

## THE SIZE OF THE MEDIEVAL ECONOMY

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*Abstract:* This chapter assesses the size of the economy during the medieval period and relates it to the long run development of the British economy. Trends in both total GDP and per capita GDP were dominated in the medieval period by the population collapse during the century after the arrival of the Black Death in 1348. Although this led to a sharp decline in total GDP, it also had strongly positive effects on average living standards, as output fell by less than population. These positive effects arose because survivors found themselves with more land and capital or, if they were landless, were able to benefit from higher real wages due to the shortage of labour. The application of this historical national accounting approach to the medieval economy makes it possible to link up with estimates of GDP per capita for later periods. After the return of population growth from the mid-fifteenth century, GDP per capita remained on a higher plateau, from which the next growth phase began in the second half of the seventeenth century, continuing into the Industrial Revolution of the eighteenth century. The path to the Industrial Revolution can thus be traced back to developments in the medieval period.

## **1. INTRODUCTION**

This chapter draws on the sources discussed in a number of the previous chapters to assess the size of the economy during the medieval period and relate it to the long run development of the British economy over the last millennium. Total output is measured by gross domestic product (GDP), which is reconstructed here from the output side, distinguishing the main sectors of agriculture, industry and services. Dividing GDP by population yields GDP per capita, a key measure of average productivity and living standards. Agricultural output is derived from manorial accounts and cross-checked against tithe accounts for the non-demesne sector, paying particular attention to capturing total agricultural output whether it was sold on the market or consumed directly by peasants. Output of key industries and services is reconstructed on an annual basis from a wide range of sources available from the thirteenth century while population data are available from 1086 onwards.

Trends in both total GDP and per capita GDP were dominated in the medieval period by the population collapse during the century after the arrival of the Black Death. Although the dramatic decline of the population after 1348 led to a sharp decline in total GDP, it also had strongly positive effects on average living standards, as output fell by less than population. These positive effects arose because survivors found themselves with more land and capital or, if they were landless, were able to benefit from higher real wages due to the shortage of labour. The application of this historical national accounting approach to the medieval economy makes it possible to link up with estimates of GDP per capita for later periods. After the return of population growth from the mid-fifteenth century, GDP per capita remained on a higher plateau, from which the next growth phase began in the second half of the seventeenth century, continuing into the Industrial Revolution of the eighteenth century.

The path to the Industrial Revolution can thus be traced back to developments in the medieval period.

## **2. MEASURING THE SIZE OF THE MEDIEVAL ECONOMY**

One way to measure the size of the medieval economy is to chart the path of the population. The English population changed dramatically, rising to a peak just before the arrival of the Black Death in 1348 before declining by more than half over the next century. However, this offers only a partial view of what happened to the size of the economy because it does not consider any change in living standards. This brings us to a crucial distinction in economics between extensive growth and intensive growth. In general, an economy can grow in size by adding more people at the same standard of living (extensive growth), by raising the average living standards of the population (intensive growth) or by some combination of the two. To assess the size of the medieval economy in full we therefore need a measure of aggregate output, which requires the estimation of gross domestic product (GDP).

Broadberry, Campbell, Klein, Overton and van Leeuwen estimated GDP in medieval England as part of a project to reconstruct British economic growth between 1270 and 1870.<sup>1</sup> They linked up with existing series for later periods so as to provide a complete quantitative picture of the British economy from medieval times to the present. It is also possible to work backwards from 1270 to 1086 to make a connection with Walker's reconstruction of GDP for England from the Domesday Book.<sup>2</sup>

## **3. ESTIMATING GDP FOR MEDIEVAL ENGLAND**

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<sup>1</sup> S. Broadberry, B. M. S. Campbell, A. Klein, M. Overton, and B. van Leeuwen, *British Economic Growth, 1270-1870* (Cambridge, 2015).

<sup>2</sup> J. T. Walker, 'National Income in Domesday England', in M. Allen, and D. Coffman (eds), *Money, Prices and Wages: Essays in Honour of Professor Nicholas Mayhew* (Basingstoke, 2015), 24-50.

Broadberry et al. reconstructed GDP by aggregating output in agriculture, industry and services, following the SNA (System of National Accounts) internationally agreed set of recommendations on how to compile measures of economic activity. The economy can first be broken down into the three main sectors of agriculture, industry and services. Agricultural output is derived from individual data on all the major crops and livestock products, industrial output from all the major industrial products and services output from all the major private and public services. Outputs of the three sectors are then aggregated into GDP using information on sectoral output shares.

### **3.1 Agriculture**

For medieval agriculture, the most important source for the output and prices of all major crops and livestock products is the impressive stock of manorial accounts that have survived and been assembled in Bruce Campbell's Medieval Accounts Database.<sup>3</sup> Figure 1 plots decadal averages of the number of sampled manorial accounts per year. The accounts were drawn up using a common template by the reeve who managed the demesne under the supervision of the lord's bailiff or steward.<sup>4</sup> During the first half of the fourteenth century, information is available for 60 to 70 manors for each year, but the numbers fell off sharply in the fifteenth century as lords increasingly decided that it no longer paid to manage their demesnes directly in the post-Black death conditions and preferred to lease out their demesnes.<sup>5</sup> Another problem raised by this source is the bias towards large ecclesiastical estates in the south and east of the country, which means that care must be taken to redress the uneven geographical coverage with an appropriate weighting scheme.

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<sup>3</sup> B. M. S. Campbell, *English Seigniorial Agriculture, 1250-1450* (Cambridge, 2000); B. M. S. Campbell, *Three Centuries of English crop yields, 1211-1491* (2007) [WWW document]. URL <http://www.cropyields.ac.uk>.

<sup>4</sup> Campbell, *English Seigniorial Agriculture*, 2.

<sup>5</sup> Broadberry et al., *British Economic Growth*, 83.

The manorial accounts yield invaluable information on three main variables: (1) the proportion of arable land sown with each crop, (2) the yield for each crop net of the deductions for grain used as seed and as fodder for working animals and (3) stocking densities, or the number of animals per sown acre of arable land for each type of non-working animal. Combining the proportions of land used for each crop with the total sown acreage for the country as a whole yields the sown acreage for each crop. When multiplied with the grain yield for each crop, this yields the total arable output. Multiplying the total sown acreage by the stocking density for each animal type yields the total number of animals. Moving from this to the output of each livestock product then requires additional information on the proportion of sheep producing wool, cattle producing milk and dairy produce and cattle, sheep and pigs producing meat, as well as the yields per animal, obtained largely from the manorial accounts.

Care must be taken in moving from data on demesnes to inferences about the whole of the agricultural sector, since the non-seigniorial sector was always larger than the seigniorial sector and the balance between them varied over time. At its peak, the seigniorial sector accounted for no more than around 25 to 30 percent of all agricultural land.<sup>6</sup> Nevertheless, although evidence on the non-seigniorial sector is more disparate, data do exist to compare with trends in the manorial sector. Postan used tax returns to shed light on the animal stocking densities of demesnes and peasant holdings, while Langdon provided information on the relative numbers and types of draught animals on seigniorial and non-seigniorial lands.<sup>7</sup> More recently, Dodds used tithe records to shed light on annual variations

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<sup>6</sup> Campbell, *English Seigniorial Agriculture*, 26.

<sup>7</sup> M.M. Postan, "Village Livestock in the Thirteenth Century", *Economic History Review*, 15 (1962), 219-249; J. Langdon, "The Economics of Horses and Oxen in Medieval England", *Agricultural History Review*, 20 (1982), 31-40; J. Langdon, *Horses, Oxen and Technological Innovation: The Use of Draught Animals in English Farming from 1066 to 1500*, (Cambridge, 1986).

in grain output and a few tithe series contain wool output.<sup>8</sup> Campbell has found a close correlation between year-on-year fluctuations in crop yields from manorial accounts and annual changes in tithe receipts.<sup>9</sup>

An important variable in the calculation of agricultural output is the total sown acreage for the country as a whole. Broadberry et al. arrived at a benchmark estimate of 8.19 million sown acres in 1290, based on a total arable acreage of 12.75 million, with 35.8 per cent of land fallow.<sup>10</sup> These estimates have been challenged as too low by Clark, but as Broadberry et al. point out, Clark's estimate is more than treble the Domesday estimate, 7 million acres more than Gregory King's estimate for England and Wales in the 1690s and over 4 million acres more than were under the plough in 1871.<sup>11</sup> In magnitude this is an amount of land equivalent in area to one or two counties the size of Yorkshire. So vast an area would inevitably have included much land that was marginal for arable cultivation and inferior in productivity and could only have been brought under the plough at the expense of other land uses, most obviously grassland of one sort or another. Yet maintaining so much extra land in cultivation would have required an additional 0.33 million working animals plus the breeding stock needed to reproduce them and patently could not have been at the expense of the several million acres of grassland that supported the national flock of over 10 million sheep growing wool for export. The Broadberry et al. (2015) figure of 12.75 million acres of arable land in 1290 should therefore be seen as an upper bound measure. Estimates for other years between 1270 and 1500 are obtained by extrapolation from 1290 on the basis of trends

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<sup>8</sup> B. Dodds, 'Estimating Arable Output Using Durham Priory Tithe Receipts, 1341-1450', *Economic History Review*, 58 (2004), 245-285; B. Dodds, *Peasants and Production in the Medieval North-East: The Evidence from Tithes 1270-1536* (Woodbridge, 2007).

<sup>9</sup> B. M. S. Campbell, 'Grain Yields on English Demesnes After the Black Death', in M. Bailey and S. H. Rigby (eds.), *Town and Countryside in the Age of the Black Death: Essays in Honour of John Hatcher* (Turnhout, 2012), 121-174, at 153-4.

<sup>10</sup> Broadberry et al., *British Economic Growth*, 74.

<sup>11</sup> G. Clark, 'Growth or Stagnation? Farming in England, 1200-1800', *Economic History Review*, 71 (2018), 55-81; S. Broadberry, B. M. S. Campbell, A. Klein, M. Overton, and B. van Leeuwen, 'Clark's Malthus Delusion: Response to 'Farming in England 1200-1800'', *Economic History Review*, 71 (2018), 639-64.

in the cropped acreage on demesnes and tithe data in the non-demesne sector.<sup>12</sup> The sown acreage for all crops is shown for a number of benchmark years in Table 1. The main trend is a sharp decline in the sown acreage for wheat, rye and oats after the arrival of the Black Death in the mid-fourteenth century, in line with the catastrophic fall in population.

Arable farming output is obtained by multiplying the amount of land sown with each crop by the grain yield for that crop net of deductions for grain used as seed and as fodder for working animals. National average yields per acre, gross of tithe and seed can be obtained from the Medieval Accounts Database, using regression analysis with dummy variables for each farm, for each region and for each year, following the approach used by Clark to extract national trends for agricultural prices:<sup>13</sup>

$$\ln(YIELD_{it}) = \alpha + \sum_{i=1}^{I-1} \beta_i LOC_i + \sum_{j=1}^{J-1} \gamma_j REG_j + \sum_{t=1}^{T-1} \delta_t YEAR_t + \varepsilon_{it} \quad (1)$$

where  $YIELD_{it}$  is the grain yield in manor or farm  $i$  in year  $t$ ,  $\alpha$  is a constant,  $LOC_i$  is a dummy for the location of each farm,  $REG_j$  is a dummy variable for the region in which each manor or farm is located,  $YEAR_t$  is a dummy for the year and  $\varepsilon_{it}$  is the error term. The dependent variable is entered logarithmically so that the location and regional dummies have the same proportional effect on grain yields in all years. The method produces an estimated national trend in index number form, and the absolute levels of the grain yields are obtained using the regional shares of the sown area in 1290 as weights for the medieval period. The regional shares of the arable acreage are shown in Table 2, while the crop distributions within each region are taken from the Medieval Accounts Database.

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<sup>12</sup> B. M. S. Campbell, K. C. Bartley, and J. P. Power, 'The Demesne-Farming Systems of Post Black Death England: A Classification', *Agricultural History Review*, 44 (1996), 131-79; Dodds, 'Estimating Arable Output'; Campbell, *English Seigniorial Agriculture*; Campbell, *Three centuries of English crop yields*.

<sup>13</sup> G. Clark, 'The Price History of English Agriculture, 1209-1914', *Research in Economic History*, 22 (2004), 41-125.

The weighted national average gross crop yields per acre for wheat are shown in Figure 2, which exhibits a high degree of short run volatility, mainly due to the impact of weather on harvests. This short run volatility has been smoothed out here with a trend based on a 10-year moving average. The main development is a downward trend in yields from around 1300 to the mid-fifteenth century, which is also visible in the yields for other crops. During the medieval period, wheat yields were higher than average in the southern counties and the southeast, barley yields were higher in the southern counties and the midlands, oat yields were higher in the southeast and pulse yields were higher in eastern counties and the midlands.<sup>14</sup>

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 believed that yields were higher on the demesnes as a result of access to better land and more capital, Stone has recently argued on the basis of evidence from Wisbech Barton in Cambridgeshire that yields were around 11 per cent higher in the non-demesne sector, where incentives were stronger for peasants. Sapoznik has made similar claims on the basis of a second Cambridgeshire manor at Oakington.<sup>15</sup> However, this is a narrow evidential base on which to attempt to build a national picture.

Since taking account of Postan's argument that the demesne lands were generally of higher quality means that the direction of the adjustment is unclear, and would anyway be quite small, Broadberry et al. assumed that yields on the demesne sector were representative

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<sup>14</sup> Broadberry et al., *British Economic Growth*, 91-3.

<sup>15</sup> M. M. Postan, "Medieval Agrarian Society in its Prime: England", in M. M. Postan (ed.), *The Cambridge Economic History of Europe, Vol. I: The Agrarian Life of the Middle Ages*, 2<sup>nd</sup> edition, (Cambridge, 1966), 549-632; D. J. Stone, "The Consumption of Field Crops in Late Medieval England", in C. M. Woolgar, D. Serjeantson, D. and T. Waldron (eds.), *Food in Medieval England: Diet and Nutrition* (Oxford, 2006), 21; A. Sapoznik, "The Productivity of Peasant Agriculture: Oakington, Cambridgeshire, 1360-99", *Economic History Review*, 66 (2013), 518-544.

of English agriculture as a whole.<sup>16</sup> 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. 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.

Total arable output net of seed and animal consumption is shown in Table 3. 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.

For pastoral output, a similar procedure to that followed for arable output was undertaken, multiplying the stocking densities per acre for each type of animal by the sown acreage to obtain the number of animals. As with the crop yields, aggregate trends in stocking densities have been obtained from data on individual farms and manors using regression analysis. The regression equation is essentially the same as equation (1), but with the logarithm of the stocking density (STOCKDENS) as the dependent variable rather than the logarithm of the grain yield. The method produces an estimated trend in index number form, and the absolute levels of the stocking densities in benchmark years are obtained as weighted averages of the regional stocking densities, using the regional shares of pastoral farming shown in Table 4. These regional groupings are different from those in arable farming, reflecting the four main types of pastoral farming. Although by 1870 dairying had spread to

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<sup>16</sup> Broadberry et al., *British Economic Growth*.

counties where it had been scarce in 1300, the core activities of farms, especially in the northwestern counties, had shifted towards the fattening of cattle. No particular region stands out as having had higher stocking densities across all livestock.

As with the arable estimates, 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.<sup>17</sup> However, the scale of this effect has been reduced by following Allen 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, mature cattle have been divided into milk and beef animals in the ratio 53 to 47 per cent.<sup>18</sup> 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.<sup>19</sup> 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.<sup>20</sup> This was the number of animals needed to supply the

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<sup>17</sup> M. Overton, and B. M. S. Campbell, "Norfolk Livestock Farming 1270-1740: A Comparative Study of Manorial Accounts and Probate Inventories", *Journal of Historical Geography*, 18 (1992), 377-396, at 388-9.

<sup>18</sup> R. C. Allen, "English and Welsh Agriculture 1300-1850: Output, Inputs and Income", Nuffield College, Oxford (2005), <http://piketty.pse.ens.fr/files/Allen2005.pdf>

<sup>19</sup> M. J. Stephenson, "Wool Yields in the Medieval Economy", *Economic History Review*, 61 (1988), 368-91, at 380.

<sup>20</sup> E.A. Wrigley, "The Transition to an Advanced Organic Economy: Half a Millennium of English Agriculture", *Economic History Review*, 59 (2006), 435-480, at 448.

wool export trade as recorded by the customs accounts and a domestic consumption equivalent of 1.18 square yards per capita *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.<sup>21</sup> 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.

To derive pastoral output from animal numbers also requires information on the proportions of animals producing milk, meat and wool and also the yields per animal. 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, 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 and these ratios are also applied to the medieval period for sheep and pigs, in line with slaughter rates documented by Campbell (1995: 164-167).<sup>22</sup> For cattle, however, slaughter rates were lower in the medieval period because there were few herds kept specifically for beef.

Yields of milk, meat and wool per animal are drawn from a number of sources, including Clark (1991), Allen (2005), Stephenson (1988) and Britnell (2004).<sup>23</sup> Data between

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<sup>21</sup> R. H. Britnell *Britain and Ireland 1050-1530: Economy and Society*, (Oxford, 2004), 417; B. M. S. Campbell, "Benchmarking Medieval Economic Development: England, Wales, Scotland, and Ireland, c.1290" *Economic History Review*, 61 (2008), 896-945.

<sup>22</sup> B.A. Holderness, 'Prices, Productivity, and Output' in G.E. Mingay (ed.), *The Agrarian History of England and Wales, Volume VI: 1750-1850* (Cambridge, 1989), 84-189, at 147; B.M.S. Campbell, 'Measuring the Commercialisation of Seigneurial Agriculture c. 1300', in R.H. Britnell and B.M.S. Campbell (eds.), *A Commercialising Economy: England 1086 to c. 1300*, (Manchester, 1995), 164-7.

<sup>23</sup> G. Clark, "Labour Productivity in English Agriculture, 1300-1860", in B. M. S. Campbell and M. Overton (eds.), *Land, Labour and Livestock: Historical Studies in European Agricultural Productivity* (Manchester, 1991), 211-35; Allen, 'English and Welsh Agriculture 1300-1850'; M. J. Stephenson, "Wool Yields in the Medieval Economy", *Economic History Review*, 61 (1988), 368-91; Britnell, *Britain and Ireland 1050-1530*.

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 5. 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.<sup>24</sup> 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 and Clarkson.<sup>25</sup> 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.

Multiplying the output volumes by their prices yields the total value of net output. The price data are taken largely from Clark.<sup>26</sup> Output can be valued in both current prices and in constant 1700 prices. Constant price output for agriculture as a whole is shown in Figure 4 together with the component series for the arable and pastoral sectors. 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.

The slower decline of pastoral output than arable output meant that the pastoral sector was increasing its share of agricultural output in constant prices during the medieval period.

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<sup>24</sup> F. M. L. Thompson, "Horses and Hay in Britain, 1830-1918", in F. M. L. Thompson (ed.), *Horses in European Economic History: A Preliminary Canter*, (Reading, 1983).

<sup>25</sup> Clark, 'Labour Productivity in English Agriculture'; L.A. Clarkson, 'The Manufacture of Leather', in G.E. Mingay (ed.), *The Agrarian History of England and Wales*, Volume VI: 1750-1850 (Cambridge, 1989), 466-85.

<sup>26</sup> Clark, "The Price History of English Agriculture".

Since relative prices were relatively stable, this meant that the share of the pastoral sector in current prices also increased, as can be seen in Table 6. However, what is perhaps most striking about this table is the already very high share of the pastoral sector in medieval England, rising above 50 per cent after the Black Death. 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 and dairy produce to supplement the less highly processed grain products that made up the bulk of the diet.

### **3.2 Industrial output**

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: textiles and leather; metals; and other industries. 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 for the period 1280-1554.<sup>27</sup> 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.

The metals sector is based on physical output volumes for the tin and iron industries. Tin produced in Cornwall and Devon was the first industry to rise to prominence, largely due to the scarcity of alternative sources of supply within Europe. Annual data on tin output are available with relatively few gaps from Hatcher.<sup>28</sup> The data are ultimately derived from recorded receipts of coinage dues which, given the government's right of pre-emption, can be taken as a reliable guide to aggregate tin output. King provides data on bar iron production

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<sup>27</sup> E. M. Carus-Wilson and O. Coleman, *England's Export Trade, 1275-1547* (Oxford, 1963).

<sup>28</sup> J. Hatcher, *English Tin Production and Trade before 1550* (Oxford, 1973), 156-9.

only for the period from 1490 so that for most of the medieval period, the metal output index is based entirely on tin.<sup>29</sup>

Food processing, construction and book production are grouped together as the relatively heterogeneous group of other industries. Although it would in principle be possible to track the output of particular food processing industries via their specific agricultural inputs such as barley for the brewing industry, wheat for the flour industry and milk for the dairy industry, there would be no reliable basis for weights at this level of disaggregation. Instead, 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).<sup>30</sup> Book production is measured by the index of new English language book titles obtained from the English Short Title Catalogue.<sup>31</sup>

An index of industrial production is constructed from these individual series using value added weights derived from Hoffmann.<sup>32</sup> Although the earliest weights provided by Hoffmann are for 1700, these can be extended back in time using output indices for the individual industries. It should be noted 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.<sup>33</sup> The logic here is that since metals grew faster than textiles

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<sup>29</sup> P. King, "The Production and Consumption of Bar Iron in Early Modern England and Wales", *Economic History Review*, 58 (2005), 1-33.

<sup>30</sup> R. Morris, *Cathedrals and Abbeys of England and Wales: The Building Church, 600-1540* (London, 1979), 179.

<sup>31</sup> [http://estc.bl.uk/F/?func=file&file\\_name=login-bl-list](http://estc.bl.uk/F/?func=file&file_name=login-bl-list)

<sup>32</sup> W.G. Hoffmann, *British Industry 1700-1950* (Oxford, 1955).

<sup>33</sup> N.F.R. Crafts. and C.K. Harley, "Output Growth and the Industrial Revolution: A Restatement of the Crafts-Harley View", *Economic History Review*, 45 (1992), 703-30, at 706-7, 722.

between 1300 and 1700, their share of total industrial output must have increased and that of textiles decreased between these two dates. Given data on output indices based on 1700 and the value added shares in the base year of 1700, implied value added shares in earlier years can be inferred using the output indices.<sup>34</sup> The implied weights for 1500 are 64.1 per cent for textiles & leather, 25.2 per cent for metals and 10.7 per cent for other industries.

Figure 5 plots the aggregate index of industrial production together with the component series for textiles & leather, metals and other industries. Overall industrial output followed a similar path to pastoral agriculture after the Black Death, as the collapse of population led to rising real wages and GDP per capita, and rising living standards led to an increased share of industrial products in household demand. This effect was most pronounced in textiles, leather and metals, while the demand for other industrial outputs declined in line with population.

### **3.3 Service sector output**

The service sector has received much less attention from economic historians than agriculture and industry. The approach pioneered by Deane and Cole to estimate service sector output in eighteenth-century Britain is followed here, but with some modifications.<sup>35</sup> For England in the period 1270-1500, services are broken down into commerce, domestic service and housing, 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

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<sup>34</sup> Broadberry et al., *British Economic Growth*, 131-6.

<sup>35</sup> P. Deane and W.A. Cole, *British Economic Growth, 1688-1959: Trends and Structure*, 2nd edn, (Cambridge, 1965).

shipping tonnage, from Carus-Wilson and Coleman.<sup>36</sup> 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, taken from Letters.<sup>37</sup> Financial intermediation is measured by the inverse of the velocity of circulation, derived from Mayhew, building on Cameron's finding of a declining velocity over the long run.<sup>38</sup> The inverse of velocity is interacted with population as a scaling factor to derive an index of financial sector activity. Deane and Cole assumed that domestic service and housing grew in line with population, and the same procedure has been followed here.<sup>39</sup> Real government revenue from O'Brien and Hunt is available for the whole period from the European State Finance Database.<sup>40</sup>

An index of service sector production is constructed from these individual series using value added weights derived from Crafts.<sup>41</sup> Although the earliest weights provided by Crafts are for 1700, these can be extended back in time using output indices for the individual industries, as described in the previous section. The implied weights for 1500 are 66.7 per cent for domestic service and housing, 17.0 per cent for government and 16.3 per cent for commerce. The resulting series for total service sector output is plotted in Figure 6, together with the component series for domestic service and housing, government and commerce. Total service sector output declined in line with population after the Black Death, driven by a sharp fall in domestic service and housing. However, commerce followed a similar path to

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<sup>36</sup> Carus-Wilson and Coleman, *England's Export Trade*.

<sup>37</sup> S. Letters, 'Gazetteer of Markets and Fairs in England and Wales to 1516', Centre for Metropolitan History (2005), <http://www.british-history.ac.uk/source.aspx?pubid=272>

<sup>38</sup> N.J. Mayhew, 'Money Supply and GDP in England 1085-1700', XVth World Economic History Congress, (Utrecht, 2005), Session E4, <http://www.wehc2009.org/programme.asp?day=2&time=4>; R. Cameron, 'England, 1750-1844', in R. Cameron (ed.), *Banking in the Early Stages of Industrialization: A Study in Comparative Economic History* (New York, 1967), 15-59.

<sup>39</sup> Deane and Cole, *British Economic Growth, 1688-1959*.

<sup>40</sup> P.K. O'Brien and P.A. Hunt, 'England, 1485-1815', in R. Bonney (ed.), *The Rise of the Fiscal State in Europe, c.1200-1850* (Oxford, 1999), 53-100; <http://www.le.ac.uk/hi/bon/ESFDB/frameset.html>

<sup>41</sup> N.F.R. Crafts, *British Economic Growth during the Industrial Revolution*, (Oxford, 1985).

pastoral agriculture and industry, as it benefitted from the rising per capita prosperity. Government services showed a powerful tendency to increase whenever the nation was mobilised for war. The campaigns waged by the first three Edwards in Wales, Scotland, Ireland and France therefore generated a dramatic surge in government revenue and service provision between the late thirteenth and mid-fourteenth centuries.

### **3.4 Extensive growth: Aggregate GDP and population**

The three real output series for the agricultural, industrial and service sectors can be combined to produce aggregate GDP using a set of sectoral weights which capture the changing structure of the economy. The sectoral shares of current price GDP for England 1381-1700 and Great Britain 1700-1870 are shown in Table 7, taken from Broadberry et al.<sup>42</sup> For the medieval period, the 1381 weights are used for 1270-1450 and the 1522 weights for 1450-1550. The weighting scheme is derived from a reconstruction of nominal GDP by sector. Real output trends from the sectoral series described earlier 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<sup>43</sup>.

Broadberry et al. use evidence of tenant numbers on individual manors to establish trends in population for the period between 1086 and 1541, ensuring a balance between the relatively high density core of regions to the south and east of a line running roughly from the Wash to the Severn Estuary, and the lower density of peripheral regions to the north and west of this line, including southwest England as well as the western and northern regions.<sup>44</sup> The approach was pioneered by Hallam for the period 1086-1315, and has been reworked for this

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<sup>42</sup> Broadberry et al., *British Economic Growth*, 194.

<sup>43</sup> S. Horrell, J. Humphries, and M. Weale, 'An Input-Output Table for 1841', *Economic History Review*, 47 (1994), 545-66.

<sup>44</sup> Broadberry et al., *British Economic Growth*, 20.

period using additional material, and then extended to the period after 1315.<sup>45</sup> Compared with Hallam, the estimates in Table 8 show a slightly smaller population increase between 1086 and the late thirteenth century, but a similar pattern of faster growth in the twelfth than in the thirteenth century. The annual population growth rates are monitored to provide a check on the credibility of the estimates by demonstrating that successive benchmark estimates do not require implausible rates of change. Significantly, during the periods of population expansion, the annual growth rates do not exceed the firmly established rates seen over sustained periods between the mid-fifteenth and early eighteenth centuries, and are well below the rates observed from the second half of the eighteenth century.<sup>46</sup>

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).<sup>47</sup> As Overton and Campbell 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. A significant advantage of the Broadberry et al. (2015) population estimates is that they have been derived jointly with a full range of other economic data and cross-checked for compatibility.

### **3.5 Intensive growth: GDP per capita**

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<sup>45</sup> H. E. Hallam, "Population Movements in England, 1086-1350", in H. E. Hallam (ed.), *The Agrarian History of England and Wales*, Vol. II, 1042-1350, (Cambridge, 1988), 508-93.

<sup>46</sup> E. A. Wrigley and R. S. Schofield, *The Population History of England, 1541-1871: A Reconstruction*, (Cambridge, 1989).

<sup>47</sup> M. Overton, and B.M.S. Campbell, 'Production et productivité dans l'agriculture anglaise, 1086-1871', *Histoire et Mesure*, 11 (1996), 255-97; Postan, 'Medieval Agrarian Society in its Prime'; R.M. Smith, 'Demographic Developments in Rural England, 1300-1348: A Survey', in B.M.S. Campbell (ed.), *Before the Black Death: Studies in the "Crisis" of the Early Fourteenth Century* (Manchester, 1991), 25-77.

To estimate GDP per capita, the aggregate GDP series is divided by population. Figure 7 plots the three aggregate series of GDP, population and GDP per capita for the period 1270-1500, based on 1500=100. This figure makes clear the central role played by the Black Death in determining the size of the English medieval economy. In 1270, England supported a population of approximately 4.37 million and the demographic boom that had brought about an increase of more than two-and-a-half fold since 1086 was almost at an end. England's population was already stagnating by the time the Great Famine struck in 1315-22, although it was the Black Death a generation later that proved to be the decisive demographic turning point. Four successive plague epidemics reduced the population by almost half between 1348 and 1377, shrinking it to a relatively securely documented 2.5 million. Numbers continued to dwindle until the mid-fifteenth century when decline finally bottomed out and hitherto rising real wages reached a plateau and stabilized for the next 60 years. The low-level equilibrium thereby established persisted until the final decades of the fifteenth century when, in defiance of periodic surges in disease mortality, signs of incipient demographic recovery became apparent.

Between 1270 and the outbreak of the Black Death in 1348-9 real GDP fluctuated a great deal but without trend. In the aftermath of that great demographic disaster, GDP turned down sharply and continued to drift downwards for the next hundred years to a temporal low in the 1430s, by which point the population had fallen by around 60 per cent of its pre-Black Death peak. Decline was then arrested and for the next 40 or 50 years real GDP stabilised at this much-reduced level. Recovery seems to have begun from the 1480s but was fitful and slow until the end of the fifteenth century.

Although the Black Death was clearly a strongly negative shock for population and GDP, its effect on GDP per capita was very positive. The population declined by 46 per cent during 1348-9, leaving survivors with more land and capital, while the labour market effects of the shortage of labour relative to land and capital benefitted even those without wealth, as real wages rose sharply. An immediate gain of 30 per cent in GDP per capita was followed by further increase over the rest of the fourteenth century as sequel outbreaks of plague thwarted any demographic recovery. The annual rate of GDP per capita growth between the 1340s and the 1400s averaged 0.54 per cent.<sup>48</sup>

### **3.6 An alternative Malthusian view**

There have also been attempts to estimate British national income from the income side. This involves the estimation of labour income from data on employment and real wages, which can then be combined with income from capital and rental income from land. In the absence of readily available data on the returns to capital and land, the real wage has been the most popular alternative to GDP per capita since the pioneering work of Phelps Brown and Hopkins, who provided an annual series for England back to the mid-thirteenth century.<sup>49</sup> However, this approach requires care because the nominal wage data are most readily available as daily wage rates, which do not come with information on the number of days worked per year. As Angeles points out, there can be substantial divergence between the trends in real wages and GDP per capita as a result of a change in the number of days worked per year, a shift in labour's share of income or a change in the relative price of consumption goods<sup>50</sup>. He shows that there was considerable divergence in English GDP per capita and real

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<sup>48</sup> Broadberry et al., *British Economic Growth*, 204.

<sup>49</sup> H. Phelps Brown, and S. V. Hopkins, 'Seven Centuries of Building Wages', *Economica*, 22 (1955), 195-206; H. Phelps Brown. and S. V. Hopkins, 'Seven Centuries of the Prices of Consumables, Compared with Builders' Wage-rates', *Economica*, 23 (1956), 296-314.

<sup>50</sup> L. Angeles, 'GDP per capita or Real Wages? Making Sense of Conflicting Views on Pre-industrial Europe', *Explorations in Economic History*, 45 (2008), 147-163

wages between 1700 and 1820 due primarily to an “industrious revolution” (or increase in days worked per year), with a distributional shift against labour and an increase in the relative price of food also having significant effects. Broadberry et al. use the same framework to explain the divergence between the daily real wage rate and GDP per capita between 1270 and 1870. The key factor explaining the divergence between the trend growth of GDP per capita and the stationarity of the real wage was the long drawn-out increase in days worked per year between the post-Black Death period and the Industrial Revolution. Subsequent research by Humphries and Weisdorf has confirmed this, with their estimates of days worked per year derived from a comparison of daily wages with annual wages from long-term contracts.<sup>51</sup> Clark’s British GDP per capita series, which adds income from capital and land rents to wage income derived on the assumption of constant days worked per year, follows a very similar path to daily real wages, and is therefore not a reliable guide to long-term growth between 1250 and 1870.<sup>52</sup>

#### **4. THE MEDIEVAL ECONOMY AND LONG-RUN ECONOMIC DEVELOPMENT**

Figure 8 provides a convenient summary of how statistical research of the medieval economy can transform our understanding of long run economic development in Britain. A popular view before the recent research on medieval historical national accounting was that economic growth began with the Industrial Revolution from the mid-eighteenth century and that nothing interesting happened from an economic viewpoint before then. However, we can now see that there were in fact two very significant earlier episodes of per capita income growth in Britain. During the medieval period, per capita income increased by about 40 per cent in the half century after the arrival of the Black Death in 1348, while during the early modern

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<sup>51</sup> J. Humphries, and J. Weisdorf, ‘Unreal Wages? Real Income and Economic Growth in England, 1260-1850’, *Economic Journal*, 129 (2019), 2867-87.

<sup>52</sup> G. Clark, *A Farewell to Alms: A Brief Economic History of the World*, (Princeton, 2007); G. Clark, ‘The Macroeconomic Aggregates for England, 1209-1869’, *Research in Economic History*, 27 (2010), 51-140.

period, per capita incomes increased by around 40 per cent again in the second half of the seventeenth century, following the Civil War. However, notice that during both these episodes, population was declining, so this was not modern economic growth as defined by Kuznets, which requires positive growth of both population and per capita income at the same time.<sup>53</sup> This is because growing per capita incomes by killing off a country's population is obviously not a sustainable long run strategy. However, we can see progress towards modern economic growth between the fourteenth and seventeenth centuries since although the per capita income growth was fairly similar in the two episodes, the decline in population during the seventeenth century, caused by the onset of more deadly epidemic diseases, was much milder than the catastrophic population collapse caused by the Black Death. Britain finally made the transition to modern economic growth in the eighteenth century as GDP per capita continued to increase when positive population growth returned.

This view of long run development before the Industrial Revolution is further bolstered by evidence of the changing structure of the British economy already encountered in Table 7. Note that agriculture's share of output declined in importance well before the eighteenth century, while the shares of industry and services increased, as would be expected for a developing nation. However, although industry increased its share of nominal GDP more rapidly than services until 1700, this ceased to be the case during the Industrial Revolution period. This may at first sight seem surprising, but can be explained by a decline in the relative price of industrial goods, as technological progress increased productivity and drove down prices. By contrast, the more modest productivity improvement in services led to an increase in their relative price, so that the share of services in nominal GDP increased more rapidly than the share of industry after 1700.

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<sup>53</sup> S. Kuznets, *Modern Economic Growth: Rate, Structure and Spread* (New Haven, 1966).

Whilst the GDP series on an annual basis only starts in 1270, a number of researchers have used the data from the Domesday Book to estimate GDP for the year of 1086. The most recent estimate by Walker provides a figure for English GDP per capita which can be compared with GDP per capita in 1348 on the eve of the Black Death pandemic.<sup>54</sup> It turns out that in real terms, GDP per capita was roughly the same in the two years. However, because the price level was substantially higher in 1348, nominal GDP per capita was also higher. Also, since population had grown from 1.71 to 4.81 million over the same period, GDP was higher in both nominal and real terms.

What does all this mean for the size of the medieval English economy? Between 1086 and 1348 there was extensive growth but without any intensive growth, as the population expanded, but living standards remained broadly unchanged. The net effect was a substantial increase in real GDP proportionally in line with the increase in population, by a factor of 2.8. However, this was followed by a period of intensive growth with negative extensive growth after the arrival of the Black Death. From 1348 the population declined from 4.81 million to a trough of 1.90 million by 1450, which put downward pressure on the size of the economy, at the same time as the rise of living standards put upward pressure on it. The net effect was that real GDP almost halved in size between 1348 and 1450.

## **5. CONCLUSIONS**

This chapter draws on the sources discussed in a number of previous chapters to assess the size of the English medieval economy. One way to measure the size of the economy is to chart the path of population, which increased from 1.71 million in 1086 to reach a peak of 4.8 million in 1348 before the arrival of the Black Death, which reduced the population to a trough of 1.9 million by 1450. As the number of people living in England increased, the size

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<sup>54</sup> Walker, 'National Income in Domesday England'.

of the economy increased. However, this offers only a partial view because it takes no account of changing living standards. An economy can grow by adding more people at the same standard of living (extensive growth), but it can also grow by increasing the living standards of the existing population (intensive growth), or indeed by some combination of both these changes. A full assessment of the size of the economy therefore requires an estimate of the path of aggregate output, measured by gross domestic product (GDP).

The chapter begins by explaining how it is possible to reconstruct GDP for medieval England from the available statistical evidence that was collected at the time and has survived. Some of these original sources, which are much richer than is commonly perceived, have been described in the earlier chapters of the book, particularly those relating to the reconstruction of population and agricultural output. The basic approach is to construct annual time series for output of the three main sectors of the economy: agriculture, industry and services. These series are then aggregated together using weights derived from a reconstruction of the structure of the economy in benchmark years.

The reconstructed English GDP can then be divided by population to arrive at GDP per capita, and all three series can be considered together to provide a full picture of the evolving size of the medieval economy. This makes clear the central role played by the Black Death. As the population declined from a peak just below 5 million in 1348 to a mid-fourteenth century low point of under 2 million, GDP also declined, but only by less than half. As a result, GDP per capita increased by around 40 per cent. Thus what seemed like a huge negative shock when examined in terms of population and GDP turned out to be a positive shock when viewed in terms of GDP per capita. Those who survived found

themselves with more land and capital or, if they were landless, were able to benefit from higher real wages due to the shortage of labour.

The chapter ends by showing how statistical research of the medieval economy can transform our understanding of the long run development of Britain. Broadberry et al. (2015) have shown how the medieval estimates of GDP can be linked up with estimates for the early modern and modern periods to provide a continuous series for the period 1270-1870. The discovery of a sustained increase in GDP per capita after the Black Death turns out to have been the first step on the road to modern economic growth. Rather than following the Malthusian path of a return to lower living standards as population recovered, the British economy remained on a plateau of higher GDP per capita before experiencing another half century of growth during the second half of the seventeenth century. Since population fell slowly during the second half of the seventeenth century, this was still not a period of Kuznetsian modern economic growth, which requires positive growth of population as well as GDP per capita. This only occurred in Britain after 1700.

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

	Wheat	Rye/ Maslin	Barley/ Dredge	Oats	Pulses	Total sown	Fallow arable	Total arable
1270	2.21	0.72	1.23	2.94	0.29	7.40	5.13	12.52
1300	2.68	0.60	1.27	3.16	0.45	8.16	4.56	12.72
1380	1.83	0.36	1.22	1.87	0.47	5.75	3.89	9.64
1420	1.61	0.32	1.17	1.66	0.45	5.21	3.53	8.75
1450	1.53	0.31	1.15	1.59	0.44	5.03	3.41	8.44

Source: Broadberry et al., *British Economic Growth*, 89, derived from Medieval Accounts Database.

**TABLE 2: Regional shares of the national sown area in 1290 (%)**

Region	Counties	1290
East Anglia	Norfolk and Suffolk	10.7
Eastern counties	Bedfordshire, Cambridgeshire, Essex, Hertfordshire, Huntingdonshire, Lincolnshire	18.2
Southern counties	Berkshire Gloucestershire, Hampshire, Herefordshire, Wiltshire, Worcestershire	14.9
Southwest	Cornwall, Devon, Dorset, Somerset	10.7
Southeast	Kent, Middlesex, Surrey, Sussex	9.0
Midlands	Buckinghamshire, Leicestershire, Northamptonshire, Oxfordshire, Rutland, Warwickshire	11.9
North	Cheshire, Cumberland, Derbyshire, Durham, Lancashire, Northumberland, Nottinghamshire, Shropshire, Staffordshire, Westmorland, Yorkshire	24.6

Source: Broadberry et al., *British Economic Growth*, 88.

**TABLE 3: English arable output net of seed and animal consumption in million bushels (10-year averages)**

	Wheat	Rye	Barley	Oats	Pulses
1270s	18.85	8.94	14.44	20.45	0.44
1300s	20.88	5.95	14.91	19.12	1.43
1350s	12.02	2.72	10.91	8.93	0.95
1400s	10.35	2.02	12.56	7.29	0.98
1450s	7.69	2.80	9.69	8.58	0.82

Source: Broadberry et al., *British Economic Growth*, 98, derived from Medieval Accounts Database.

**TABLE 4: Regional weights for the pastoral sector by type of farming and year**

Type of Pastoral Farming	Counties	%
Region 1: Mixed enterprises with some dairying on grass / mixed husbandry	Essex, Herefordshire	7.2
Region 2: Fattening on arable, leys and grass/ mainly cattle based husbandry	Bedfordshire, Cambridgeshire, Huntingdonshire, Lincolnshire, Norfolk, Suffolk, Yorkshire (East Riding)	27.7
Region 3: Rearing with some fattening / extensive mixed husbandry	Cheshire, Cornwall, Cumberland, Derbyshire, Devon, Dorset, Durham, Hampshire, Gloucestershire, Lancashire, Leicestershire, Northumberland, Nottinghamshire, Shropshire, Somerset, Staffordshire, Westmorland, Wiltshire, Yorkshire (North and West Ridings)	42.1
Region 4: Primarily dairying / cattle husbandry	Berkshire, Buckinghamshire, Herefordshire, Kent, Middlesex, Northamptonshire, Oxfordshire, Rutland, Sussex, Surrey, Warwickshire, Worcestershire	23.0

Source: Broadberry et al., *British Economic Growth*, 101-2.

**TABLE 5: 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

Source: Broadberry et al., *British Economic Growth*, 112, derived from Medieval Accounts Database.

**TABLE 6: Current price output shares in English agriculture, 10-year averages (%)**

	Arable	Pastoral
1270s	60.1	39.9
1300s	51.2	48.8
1350s	48.8	51.2
1400s	46.3	53.7
1450s	38.4	61.6

Source: Broadberry et al., *British Economic Growth*, 116-17, derived from Medieval Accounts Database.

**TABLE 7: Sectoral shares in current price GDP, England 1381-1700 and Great Britain 1700-1870 (%)**

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
1700	England and 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

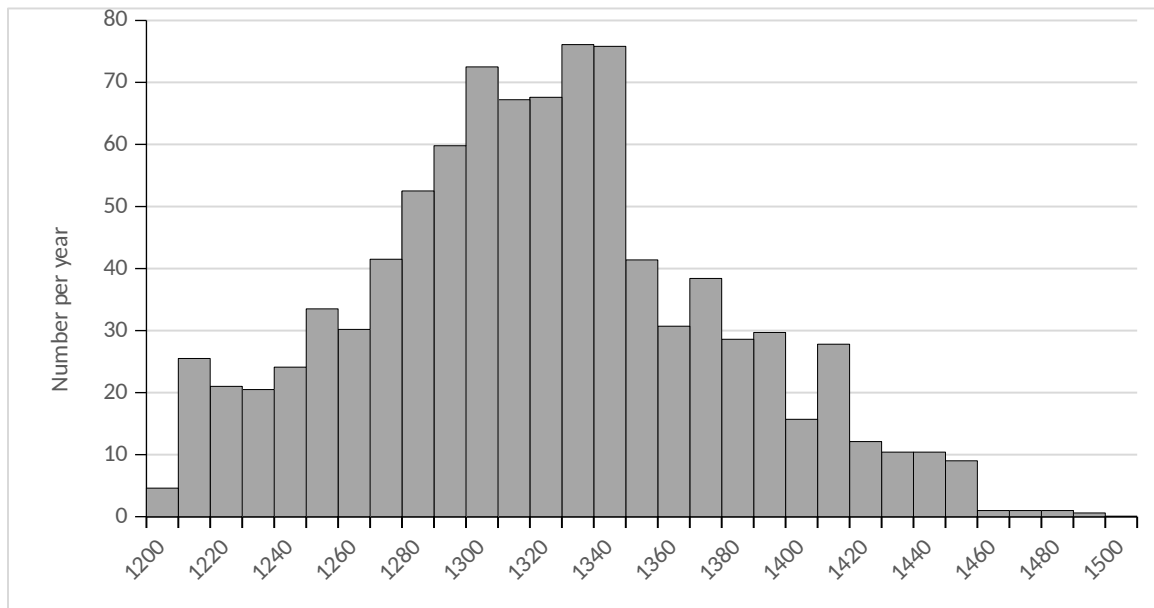
Source: Broadberry et al., *British Economic Growth*, 344.

**TABLE 8: English population, 1086-1541 (millions)**

Year:	Total population:	Year:	Total population:
1086	1.71	1348	4.81
1190	3.10	1351	2.60
1220	3.97	1377	2.50
1250	4.23	1400	2.08
1279	4.43	1430	2.02
1290	4.75	1450	1.90
1315	4.69	1522	2.35
1325	4.12	1541	2.83

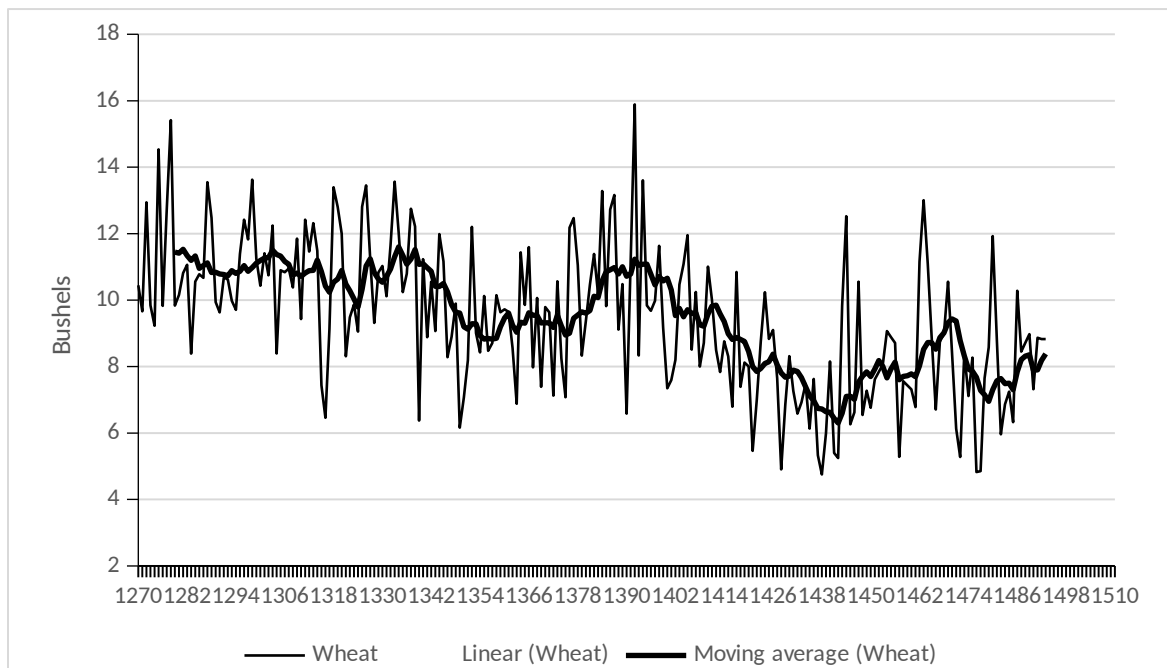
Source: Broadberry et al., *British Economic Growth*, 20.

**FIGURE 1: Number of sampled manors per year in the Medieval Accounts Database (decadal averages)**



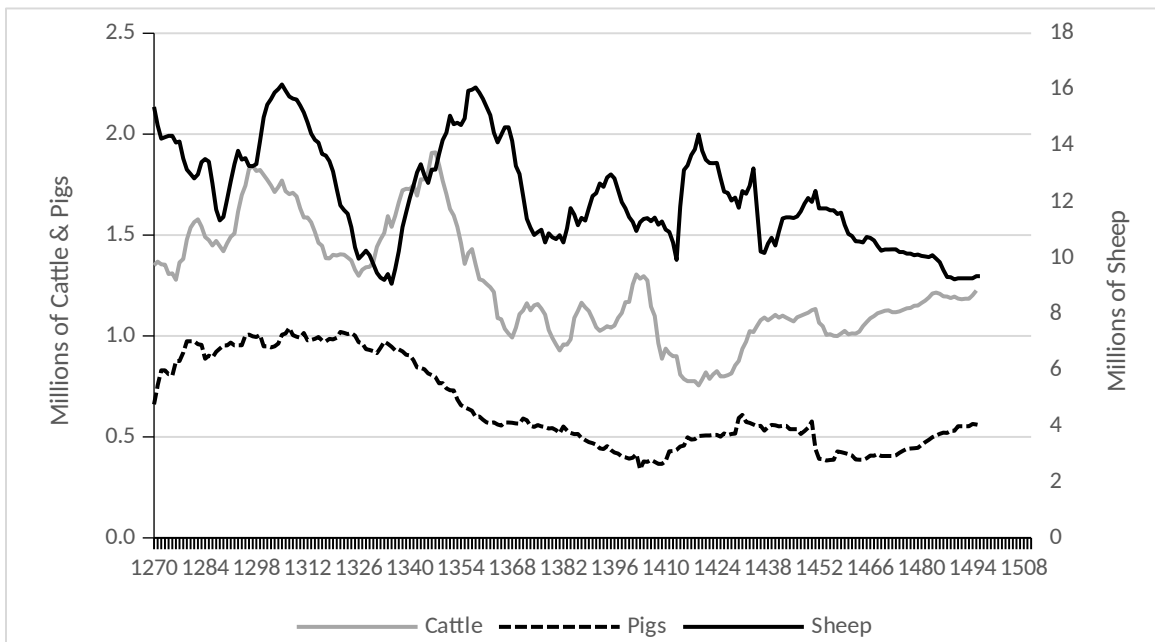
Source: Broadberry et al., *British Economic Growth*, 81.

**FIGURE 2: English weighted national average gross wheat yields per acre (bushels, log scale)**



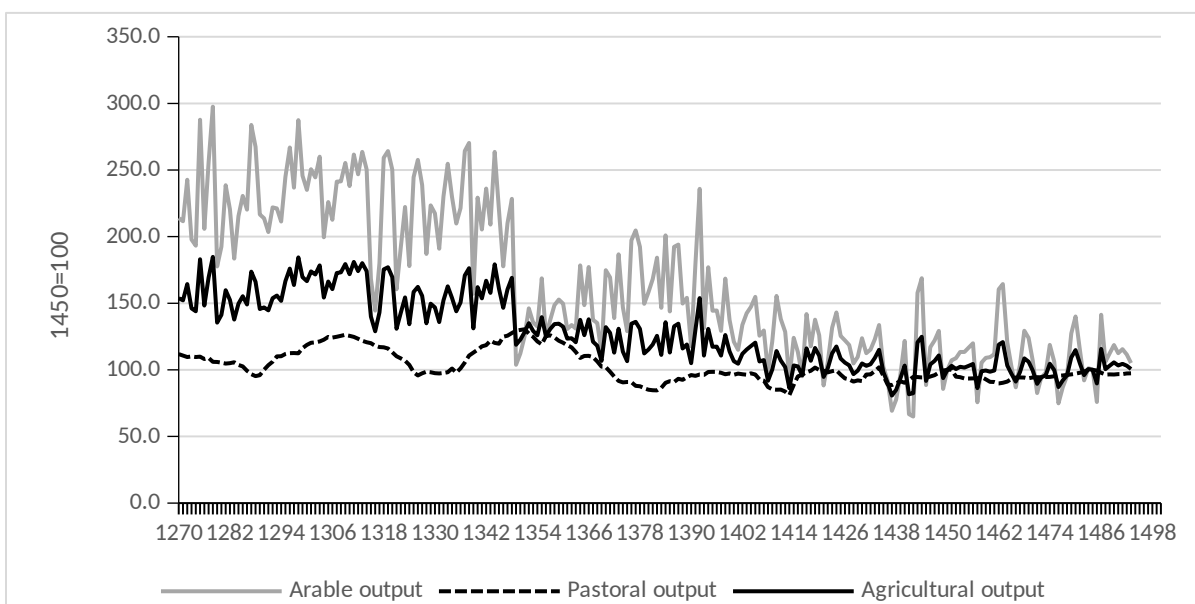
Source: Broadberry et al., *British Economic Growth*, 95, , derived from Medieval Accounts Database.

**FIGURE 3: Numbers of non-working livestock in English farming (millions, 10-year moving averages)**



Source: Broadberry et al., *British Economic Growth*, 107, derived from Medieval Accounts Database.

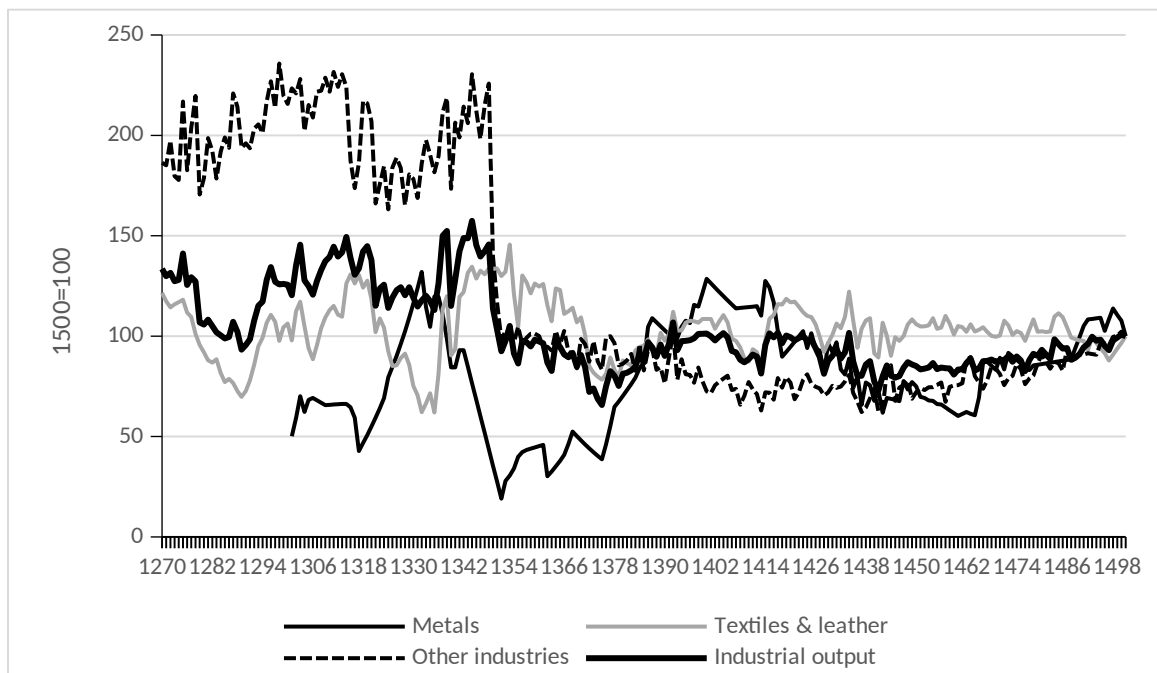
**FIGURE 4: English arable, pastoral and total agricultural output (1450=100)**



Source: Derived from Broadberry et al., *British Economic Growth*, 114, rebased on 1450=100.

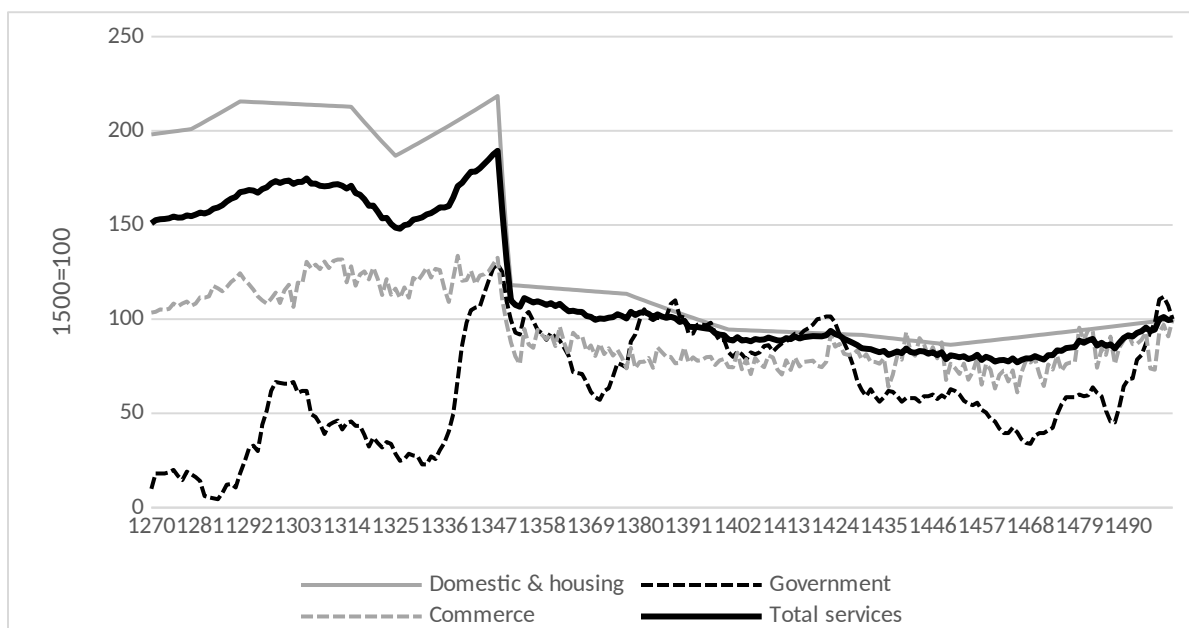


**FIGURE 5: English industrial production (1500=100)**



Source: Derived from Broadberry et al., *British Economic Growth*, 157, rebased on 1500=100.

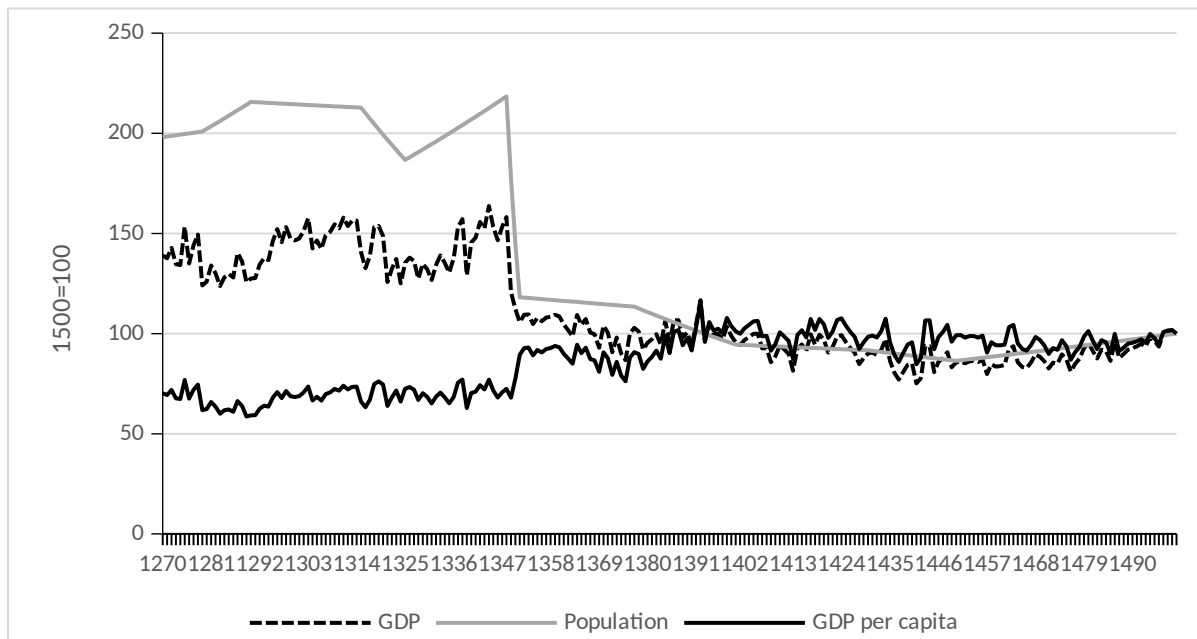
**FIGURE 6: English service-sector output (1500=100)**



Source: Derived from Broadberry et al., *British Economic Growth*, 163, rebased on 1500=100.

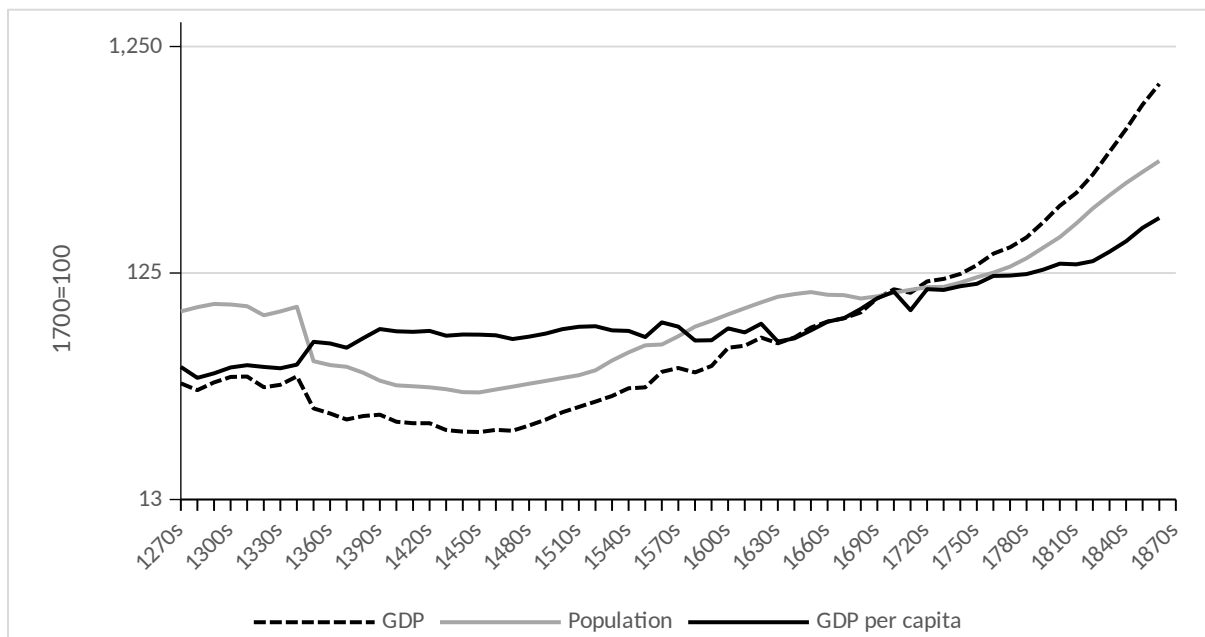


**FIGURE 7: Real GDP, population and real GDP per capita, England 1270-1500 (1500=100)**



Source: Derived from Broadberry et al., *British Economic Growth*, 204, rebased on 1500=100.

**FIGURE 8: Real GDP, population and real GDP per capita, England 1270-1700 and Great Britain 1700-1870 (averages per decade, log scale, 1700 = 100)**



Source: Broadberry et al., *British Economic Growth*, 204.

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