.82	1.16	48.12	22.63	7.76	35.55

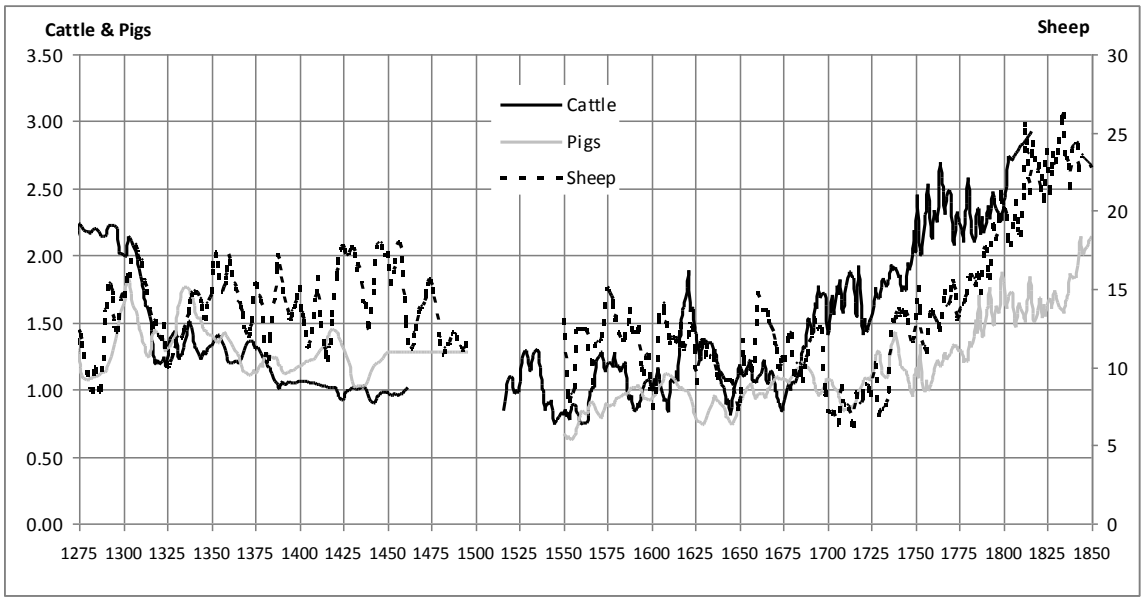
Source: Output gross of tithe and net of seed derived by multiplying sown area from Table 1 with net yields from Table 2. The sown area from Table 1 was interpolated where necessary. Consumption by working animals is derived from the numbers of working animals shown in Figure 2.

TABLE 4: Numbers of non-working animals in England (millions)

	Milk cattle	Beef cattle	Calves	Sheep	Swine	Livestock Unites per 100 Acres
1250-1299	0.63	0.57	0.63	11.65	1.36	45.65
1300-1349	0.71	0.64	0.71	13.64	1.52	50.04
1350-1399	0.45	0.40	0.45	14.38	1.23	55.15
1400-1449	0.39	0.35	0.39	14.87	1.22	56.28
1450-1499	0.34	0.30	0.34	13.45	1.28	49.90
1550-1599	0.33	0.30	0.33	11.32	0.86	36.63
1600-1649	0.37	0.33	0.37	12.19	0.92	33.22
1650-1699	0.42	0.38	0.42	12.39	1.04	34.93
1700-1749	0.48	0.43	0.48	11.07	1.08	32.48
1750-1799	0.66	0.60	0.66	14.96	1.32	37.49
1800-1849	0.84	0.76	0.84	22.32	1.72	43.25

Sources and notes: Derived from Medieval Accounts Database; Early Modern Probate Inventory Database; Allen (2005); John (1989 Tales III.1 and III.2).
* Livestock units compare different animals on the basis of relative feed requirements. Ratios from Campbell (2000: 104-107): (adult cattle for beef and milk x 1.2) + (immature cattle x 0.8) + (sheep and swine x 0.1).

FIGURE 3: Non-working livestock in England in Millions (5-year Average)



Sources: Derived from the Medieval Accounts Database; Early Modern Probate Inventories Database; Allen (2005); John (1989); Mitchell (1988); Turner (1998).

TABLE 5: Percentages of English animals producing specific products

	Milk	Beef	Veal	Mutton	Pork	Wool
1300	90	25	15.2	26	49	90
1420	90	25	17.5	26	49	90
1600	90	25	21.1	25	49	90
1830	90	25	25.0	37.6	93.1	81.3

Sources: Holderness (1989: 147); Clark (1991); Ecclestone (1996).

TABLE 6: English yields per animal

Years	Milk (gallons)	Beef (lb)	Veal (lb)	Mutton (lb)	Pork (lb)	Wool (lb)
1250-1299	100.00	168.00	29.00	22.00	64.00	1.53
1300-1349	107.01	177.90	30.73	23.17	65.29	1.77
1350-1399	122.69	199.73	34.54	25.75	67.99	1.62
1400-1449	140.67	224.23	38.83	28.60	70.81	1.38
1450-1499	161.28	251.74	43.65	31.78	73.74	1.32
1550-1599	212.01	317.30	55.15	39.22	79.97	1.79
1600-1649	243.07	356.23	61.99	43.57	83.28	2.08
1650-1699	278.69	399.93	69.68	48.41	86.73	2.42
1700-1749	319.52	449.00	78.33	53.78	90.32	2.81
1750-1799	366.34	504.08	88.05	59.74	94.06	3.27
1800-1849	420.02	565.93	98.98	66.37	97.96	3.80

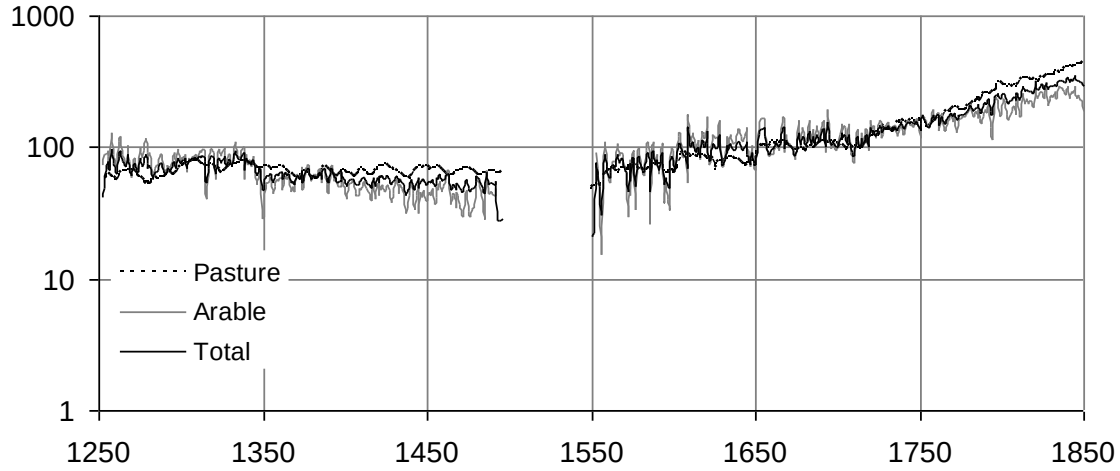
Sources and notes: Beef, pork, milk, and mutton are obtained from Clark (1991: 216), while veal is taken from Allen (2005: Table 6). Wool yield index from Stephenson (1988: Table 3), with the benchmark of 1.4 lb in 1300 from Britnell (2004: 416). The missing years were interpolated log-linearly.

TABLE 7: Output in English pastoral farming

Years	Milk (m. gals)	Beef (m. lb)	Veal (m. lb)	Mutton (m. lb)	Pork (m. lb)	Wool (m. lb)
1250-1299	56.98	23.84	2.70	66.00	43.25	16.09
1300-1349	68.32	28.31	3.41	82.02	48.47	21.55
1350-1399	49.64	20.16	2.59	96.08	40.99	21.13
1400-1449	49.22	19.60	2.66	110.88	42.20	18.44
1450-1499	48.58	18.96	2.72	110.43	46.27	15.86
1550-1599	62.68	23.50	3.73	111.28	33.88	18.28
1600-1649	79.97	29.37	4.88	132.61	37.43	22.77
1650-1699	105.93	38.04	6.63	156.56	48.67	28.14
1700-1749	137.92	48.56	8.85	165.25	62.58	28.09
1750-1799	219.84	75.72	14.40	285.55	96.20	41.65
1800-1849	318.84	107.57	20.86	550.76	154.54	69.33

Sources: Total output estimates are derived by multiplying animal numbers from Table 4 with the percentage of animals producing in Table 5. The resulting numbers of producing animals are then multiplied with the animal yields from Table 6.

FIGURE 4: Indexed output in English arable and pastoral agriculture (1700=100, log scale)



Sources: See text.

TABLE 8: Output growth in English agriculture in constant 1700 prices (5-year moving averages)

Years	Arable sector (% *per annum*)	Pastoral sector (% *per annum*)	Total agriculture (% *per annum*)
1275-1300	0.03	0.62	0.25
1300-1348	-1.19	-0.03	-0.65
1348-1400	0.16	-0.18	-0.01
1400-1450	-0.39	0.19	-0.08
1450-1475	-0.68	-0.08	-0.33
1475-1555	0.54	-0.32	0.10
1555-1600	0.57	0.43	0.51
1600-1650	-0.01	0.39	0.16
1650-1700	0.15	0.45	0.27
1700-1750	0.46	0.80	0.61
1750-1800	0.65	1.31	0.97
1800-1850	0.18	0.72	0.49
1250-1348	-0.56	0.17	-0.24
1250-1700	0.07	0.13	0.09
1250-1850	0.17	0.33	0.25
1700-1850	0.46	0.95	0.71

Sources: Derived from Medieval Accounts Database; Early Modern Probate Inventories Database; Modern Farm Accounts Database.

TABLE 9: Output shares in English agriculture, in current prices, 20-year averages (%)

A. Arable products

Year	Wheat	Rye	Barley	Oats	Pulses	Potatoes	Total arable products
1300	20.1	2.6	7.0	6.4	1.1	0.0	37.2
1380	16.0	1.7	11.7	4.3	1.3	0.0	34.9
1420	11.1	1.4	6.8	3.3	0.9	0.0	23.5
1600	21.4	5.5	9.8	3.1	2.6	0.0	42.5
1700	31.8	3.8	15.6	1.2	4.4	0.2	57.0
1800	27.3	0.4	9.8	6.1	2.9	3.0	49.3
1850	21.3	0.3	11.2	2.5	2.1	6.3	43.7

B. Pastoral products

Year	Dairy	Beef	Pork	Mutton	Hay	Wool	Hides	Total pastoral products
1300	5.6	1.7	28.7	12.5	0.7	12.5	1.1	62.8
1380	4.8	1.6	28.7	15.3	0.8	13.3	0.6	65.1
1420	5.0	1.6	34.6	20.1	0.6	12.8	1.7	76.3
1600	6.5	2.0	28.5	9.4	1.5	8.3	1.3	57.4
1700	8.1	2.5	12.8	9.8	3.7	5.4	0.9	43.1
1800	12.2	4.3	8.5	13.1	8.6	3.3	0.8	50.7
1850	14.8	3.5	11.5	14.0	8.2	3.5	0.7	56.3

Sources: Derived from Medieval Accounts Database; Early Modern Probate Inventories Database; Modern Farm Accounts Database.

TABLE 10: English industrial output weights, circa 1700

	%
Tin	0.9
Iron	5.6
Books	4.4
Coal	4.0
Woollens	64.5
Food	10.7
Building	9.9
Total	100.0

Sources: Derived from Hoffmann (1955).

TABLE 11: Growth of English industrial production, 1300-1700

	% per annum
1300-1350	0.19
1350-1400	-0.10
1400-1450	0.01
1450-1490	-0.47
1490-1560	0.57
1560-1600	0.14
1600-1650	0.58
1650-1700	0.57
1300-1700	0.29

Sources and notes: See text. Growth rates calculated using 5-year averages. For 1300-1350, outliers removed.

FIGURE 5: English industrial production index, 1300-1700 (1700=100, log scale)

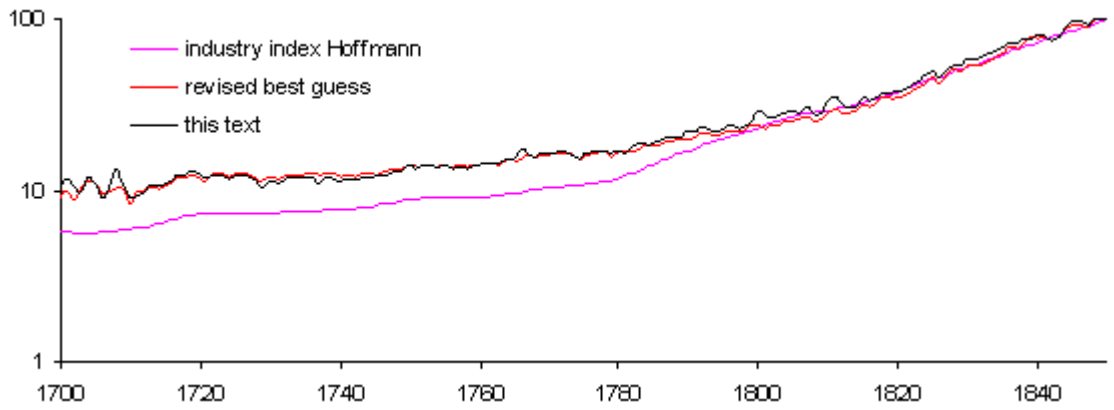
Sources: See text.

TABLE 12: Output growth in British industry, 1700-1850 (% per annum)

	Crafts-Harley	Present estimates (annual data)	Present estimates (5-year averages)
1700-1760	0.71	0.49	0.42
1760-1780	1.29	1.00	0.95
1780-1801	1.96	2.18	2.28
1801-1830	2.78	2.68	2.57
1830-1850	--	2.78	2.76

Sources: Crafts (1985: 32); Crafts and Harley (1992: 715); see text.

FIGURE 6: British industrial output in real terms, 1700-1850 (1850=100, log scale)



Sources: Crafts and Harley (1992); Hoffmann (1955); see text.

TABLE 13: English service sector weights, circa 1700

	(%)
Commerce	37.2
Housing and domestic	46.5
Government	16.3
Total	100.0

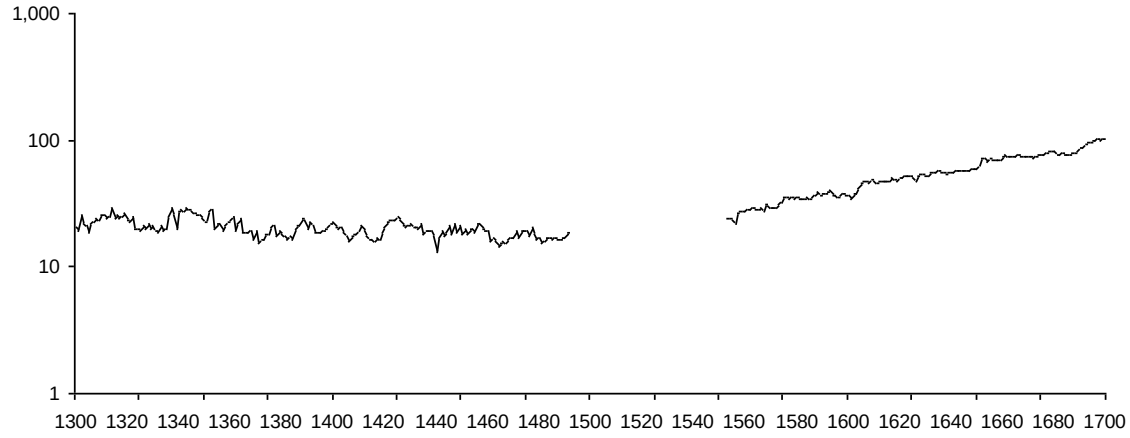
Sources: Crafts (1985: 16).

TABLE 14: Growth of English service sector output, 1300-1700

	% per annum
1300-1350	0.23
1350-1400	-0.29
1400-1450	-0.19
1450-1490	-0.22
1490-1560	0.66
1560-1600	0.68
1600-1650	1.08
1650-1700	0.95
1300-1700	0.38

Sources and notes: See text. Growth rates calculated using 5-year averages.

FIGURE 7: English service sector output, 1300-1700 (1700=100, log scale)



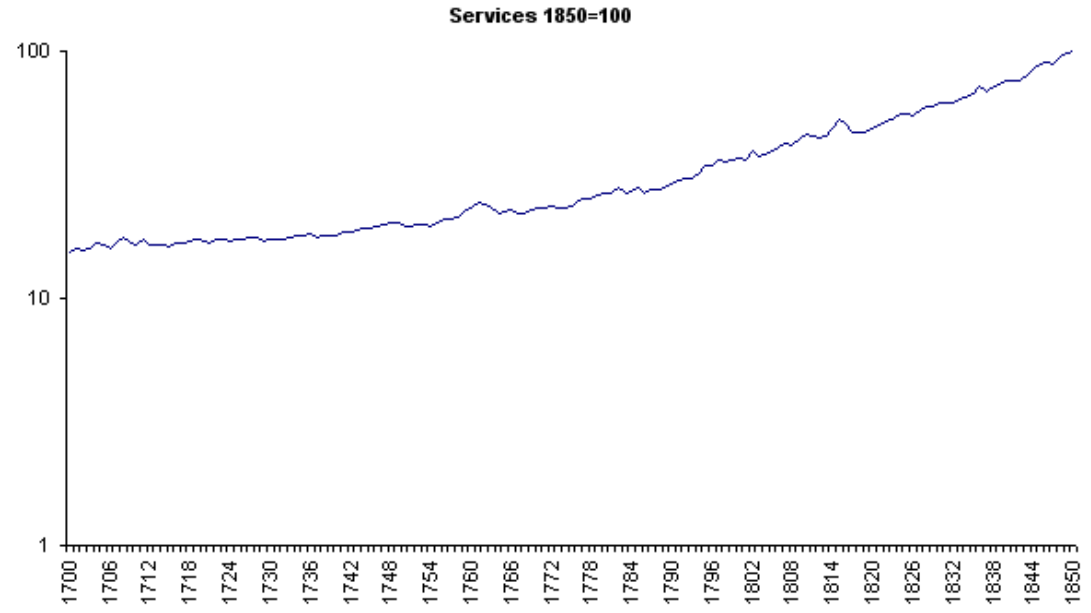
Sources: See text.

TABLE 15: Output growth in British services, 1700-1850 (% per annum)

	Crafts-Harley	Present estimates (annual data)	Present estimates (5-year averages)
1700-1760	0.74	0.71	0.63
1760-1780	0.77	0.69	0.71
1780-1801	1.31	1.41	1.62
1801-1830	1.68	1.87	1.71
1830-1850	--	2.46	2.21

Sources: Derived from Crafts (1985: 16-17, 32, 37); Crafts and Harley (1992: 715); see text.

FIGURE 8: British service sector output in real terms, 1700-1850 (1850=100, log scale)



Sources: See text.

TABLE 16: Sectoral shares in English GDP, 1300-1700 (%)

	1381	1522	1700
Agriculture	65	57	37
Industry	25	26	20
Services	10	17	43
Total	100	100	100

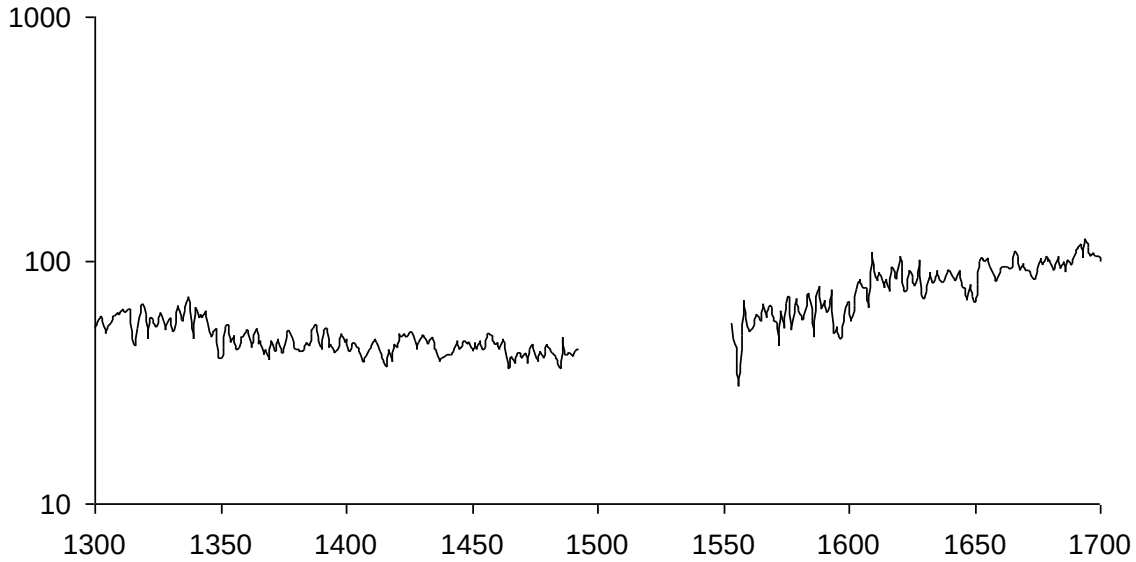
Sources and notes: 1381: derived from the Poll Tax Returns; 1522: derived from the Muster Rolls; 1700: Crafts (1985: 16). 1381 weights used for 1300-1450; 1522 weights used for 1450-1650; 1700 weights used for 1650-1700. The weights incorporate information on relative sectoral incomes as well as occupational shares.

TABLE 17: Growth of English GDP, 1300-1700

	% per annum
1300-1348	-0.02
1300-1350	-0.37
1350-1400	0.01
1400-1450	-0.07
1450-1490	-0.16
1490-1560	0.44
1560-1600	0.25
1600-1650	0.46
1650-1700	0.55
1300-1700	0.15

Sources: See text. Growth rates calculated using 5-year averages.

FIGURE 9: English real GDP, 1300-1700 (1700=100, log scale)



Sources: See text.

TABLE 18: English population, 1300-1700

A. Levels of population (millions)

	Total population
1300	4.72
1348	4.25
1350	2.93
1400	2.18
1450	1.71
1490	1.93
1560	3.06
1600	4.11
1650	5.33
1700	5.19

B. Growth rates of population (% per annum)

	Total population
1300-1348	-0.21
1300-1350	-0.95
1350-1400	-0.59
1400-1450	-0.48
1450-1490	0.30
1490-1560	0.66
1560-1600	0.74
1600-1650	0.52
1650-1700	-0.05
1300-1700	0.02

Sources: Medieval period: regression analysis based on parish data (see text); Wrigley *et al.* (1997), interpolated using Wrigley and Schofield (1989).

TABLE 19: Growth of English GDP per capita, 1300-1700

	% per annum
1300-1348	0.19
1300-1350	0.58
1350-1400	0.60
1400-1450	0.42
1450-1490	-0.46
1490-1560	-0.22
1560-1600	-0.49
1600-1650	-0.06
1650-1700	0.60
1300-1700	0.13

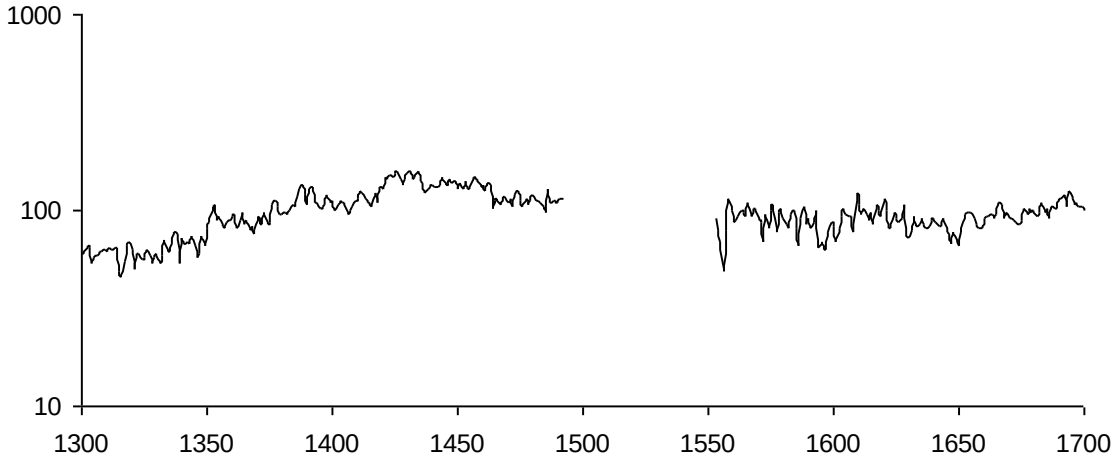
Sources and notes: See text. Growth rates calculated using 5-year averages.

FIGURE 10: English real GDP per capita, 1300-1700

A. 1700=100, linear scale

-

B. 1700=100, log scale



Sources: See text.

TABLE 20: British sectoral weights, 1700-1850 (%)

	1700	1841
Agriculture	37	28
Industry	20	44
Services	43	28
GDP	100	100

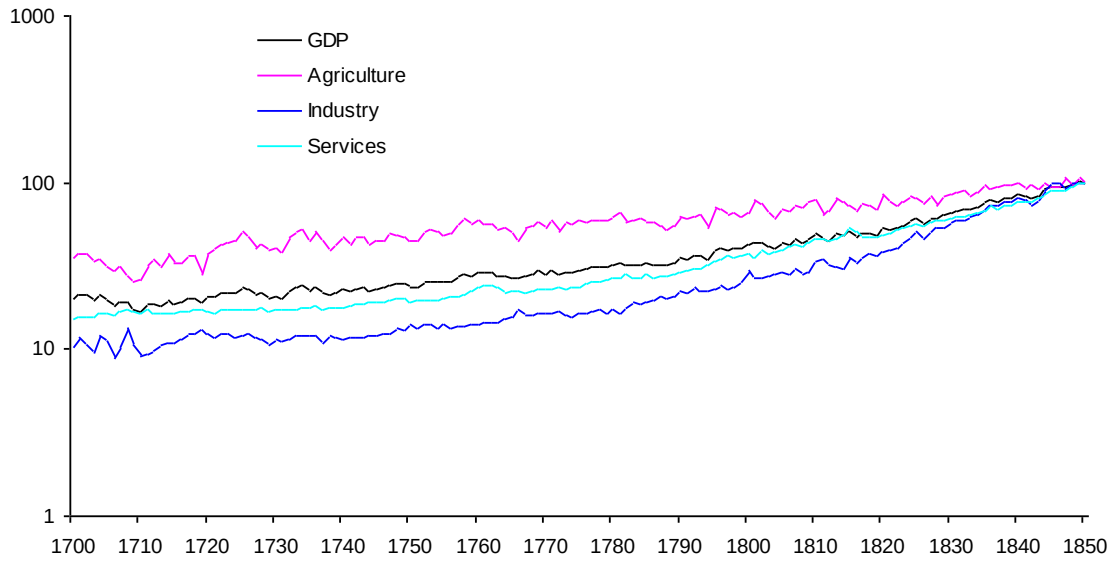
Sources and notes: Crafts (1985: 16-17); Horrell *et al.* (1994); 1700 weights used for 1700-1800; 1841 weights used for 1800-1850.

TABLE 21: British GDP growth, 1700-1850 (% per annum)

	Crafts-Harley	Present estimates (annual data)	Present estimates (5-year averages)
1700-1760	0.69	0.68	0.46
1760-1780	0.64	0.75	0.77
1780-1801	1.38	1.48	1.49
1801-1830	1.90	1.47	1.48
1830-1850	--	1.78	1.81
1700-1850	--	1.10	1.02

Sources: Crafts (1985: 45); Crafts and Harley (1992: 715); derived from Appendix 1.

FIGURE 11: British GDP in real terms, 1700-1850 (1850=100, log scale)



Sources: See text.

TABLE 22: Average annual growth rate of British population and per capita income, 1700-1850 (% per annum)

	Population growth	Per capita GDP growth (annual data)	Per capita GDP growth (5-year averages)
1700-1760	0.32	0.36	0.17
1760-1780	0.62	0.13	0.16
1780-1801	0.97	0.50	0.50
1801-1830	1.43	0.03	0.05
1830-1850	1.24	0.54	0.69
1700-1850	0.79	0.31	0.26

Sources: Mitchell (1988), Wrigley and Schofield (1989), Schofield (1994) and Wrigley *et al.* (1997); see text.

FIGURE 12: British real GDP per capita, 1700-1850 (1850 = 100)

Sources: See text.

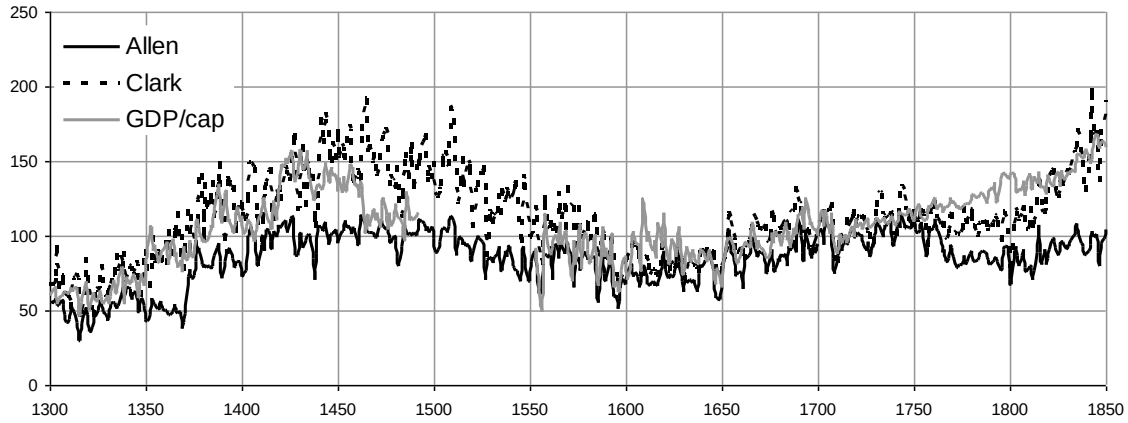
TABLE 23: Per capita daily kilocalorie consumption of major arable crops and animal products in England

Years	Population (mlns)	Animal	Arable			Total	Total (with 10% higher arable production in non-demesne sector)
		Kcal	Kcal. net of seed	Kcal. net of seed, losses, & fodder	% food extraction rate	Kcalories	Kcalories
1300	4.61	155	2,316	1,315	*57*	1,470	1,568
1380	2.36	232	2,985	1,563	*52*	1,795	1,922
1420	2.71	260	2,477	1,285	*52*	1,545	1,660
1450	2.67	279	2,355	1,218	*52*	1,497	1,611
1600	4.15	214	2,923	1,464	*50*	1,678	1,678
1700	5.20	232	*3,242	*1,735	*48*	1,771	1,771
1750	5.92	330	*3,831	*1,782	*45*	2,065	2,065
1800	8.65	378	*3,676	*1,733	*47*	2,110	2,110
1850	15.67	321	*3,184	*1,529	*48*	1,850	1,850

Sources and notes: This Table is based on 20-year averages. Kilocalories per bushel for the medieval period are taken from Campbell *et al.* (1993: 41). Following Overton and Campbell (1996: Table XIII), storage losses are assumed to have been 10%, with food conversion losses of 20% for wheat and rye, 22% for barley, and 44% for oats when processed into bread, and 70% for barley and oats when malted and brewed into ale/beer. For the post Black Death period (1380 and 1420) patterns of grain consumption are assumed to have been equivalent to those for 1600 given by Overton and Campbell (1996: Table XII): 98% of wheat and rye and all oats not fed to livestock were eaten. However, we assumed that 50% of barley was eaten and the remainder brewed. For the pre-Black Death period it is assumed that 60% of barley was eaten and only 40% brewed. For 1600-1850 the estimates of Overton and Campbell (1996: Tables XII and XIII) were followed.

*Includes net grain imports and potatoes.

FIGURE 13: Indexed daily real wage of an unskilled building worker and GDP per capita (11-year moving averages; 1700=100)



Sources: Allen (2001); Clark (2005; 2007a); see text.

TABLE 24: GDP per capita levels in 1990 international dollars

	Great Britain	Netherlands	Belgium	Italy	Spain	Germany	Sweden
1300	931			1,644			
1400	1,681	1,213		1,726			
1500	1,724	1,440	929	1,644	1,295	1,332	
1570	1,377	1,618	1,089	1,463			860
1600	1,217	2,038	1,073	1,302	1,382	894	
1650	1,181	2,010	1,203	1,255		1,130	
1700	1,603	2,008	1,264	1,398	1,230	1,068	
1750	1,688	2,071	1,375	1,553	1,191	1,162	
1800	2,037	2,310	1,497	1,333	1,205	1,140	953
1820	1,960	1,842	1,534	1,445			1,009
1850	2,330	2,371	1,841	1,350	1,487	1,428	1,289

Sources: Netherlands: van Leuwen and van Zanden (2009); Belgium: Buyst (2009); Blomme and van der Wee (1994); Italy: Malanima (2009); Spain: Álvarez-Nogal and Prados de la Escosura (2009); Germany: Pfister (2009); Sweden: Krantz (2004); Krantz and Schön (2007).

REFERENCES

Allen, R.C. (2001), "The Great Divergence in European Wages and Prices from the Middle Ages to the First World War", *Explorations in Economic History*, 38, 411-447.

Allen, R.C. (2005) "English and Welsh Agriculture 1300-1850: Output, Inputs and Income", Nuffield College, Oxford, http://www.nuffield.ox.ac.uk/users/allen/unpublished/AllenE&W.pdf.

Allen, R.C. (2009), *The British Industrial Revolution in Global Perspective*, Cambridge: Cambridge University Press.

Álvarez-Nogal, C. and Prados de la Escosura, L. (2009), "*The Rise and Fall of Spain, 800-1850", Universidad Carlos III, Madrid*.

Beveridge, W. (1939), *Prices and Wages in England from the Twelfth to the Nineteenth Century, Vol. I, Price Tables: Mercantile Era*, London: Longmans, Green.

Biddick, K. (1989), *The Other Economy: Pastoral Husbandry on a Medieval Estate*, Berkeley: University of California Press.

Blomme, J. and van der Wee, H. (1994), "The Belgian Economy in a Long-Term Historical Perspective: Economic Development in Flanders and Brabant, 1500-1812", in Maddison, A. and van der Wee, H. (eds.), *Economic Growth and Structural Change: Comparative Approaches over the Long Run*, Milan: International Economic History Congress, 77-96.

Britnell R. H. (2004), *Britain and Ireland 1050-1530: Economy and Society*, Oxford: Oxford University Press.

Broadberry, S.N. and Gupta, B. (2006), "The Early Modern Great Divergence: Wages, Prices and Economic Development in Europe and Asia, 1500-1800", *Economic History Review*, 59, 2-31.

Buyst, E. (2009), Estimates of Economic Growth in the Southern Low Countries/Belgium, c.1770-1846", Centre for Economic Studies, Katholieke Universiteit Leuven.

Campbell, B.M.S. (2000), *English Seigniorial Agriculture, 1250-1450*, Cambridge: Cambridge University Press.

Campbell, B.M.S. (2007), *Three centuries of English crop yields, 1211-1491* [WWW document]. URL http://www.cropyields.ac.uk.

Campbell, B. M. S., Bartley, K.C. and Power, J. P. (1996), "The Demesne-Farming Systems of Post Black Death England: A Classification", *Agricultural History Review*, 44, 131-79.

Carus-Wilson, E.M. and Coleman, O. (1963), *England's Export Trade, 1275-1547*, Oxford: Clarendon.

Clark. G. (1991), "Labour Productivity in English Agriculture, 1300-1860", in Campbell B.M.S and Overton, M. (eds.), *Land, Labour and Livestock: Historical Studies in European Agricultural Productivity*, Manchester: Manchester University Press, 211-235.

Clark, G. (2004), "The Price History of English Agriculture, 1209-1914", *Research in Economic History*, 22, 41-125.

Clark, G. (2005), "The Condition of the Working-Class in England, 1209-2004", *Journal of Political Economy*, 113, 1307-1340.

Clark, G. (2007a), "The Long March of History: Farm Wages, Population and Economic Growth, England 1209-1869", *Economic History Review*, 60, 97-135.

Clark, G. (2007b), *A Farewell to Alms: A Brief Economic History of the World*, Princeton: Princeton University Press.

Clarkson, L.A. (1989), "The Manufacture of Leather", in Mingay, G.E. (ed.), *The Agrarian History of England and Wales, Volume VI: 1750-1850*, Cambridge: Cambridge University Press, 466-485.

Crafts, N.F.R. (1985), *British Economic Growth during the Industrial Revolution*, Oxford: Oxford University Press.

Crafts, N.F.R. and Harley, C.K. (1992), "Output Growth and the Industrial Revolution: A Restatement of the Crafts-Harley View", *Economic History Review*, 45, 703-730.

Crafts, N.F.R., Leybourne, S.J. and Mills, T.C. (1989), "Trends and Cycles in British Industrial Production, 1700-1913", *Journal of the Royal Statistical Society, Series A*, 152, 43-60.

Deane, P. and Cole, W.A. (1967), *British Economic Growth, 1688-1959: Trends and Structure*, 2nd edition, Cambridge: Cambridge University Press.

Dodds, B. (2004), "Estimating Arable Output Using Durham Priory Tithe Receipts, 1341-1450", *Economic History Review*, 58, 245-285.

Dodds, B. (2007), *Peasants and Production in the Medieval North-East: The Evidence from Tithes 1270-1536*, Woodbridge: Boydell & Brewer.

Ecclestone, M. J. (1996), "Dairy Production on the Glastonbury Abbey Demesnes 1258-1334", unpublished M.A. dissertation, University of Bristol.

Farmer, D. L. (1988), "Prices and Wages", in Hallam, H.E. (ed.), *The Agrarian History of England and Wales, Volume II: 1042-1350*, Cambridge: Cambridge University Press, 715-817.

Farmer, D. L. (1991), "Prices and Wages, 1350-1500", in Miller, E. (ed.), *The Agrarian History of England and Wales, Volume III: 1348-1500*, Cambridge: Cambridge University Press, 431-525.

Feinstein, C.H. (1988), "National Statistics, 1760-1920: Sources and Methods of Estimation for Domestic Reproducible Fixed Assets, Stocks and Works in Progress, Overseas Assets, and Land", in Feinstein, C.H. and Pollard, S. (eds.), *Studies in Capital Formation in the United Kingdom, 1750-1920*, Oxford: Oxford University Press, 257-471.

Harley, C. K. (1982) "British Industrialization Before 1841: Evidence of Slower Growth During the Industrial Revolution", *Journal of Economic History*, 42, 267-289.

Hatcher, J. (1973), *English Tin Production and Trade before 1550*, Oxford: Clarendon Press.

Hatcher, J. (1993), *The History of the British Coal Industry, Volume 1, Before 1700: Towards the Age of Coal*, Oxford; Oxford University Press.

Hoffmann, W.G. (1955), *British Industry 1700-1950*, Oxford: Blackwell.

Holderness, B.A. (1989), "Prices, Productivity, and Output", in Mingay, G.E. (ed.), *The Agrarian History of England and Wales, Volume VI: 1750-1850*, Cambridge: Cambridge University Press, 84-189.

Horrell, S., Humphries, J. and Weale, M. (1994), "An Input-Output Table for 1841", *Economic History Review*, 47, 545-566.

John A.H. (1989), "Statistical Appendix", in Mingay G. E. (ed.), *The Agrarian History of England and Wales, Volume VI: 1750-1850*, Cambridge, Cambridge University Press, 972-1155.

King, G. [1696] (1936), "Natural and Political Observations and Conclusions upon the State and Condition of England", in Barnett, G.E. (ed.), *Two Tracts by Gregory King*, Baltimore: Johns Hopkins Press.

King, P. (2005), "The Production and Consumption of Bar Iron in Early Modern England and Wales", *Economic History Review*, 58, 1-33.

Krantz, O. (2004), "An Estimate of Swedish GDP in 1571", in Heikkinen, S. and van Zanden, J.L. (eds.), *Exploring Economic Growth: Essays in Measurement and Analysis*, Amsterdam: Aksant, 105-130.

Krantz, O. and Schön, L. (2007), "Swedish Historical National Accounts, 1800-2000", Lund University Macroeconomic and Demographic Database, http://www.ehl.lu.se/database/LU-MADD/National%20Accounts/default.htm.

van Leeuwen, B. and van Zanden, J.L. (2009), "The Origins of modern Economic Growth? Holland between 1500 and 1800", University of Warwick and IISG, Amsterdam.

Livi-Bacci, M. (1991), *Population and Nutrition*, Cambridge: Cambridge University Press.

Maddison, A. (2003), *The World Economy: Historical Statistics*, Paris: Organisation for Economic Co-operation and Development.

Malanima, P. (2009), "Italian GDP, 1300-1913", Institute of Studies on Mediterranean Societies (ISSM), Italian National Research Counciln (CNR).

Mitchell, B.R. (1988), *British Historical Statistics*, Cambridge: Cambridge University Press.

Nef, J.U. (1932), *The Rise of the British Coal Industry, Volume II*, London: Routledge.

O'Brien, P.K. and Hunt, P.A. (1999), "England, 1485-1815", in Bonney, R. (ed.), *The Rise of the Fiscal State in Europe, c.1200-1850*, Oxford: Oxford University Press, 53-100.

Overton, M. (1996), *Agricultural Revolution in England: The Transformation of the Agrarian Economy 1500-1850*, Cambridge: Cambridge University Press.

Overton, M. (2006), "Household Wealth, Indebtedness, and Economic Growth in Early Modern England", presented at International Economic History Congress, Helsinki, Session 122, Progress, Stasis, and Crisis: Demographic and Economic Developments in England and Beyond, AD c.1000-c.1800, http://www.helsinki.fi/iehc2006/sessions81_124.html.

Overton, M. and Campbell, B.M.S. (1996), "Production et productivité dans l'agriculture anglais, 1086-1871", *Histoire et Mesure*, 11, 255-297.

Overton, M., Whittle, J., Dean, D. and Haan, A. (2004), *Production and Consumption in English Households, 1600-1750*, London: Routledge.

Pfister, U. (2009), "German Economic Growth, 1500-1850", Historisches Seminar, Westfälische Wilhelms-Universität Münster.

Phelps Brown, H. and Hopkins, S.V. (1981), *A Perspective of Wages and Prices*, London: Methuen.

Pomeranz, K. (2000), *The Great Divergence: China, Europe, and the Making of the Modern World Economy*, Princeton, NJ: Princeton University Press.

Postan, M.M. (1966), "Medieval Agrarian Society in its Prime: England", in Postan, M.M. (ed.), *The Cambridge Economic History of Europe, Vol. I: The Agrarian Life of the Middle Ages*, second edition, Cambridge: Cambridge University Press, 549-632.

Postan, M.M. (1972), *The Medieval Economy and Society: An Economic History of Britain in the Middle Ages*, London: Weidenfeld and Nicolson.

Prince, H.C. (1989), "The Changing Rural Landscape, 1750-1850", in Mingay, G.E. (ed.), *The Agrarian History of England and Wales, Volume VI: 1750-1850*, Cambridge: Cambridge University Press, 7-83.

Sapoznik, A. (2008), "Using Tithes to Compare Landlord and Peasant Cropping Patterns at Fourteenth-Century Oakington", Economic History Society Annual Conference, Nottingham.

Schofield, R. (1994), "British population change, 1700-1871", in Floud, R. and McClosky, D.N. (eds.), *The Economic History of Britain since 1700, Second Edition: Volume 1: 1700-1860*, Cambridge: Cambridge University Press, 60-95.

Smith, R.M. (1991), "Demographic Developments in Rural England, 1300-1348: A Survey", in Campbell, B.M.S. (ed.), *Before the Black Death: Studies in the "Crisis" of the Early Fourteenth Century*, Manchester: Manchester University Press, 25-77.

Stephenson, M. J. (1988), "Wool Yields in the Medieval Economy", *Economic History Review*, 61, 368-91.

Stone, D. J. (2006), "The Consumption of Field Crops in Late Medieval England", in Woolgar, C.M., Serjeantson, D. and Waldron, T. (eds.), *Food in Medieval England: Diet and Nutrition*, Oxford: Oxford University Press.

Thorold Rogers, J.E. (1866-1902), *A History of Agriculture and Prices in England*, Volumes 1-6, Oxford: Clarendon Press.

Turner, M.E. (1998), "Counting Sheep: Waking up to New Estimates of Livestock Numbers in England", *Agricultural History Review*, 46, 142-161.

Turner, M.E., J.V. Beckett, and B. Afton (2001), *Farm Production in England 1700-1914*, Oxford: Oxford University Press.

Wrigley, E.A. (2006), "The Transition to an Advanced Organic Economy: Half a Millennium of English Agriculture", *Economic History Review*, 59, 435-480.

Wrigley, E.A. and Schofield, R.S. (1989), *The Population History of England, 1541-1871: A Reconstruction*, Cambridge: Cambridge University Press.

Wrigley, E.A., Davies, R.S., Oeppen, J.E. and Schofield, R.S. (1997), *English Population History from Family Reconstitution, 1580-1837*, Cambridge: Cambridge University Press.