The Long March of History: Farm Wages, Population and Economic Growth, England 1209-1869

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The Long March of History: Farm Wages, Population and Economic Growth, England 1209-1869[1]

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The wage and price history of pre-industrial England is uniquely well documented. England achieved substantial political stability by 1066. There was little of the internal strife that proved so destructive of documentary history in other countries. Also England's island position and relative military success protected it from foreign invasion, except for the depredations of the Scots along the northern border. England further witnessed the early development of markets and monetary exchange. In particular though surviving reports of privately paid wages exist only from 1208-9, the payment of money wages to workers was clearly already well established by that date. A large number of documents with such wages and prices survive from then on in the records of churches, monasteries, colleges, charities, and government.

These documents have been the basis of many studies of pre-industrial wages and prices. But comparatively few of these studies have focused on the wages of the majority of workers in

[1] The research in this paper was funded by NSF grants SES 91-22191 and SES 02-41376. I thank both Joyce Burnette and John Munro for their great generosity in sharing data on wages they assembled from manuscript sources with me. John Munro also shared with me his entries of threshing payments and day wages for the

England before 1800, those in agriculture. And none of the farm wage studies give a consistent measure of both nominal and real wages over the long pre-industrial era.[2] It is impossible to even get an estimate of real farm day wages in 1300 compared to 1800 using these sources without having to chain together five different sources.

Assembling the available evidence on farm wages, including both new manuscript material and unpublished material from the archives of Lord Beveridge and David Farmer, this paper constructs a consistent series for the estimated day wages of male farm labourers from 1209 to 1869. Dividing nominal wages by an index of the prices of farm output the paper estimates also the marginal product of labour (MPL) in agriculture.[3] This derivation assumes that cultivators hired labour up to the point where the day wage equaled the value of the extra output gained from an extra day of labor input. However the paper shows that cultivators did respond to the cost of labor when making decisions about how much to employ even for the medieval period. The paper further estimates the purchasing power of the day wage for the goods bought by farm labourers, which is of course their real wage. The nominal and real wages by year are reported in the appendix.

The second part of the paper explores the implications of these series for English economic history. The MPL estimate can be used to get an idea of output per worker in agriculture over time. They suggest some gains in output per worker between 1300 and 1800, but much less than many authors estimate.[4] They also suggest circa 1450 output per worker in agriculture in England was as high as in 1850.

Winchester estates from the Beveridge Archive at LSE. Without their gifts this paper would be considerably diminished.

[2]Beveridge, 'Wages', gives piece rates and day wages by decade for farm workers on the Winchester estates 1209-1453, but no cost of living measures. Farmer, 'Prices and Wages', gives annual piece rates only for 1209-1474, and a limited cost of living measure. Bowden, 'Appendix', gives decadal estimates of day wages from 1450 to 1750, sometimes drawn only from Oxford and Cambridge, but again with very imperfect cost of living measures.

[3] The price index is from Clark, 'Price History'.

[4] See, for example, Wigley, 'Transition'.

But the huge swings evident in the MPL suggest that output per worker alone is a poor guide to agricultural efficiency. To say anything we need to know the number of workers in agriculture, or failing that overall population. The paper also estimates a decadal series for population in England from 1200 to 1530. I show the validity of this series by correlating it with the MPL from 1250-1530. The close match argues strongly in favor of this series, and for the conclusion that agricultural efficiency remained unchanged from 1250 to 1530. With the modest assumption of no efficiency advance between the 1520s and 1540s it is also possible to fix the implied level of population for the years before 1530. The suggested peak medieval population is 6 million, at the high end of estimates in the literature and in line with the views of M. M. Postan and, more recently, Richard Smith.[5] The MPL series rejects the more recent revisionism of Bruce Campbell and Ian Blanchard which suggests a maximum medieval population of 4-4.5 million.[6] If the index were set to the level of 4 million in 1300, as suggested by Campbell, then it would generate implausible implications for the years 1500-1540. The implied level of population in the 1520s would be 1.6 million, which would have to grow to 3 million by the 1540s: a rate of 3 percent per year. At the same time as this unprecedented population growth agricultural productivity would have to advance substantially just in these years to keep the MPL from falling sharply. A new population estimate that explicitly incorporates the evidence of the MPL is proposed by decade for the years 1250-1540.

Finally the paper shows that the MPL and real wage estimates, combined with what we know about population, suggest stasis both in agricultural technology and in the general efficiency of the economy from 1250 to at least 1600. This was followed by a period of efficiency growth that preceded the Industrial Revolution. The only other period before 1800 where the economy potentially experienced efficiency advance is in the early thirteenth century.

[5] Smith, 'Human Resources', pp. 189-91.
[6] Campbell, *English Seigniorial Agriculture*, p. 403; Blanchard, *A Concept too Many*, pp. 36-8.

The real wage evidence is consistent with the Malthusian model of the determination of incomes and population levels for England all the way from 1200 to 1800. Living standards were determined by fertility and mortality rates. And population adjusted to these living standards. There is no sign of any secular trend towards higher living standards in the pre-industrial era.

Nominal Day Wages

Column 2 of table 1 summarizes the numbers of places for which there is day wage evidence, by decade. Explicit evidence on farm day wages begins only in the 1240s, and then on a limited basis. The evidence is also thin for 1460-1540. To supplement the day wage evidence payments per bushel for threshing grain were used. Such piece rate payments were more abundant for the middle ages than day wages. Column 3 of table 1 shows the numbers of places contributing information on threshing payments by decade. Such threshing payments are available back to 1208-9 on some Winchester manors. In the years 1460 to 1540 the threshing evidence, though limited, helps fill out the scant day wage evidence.

To combine these two sources into a day wage estimate a regression combining day wages and threshing piece rate payments is employed. Hand threshing as a task did not change technologically from 1209 to 1850. However at times when day wages were high relative to grain prices the threshing payment per bushel fell relative to the day wage. Assuming piece and day workers earned the same wage per day the implied number of bushels threshed per day thus changed over time. The regression accommodates this by using the threshing payments only to fill in the wage series, but not determine its long run level. The only exception is the years before 1349 when it is assumed that threshing rates were constant since real wages varied by more modest amounts in this interval. Wages were sometimes quoted by season so allowance was made for seasonal differences in wages. The unit of observation was the average payment in

a given season of a given year and place for a particular type of work. Treated this way the 35,000 records in the wages database reduced to 19,417 observations. Table 2 shows the composition of the various types of observation in this sample. Direct day wage quotes provide less than half the observations.

The average day wage varied widely by location. In the medieval period, for example, day wages on the Westminster manors of Eybury, Hyde, and Knightsbridge near London were about 28 percent higher than average wages on a selection of the Winchester manors. In years where there are few wage observations sampling error can thus be significant. There were also regional differences in wage trends, with the north in particular showing more wage growth over time. In the regression fixed effects for location are included to control for persistently higher wage levels in areas near towns. Time trends for the north, midland and south west regions were included to control for different regional wage trends.

The appendix reports the exact specification of the regression, and the values of the major control variables estimated. A comparison of the estimated level of this wage series with the broad cross sections of wages available in the years 1767-1770 (from Arthur Young), 1832 (from the Poor Law Report) and 1849-50 and 1859-60 (from the Gardeners' Chronicle and Agricultural Gazette) reported in table 3 suggests that it averages 4.7 percent below the national farm wage. The reason may be that the benchmark averages include allowances for the money value of beer given to workers at work, which the data in this sample generally does not include. The final nominal wage series was adjusted upwards in all years by 4.9 percent to fit these benchmarks. Once that is done the adjusted series fits the benchmarks well, as table 3 shows. Appendix table A2 records the resulting estimated national day wage outside hay and harvest by year.

Figure 1 shows the raw average day wage by decade, not controlling for place or location compared to the estimated national wage derived from the regression. It is noticeable that the

national nominal day wage estimated here is typically 80-85 percent of the raw averages before 1700. The source of this deviation is two fold. Wages earlier tended to be drawn more heavily from high wage farms near urbanized locations, such as Hyde, Knightsbridge and Eybury near London. In contrast after 1760 the wages come mainly from very rural locations. Before 1700 the wages were drawn heavily from the south, which was then the high wage location. Thus before 1700 59 percent of observations are from the south east, in contrast to 3 percent from the north. The regional trends in the regression equation correct for this under representation. Figure 1 also shows that both Beveridge's estimate of nominal day wages on a sample of the Winchester estates before 1453 and Bowden's estimates of day wages from 1450 to 1750 are generally too high, though by variable amounts.

One measure of whether the estimation procedure improves the estimate of wages is to compare the variance of the raw wage averages with that of the estimated day wage in periods of little trend in nominal wages. For the years 1250 to 1349 the coefficient of variation of the raw average wages is 0.23, and of the estimated day wages 0.08, less than half as large. For 1350 to 1549 the coefficient of variation of the raw wage level is 0.19, and for the estimated wage 0.12. Thus for these early years the estimation procedure is removing a lot of noise from the yearly wage estimates.

As is implied by Appendix table A1 the ratio of day wages to threshing payments per bushel changed over time. In a competitive labour market this ratio of day wages to piece rates will index the productivity of workers in threshing, that is the bushels threshed per day. For threshing wheat, for example, the implied threshing rate in 1209-1349 was 5.1 bushels per day. But for 1350-1525 it averaged 7.0 bushels per day, in 1525-1649, 5.1 bushels again, while by 1650-1850 it had fallen to 4.1 bushels per day.

Part of the reason for this variation in threshing rates was undoubtedly that the day wage measured in terms in terms of the price of grains varied dramatically over time. Figure 2 shows the day wage measured in equivalent quarters of wheat, barley and oats from 1209 to 1869.[7] From the 1370s to1500 wages in grain units were nearly three times their normal pre-industrial level. These high grain wages correlate with relatively lower piece rates for threshing. We know the amount of threshed grain extracted from a given quantity of grain in the sheaf increases with longer threshing. When wages were low it would be profitable to thresh each sheaf longer and extract more of the grain. But even controlling for this there is still a downwards secular trend in the implied numbers of bushels threshed controlling for the grain wage. The reason for this secular decline in threshing rates is unclear. Perhaps types of grain were developed which had less easily shed seed that required more threshing to extract from the straw.[8]

One implication of the changing threshing rates is that the threshing payments reported by Lord Beveridge and David Farmer as an index of farm wages in the years 1209-1474 do not serve as a reliable proxy for day wage rates.[9] Threshing payments increased much less between 1350 and 1400 that actual measures of day wages. For the years before 1270 when I mainly rely on threshing payments to estimate day wages we thus need to make an assumption about what the ratio was in this period. It is assumed for these years that it was the same as that of 1270-1349. The resulting estimates of real wages suggest they were not too much higher before 1275 as they were for 1275-49, and we see above that grain wages are an important predictor of threshing rates, so this assumption is consistent with the resulting wage estimates.

Real Wages

[7] The grain prices are from Clark, 'Price History'.
[8] The gain from this would be less wastage of grain through early dropping of seed in the field.
[9] Beveridge, 'Wages', Farmer, 'Prices and Wages'.

Having derived nominal wages there are two types of "real" wage that can be derived. The first is the cost of labour to the farmer relative to the goods being produced on the farm. This does not matter to the labourer, but in labour market where employers seek to maximize profits it will measure the marginal product of farm labour (MPL), the amount of extra output each day of labour produced on the margin. In such a case

$$w = p \times MPL .$$

So

$$MPL = \frac{w}{p}$$

where w is the nominal wage and p the price of farm output.[10]

The assumption that medieval cultivators acted in such a way as to meet this condition may seem fanciful, but after the Black Death when the implied MPL rose very substantially we see that the implied threshing, reaping and mowing work rates rose substantially, then declined again when the MPL fell. Thus even medieval cultivators seem to have responded to labor costs in deciding how carefully to have workers perform tasks. So it is not implausible that the wage divided by product prices will indicate the MPL even in 1300. The MPL matters for considerations of technological advance in agriculture. Figure 3 shows an index of the MPL, which is just nominal wages divided by this output price index, with the years 1860-9 set to 100.[11]

The second real wage measure is the purchasing power of farm wages for the workers: the amount the day wage could buy of the goods consumed by farm workers, which included importantly candles, soap, shoes, textiles, housing, tea and sugar produced outside the domestic agricultural sector. This measures the standard of living of farm workers. These two wage measures can in principle differ substantially, and do indeed differ for these years.

[10] Strictly farmers must be acting as though to maximize profits and must take the wage they face as given.
[11] The price index is from Clark, 'Price History'.

The farm workers' cost of living index is formed as a geometric index of the prices of each component, with expenditure shares used as weights. It thus assumes constant shares of expenditure on each item as relative prices change. That is, if p_{it} is the price index for each commodity i in year t, and α_i is the expenditure share of commodity i, then the overall price level in each year, p_t is calculated as,

$$p_t = \prod_i p_{it}^{a_i} = p_1^{a_1} p_2^{a_2} \ldots\ldots p_n^{a_n}$$

where n is the number of good consumed. Equivalently

$$\ln(p_t) = \sum_i a_i \ln(p_{it})$$

The weights for expenditures, the a_i , are derived mainly from budget studies of farm workers expenditures collected in the years 1786-1854, as summarized by Sarah Horrell.[12] Table 4 shows the weights Horrell estimates, and the weights used in this study. Clark, 'Farm Wages', discusses why this index was employed and the derivation of these weights in detail. There are only two major deviations from Horrell. First grain prices rather than bread prices are used for the years before 1816 even for years when bread prices are available. Second drink gets much more weight (8 percent) than these budget reports would suggest, since ancillary evidence suggests that beer consumption by agricultural workers was significant. The budget summarized by Horrell, collected by social investigators, are likely to have understated the consumption of beer because of social disapproval that such consumption by the poor.

Since, as we shall see, real living standards of farm workers generally lay within 50 percent of living standards in 1787-1854, the period which gave us the budget weights, a fixed

set of weights is used throughout. There are 36 items in the cost of living index, including such exotica as stockings, gloves, and trenchers, which were amalgamated into 12 subcategories: grains and potato, dairy, meats, sugars, drink, salt, fuel, light, soap, clothing, lodging, and services, with the weights given to each shown in table 4. Some of items such as potatoes and cane sugar (as opposed to honey) only appear later. Table 5 reports by decade the values of the more important of these sub-indices, and the cost of living index as a whole, with 1860-9 set to 100 in each case.[13]

The resulting estimate real purchasing power of a day's wages for a male agricultural labourer is given in appendix table A2. It is also shown by decade in figure 4, as well as in the last column of table 1, where 1860-9 is set to 100. Displayed for comparison in figure 4 is an estimate of building labourer's real wages calculated using the same cost of living index.[14] The two real wage series move in relative harmony, except that after 1650 building wages gained steadily relative to those of farm laborers. Indeed in the earlier years such as 1400-1500 farm laborers often earned more than building laborers. By the nineteenth century farm labourers earned only 78 percent of the wages of building labourers. Thus the premium of the building workers, many more of whom were located in towns, was in the order of 25 percent or less over this long interval. Given higher housing, food and fuel costs in towns the differences in standards of living were even smaller than this.

Since the gap between farm and building wages increases somewhat over time, we see that there is no sign of any better integration of the labour market by the nineteenth century than

[12] Horrell, 'Home Demand'.
[13] Clark, 'Price History' gives the annual prices and the sources of the 16 domestic farm produced items in the cost of living index: wheat, barley, oats, peas, potatoes, cheese, butter, milk, beef, mutton, pork, bacon, suet, eggs, cider, firewood. Clark, "Condition of the Working Class' gives the sources for the other 20 items: fish, beer, tea, sugar, candles, coal gas, soap, coal, charcoal, salt, shoes, gloves, stockings, wool cloth, linen cloth, cotton cloth, housing, trenchers, pewter, and services. Housing here is estimated as the rental cost of housing of standard quality for areas outside London.
[14] The labourers' nominal wages are from Clark, 'Condition of the Working Class'.

there was in the thirteenth century. There is certainly no sign of a "dual" labour market in pre-industrial England such as has been posited for modern pre-industrial economies.

Farm workers had the lowest real wages in the recorded history of England around 1300. Indeed the worst year on record is 1316 when real day wages were just 29 percent of their average level in the 1860s. The second worst year, at 32 percent, was 1317 explaining the Great Famine of these years. But 1310-11 and 1322-23 also saw successive years of real wages at 36 percent or below of the 1860s. Thus 1310-1323 saw 6 of the 7 worst years of real wages in record history, 1296 being the seventh year. Wages 1290-1319 averaged one third less than those in the next low point in wage history, in the early seventeenth century. By the 1760s and the eve of the Industrial Revolution real day wages had increased about 70 percent from the pre-Black Death trough.

The MPL and Agricultural Productivity

England had one of the most efficient agricultures in the world by 1850. Indeed it was the high labour productivity of English agriculture, in part, that allowed the share of labour employed in agriculture to fall so much in the Industrial Revolution era. But there has been continued debate about when, and how, output per worker increased. Some have favored the Industrial Revolution era, others the seventeenth century, and yet others have argued that high output per worker was achieved by the later Middle Ages. Thus at one extreme Eona Karakacili recently presented data from a medieval estate implying that output per man-day in arable agriculture before the Black Death "either surpassed or met the literature's best estimates for English workers until 1800" and was respectable even by the standards of 1850.[15] At another extreme recently E. A.Wrigley adduce evidence based on overall yields per acre and the

[15] Karakacili, 'English Agrarian Labour Productivity', p. 24.

presumed numbers of workers per acre that suggest output per worker in 1800 was 3-4 times that in 1300.[16]

The MPL series derived above casts new light on this issue. Output per man-day, the average product of labour (APL), is connected to the MPL, by the simple formula

$$APL = \frac{Q}{L} = \left(\frac{pQ}{wL}\right)\frac{w}{p} = \frac{MPL}{b}$$

where *b* is the share of labor costs in all production costs, as long as cultivators take the day wage as given and adjust their labor usage accordingly to maximize profits. Even if wages are set by custom in early labor markets the equation above should hold as long as farmers adapt to the wage cost in their cultivation methods. Thus the data presented in figure 3 on MPL will not directly show output per worker. But if the share of labour *b* is relatively constant, then the MPL will correlate highly with labour productivity.[17] Also since *b* is at maximum 1, the wage is a lower bound on the output per day of farm workers. If net output per worker was less than the wage, farmers would certainly gain by employing fewer workers

There is sufficient information to estimate *b* only for a few years. The second column of table 6 shows these estimates of *b*. They vary within a moderate range of 0.38-0.49, suggesting that the MPL alone may serve as an index of output per worker over the very long run.[18] For the pre-plague years the estimated share of labour costs on seigniorial estates is 38-49 percent. Output per acre was estimated at 38 d. for 1300-49, capital per acre 63 d., and interest and depreciation on capital 8d.[19] Tithe would be about 5 d. per acre if collected in full. Land rents

[16] Wrigley, 'Transition', p. 31. Clark, 'Labour Productivity' earlier made a similar estimate. For an estimate intermediate between these and Karakacili see Allen, 'Economic Structure'.
[17] If the production function is Cobb-Douglass then the MPL will vary one to one with output.
[18] That is, the production function may be close to Cobb-Douglass.
[19] Output was obtained by updating the tables in Clark, 'Labour Productivity' with the more comprehensive data of Campbell, *English Seigniorial Agriculture* on land use, grain yields, and stocking ratios. This implies net demesne output per acre 1300-49 was 38 d., adding just 1 d. for for omitted sales of hay, honey, cider, firewood and timber. The capital stock per acre is estimated at 63 d. (21 d. of stored grains, 35 d. of animals, 7 d. of implements), with an annual interest and depreciation cost of 8 d (allowing 10 percent as the interest cost, a 3 percent depreciation of grains in storage, and a 10 percent depreciation of tools).

can be estimated in two ways. Based on the Inquisitiones Post Mortem that probably understate values, rents per acre averaged 6 d. or less, producing a joint rent and tithe share of 29 percent, and a labor share of 49 percent.[20] An alternative estimate, extrapolating back the rent series in Clark, 'The Agricultural Revolution' with fresh data for the years before, suggests a higher value for rent and tithe of 15.5 d. per acre, and a labor share of only 38 percent.

Applying these share estimates to the MPL gives the new, more optimistic, estimate of labour productivity circa 1300 shown in table 6. The gains from 1300 to 1800 were only 33 to 70 percent. But these estimates suggest that there was no reasonable share of labor in costs that would make medieval labour productivity as high as in the 1770s, as Karakacili argues, given the substantially lower MPL in 1300 than in 1770. This still means, however, that agricultural output per worker in pre-plague England was as high as in most European countries, such as France or Ireland, in the mid-nineteenth century.[21]

Are these new estimates feasible, and why do they not match the earlier estimates of Clark, and the recent ones of Wrigley? The first check is against the implied productivity of labor on specific tasks given by piece rates for threshing grains, mowing grass, and reaping wheat. As Clark, 'Labour Productivity' pointed out, it is puzzling that the task specific estimates of labor productivity for the major tasks in agriculture, which absorbed 40-50 percent of all male labor inputs, showed little gains between 1300 and 1800 or even 1850-60. Table 7, for example, shows estimated (net) output per worker in threshing wheat, reaping wheat, and mowing meadow in 1300-49, 1400-49, 1768-71, 1794-1806, 1850 and 1860. In threshing labor productivity declines between 1300 and 1770-1860, in reaping it gains by about 70 percent, and in mowing by about 80 percent. Aggregating across these tasks there was no more than a 25

[20] This estimate assumes that arable rented at 4.7 d. per acre on average, and pasture and meadow at 12d. per acre. See Campbell, *English Seigniorial Agriculture*.
[21] Clark, 'Labour Productivity', gives estimates for these other countries circa 1850.

percent gain in labor productivity. Nothing here supports substantial gains, everything supports limited labour productivity gains.

The second check of the MPL estimates of medieval labor productivity is whether they imply an occupational structure in 1300 that has an impossibly small farm worker share. Based on the labor productivity estimates of table 6 an acre of farmland circa 1300 would require the equivalent of 11-14 days of adult male labor. We do not know the number of days per year a farm worker typically worked in 1300. If it was the 300 of the nineteenth century then each full time adult male would cultivate 29-37 acres, counting as adult males 20 and over.[22] The last column of table 6 shows the male farm labor force in 1300, assuming the area cultivated was the same as in the 1880s, and later estimates of the labor force. The implication is thus for a farm labor force of 0.75-1.00 m. in 1300, compared to 0.75 m. in 1770 and 1 m in 1850 and 1860, though since work days per year were potentially less in 1300, the earlier labor force was likely higher. At the average population calculated for medieval England in 1300-49 below, of 5.4 million, that would imply in turn that 57-78% of the male labor force was in farming, if all workers put in an average of 300 days per year. The share would be correspondingly higher if workers worked only 275 or 250 days as seems quite possible. Thus these labor productivity estimates produce estimates of the occupational structure that are not implausible.

The first two columns of table 8 shows the area in acres and the numbers of males 20+ reporting agriculture as their occupation in 1831 in the Essex villages with surviving tithe penny records of male population around 1300. If we project back the likely labor requirements in farming in these villages in 1300 based on the estimated sizes of the farm labor force nationally in 1300 and 1831 we get the numbers in the next column. These are the numbers of farm laborers we would expect to see in these communities in 1300 based on our labor productivity

[22] Assuming that 75 percent of labor payments were to males adult under this definition, as was the case for English agriculture in 1851.

estimate. The final column shows the numbers of 20+ age males available based on the work of Larry Poos on the tithing penny records. As can be seen, even at the high labor productivities posited for 1300 the expected farm labor requirement of 1,407-1,913 males would absorb nearly the entire male population of these villages of 1,532. Again the new labor productivity estimates are plausible.

Finally if these new medieval labor productivity estimates seem plausible, why do Wrigley, 'Transition', and Clark, 'Labour Productivity' produce much lower estimates? Wrigley estimates about the same numbers of farm workers in the medieval England as is estimated here. But he has a low estimate of total output because he follows Campbell, *English Seigniorial Agriculture* in assuming only 6.7 million sown acres out of a total cultivable area in England of 26.5 million acres. This generates a low estimate of output per worker. When we discuss population below we shall see below that that assumption of only 6.7 million sown acres is too low. Clark, 'Labour Productivity' estimates workers per sown acre from estimates of households per sown acre as with Kosminsky's analysis of the Hundred Rolls of 1279-80. The total number of acres per worker is calculated in this way as 11-15, which generates the low labor productivity estimates. But these estimates are less secure than the MPL estimates and the output per acre estimates used above, since they involve many ancillary assumptions: the average size of the household, the fraction employed in agriculture, the ratio of sown to all acres.

A remaining puzzle is why, if labor productivity was comparatively high in medieval England, urbanization rates were so low, at less than 5 percent? The lack of urbanization, indeed, is a feature that Wrigley takes as supporting low labor productivity circa 1300. For if agricultural labor productivity was high, so that each farm worker can feed many non-farm workers, then so also should the share of workers in non-agricultural occupations have been high. And these workers, not being attached to the land, typically locate in towns and cities. The

significant gains in urbanization in England between 1300 and 1800, from 3 percent to 20 percent, seemingly suggests much greater farm labor productivity by the latter years. This puzzle is in fact greater for 1450 than for 1300. For by 1450 there is no possibility labor productivity could have been any less than in 1770 or 1800. As table 6 reveals, farm workers' day wages then were alone three quarters of output per worker in 1770. Why didn't the undoubted rise in output per worker after the plague lead to a significant gain in urbanization?

The measure of urbanization used above, however, is the proportion of the population in towns of 10,000 or more. Christopher Dyer has argued that if all towns are included then 15-20 percent of England was urbanized in 1300.[23] Dyer thus argues that England had an unusual urban structure with many more small urban locations. This might be created, for example, by England having an unusual degree of security from organized violence in the middle ages so that security as a motive for larger urban agglomerations was absent.

Thus overall there seems no compelling reason to reject the MPL estimates of figure 3 as offering a guide to likely output per worker in agriculture over the long run.

Nominal Wages and the Nature of Early Labor Markets

Below I estimate population in medieval England using the MPL to proxy for population. To do this I need one further assumption to hold. This is that the agricultural wage tended to clear the labor market, and at least to an approximation balanced labor supplies with labor demands. In particular wages cannot be set by some customary standard. Many scholars of the middle ages will be skeptical of this assumption.[24] Since this is important for what follows, let us consider nominal wages in the years 1280-1440, where wage quotes are plentiful and ask

[23] Dyer, *Everyday Life*, p. 302.
[24] John Munro, for one, has argued strongly against such an assumption, viewing building workers' wages as having adjusted slowly to economic conditions. Munro, 'Wage Stickiness'; Munro, 'Postan'.

whether the evidence of these years supports or contradicts the assumption that wages adjusted to match demand and supply of labour.

If nominal wages moved up and down regularly in these years there would be no question of their flexibility. However, there were long periods in which nominal wages were stable, 1270-1315 for example, and very few periods in which nominal wages fell. The stability of nominal wages over long periods does not in itself imply that markets failed to work. Labor demand and supply might just have happened to be in balance at those nominal wages for long periods. But their stability makes it harder to be confident that a relatively free labor market indeed operated.

The presence of sudden population losses in the medieval years caused by plague as in 1348-9 and famine as in 1316-17, however, allows one check as to whether wages rapidly responded to changes in supplies as we would expect in a competitive market, or whether wages failed to adjust, or adjusted slowly, since nominal wages were governed strongly by custom.

Sudden losses of population should create an immediate increase in nominal wages if labor markets were competitive for two reasons. The first is that the population decline would reduce real output, Y. As long as the money supply (M) and the velocity of circulation of money (V) is unaffected by the population loss, then since

$$MV = PY$$

the price level P would have increased.[25] Nominal wages would have to proportionately increase to maintain real wages. But since the demographic decline further makes labor scarce relative to land and capital, real wages should rise in a competitive market, causing further upward movement of nominal wages. Thus any sudden fall in population should immediately increase money wages.

[25] Not all prices need rise since there would be important changes in relative prices after a demographic shock, with farm output becoming relative cheaper and manufactured output becoming more expensive.

Figure 5, which shows the estimated nominal wage in each year for 1280-1440, attempts to detect whether demographic shocks lead to sudden adjustments of nominal wages for the years where we have the best wage measures. Even with a lot of data there is still a sampling error in the wage estimate for any year, so that the line is not as smooth as the true average wage series would be. But the movement of the series is characterized by a number of relatively abrupt wage changes followed by long periods of stability. These breaks, which are all statistically highly significant, so that they cannot be attributed to chance, are also shown in figure 5. They occurred around 1316, 1350, 1352, 1364, 1372, 1389, 1399 and 1424.

The experience in both 1316 and 1350 is suggestive that wages were certainly flexible upwards and by the degree we would expect in a competitive market. In 1316 nominal wages rose to a new level 14 percent above the pre-famine level. This is consistent with the widespread notion that population losses in the famine of 1315-7 were in the order of 10 percent. The immediate effect of the Black Death in 1348-9 was a rise in wages of 101 percent by 1350, a rise that began in 1349. Clearly wages nominal wages were again highly responsive to this shock, and with a magnitude that is consistent with the typical estimate of a 25-40 percent population loss.

Interestingly, though, the wage level fell back by about 14 percent between 1351 and 1352. The Statute of Labourers of 1351, which theoretically fixed wages at pre-plague levels, may thus have depressed reported wages below their market clearing levels, at least for a few years, though the effect was clearly modest even in the short run. The statute explicitly, for example, called for payments for threshing wheat to be no more than 2.5 d. per quarter. Of 20 manors reporting wheat threshing payments in 1352 or 1353, only 5 had rates sanctioned by the Statute. Even if the Statute repressed reported wages it does not imply that the wages paid were really below the market clearing rate, for there were many ways of making side payments to

workers through food and other gifts to bring up low nominal wages to the market rate. So the Statute may well have had an effect only on the form of wages, not on the total wage payments themselves. But it does suggest that at least in the 1350s reported wages may well understate market rates. Over time we can assume that distortions in reported wages stemming from the Statute diminished gradually.

After 1352 there were four years in which the data suggest a relatively rapid upward movement in wages to a new level: 1364, 1372, 1399 and 1424. These correspond loosely, but not precisely, to later reported plague epidemics, and many reported plague episodes in these years have no effect on wages. Thus national plague outbreaks are reported for 1361-2, 1369, 1375, 1379-83, 1390-1, 1399-1400, 1405-6, 1411-2, 1420-3, 1426-9, 1433-5, and 1438-9.[26] We have little idea of the relative severity of these various plague outbreaks, so the nominal wage behavior in response to these may just reflect their comparative impacts on population. But the coordinated upwards movements of nominal wages across a range of locations in short periods does suggest that wages were again flexible upwards in response to labour market shocks.

The decline in wages around 1389 might seemingly prove that nominal wages were also flexible downwards. But the cause is a little mysterious. Population cannot grow suddenly, to cause a sudden nominal wage decline, but there can be rapid contractions in the nominal money supply which would in a competitive market lead to a drop in nominal wages.

Thus the verdict on medieval labor markets would be that wages certainly display upward flexibility. That the were downward flexible is less easy to demonstrate since on only two occasions in the years 1270-1450 do wages clearly decline. The decline in 1352 may well owe to the Statute of Labourers, so there is only one decline attributable to market forces. Also the Statute of Labourers may have depressed reported wages below market clearing wages in the 1350s, so that in this decade reported wages were too low, though most likely by 14 percent or

less. In the years 1320-1350 the money supply in England seems to have declined significantly.[27] In response average prices fell also, but nominal wages did not decline. Thus real wages rose. Below we attribute that to a decline in population from 1320-1349, but if nominal wages were inflexible downward these movements in the money base will produce for some periods misleading implications about the likely population of England. But in periods such as 1350-1430 with persistent upward movement of nominal wages the wage can be assumed to reflect labor supply and demand.

THE MPL AND ENGLISH POPULATION

Huge swings in the MPL are evident over time in figure 3. The MPL varies from 85 percent the level of the 1860s before 1270, to only about half the level in 1270-1329, to 150 percent of the level in the fifteenth century. The earlier movements are inversely related to estimated population levels. Thus we get little idea about agricultural efficiency gains from looking at output per worker alone, or the MPL, unless we also have measures of earlier populations.

Unfortunately English population before 1540 when parish register estimates become available is uncertain. Population estimates for 1300-1315, when the medieval population is believed to have been at its maximum, have ranged from 4 million to 6.5 million. Bruce Campbell recently pronounced in favor of a maximum medieval population of 4-4.25 million in 1300-49, based on estimates of the total food output in England. But others such as Richard Smith, relying on the extent of population losses in the handful of communities for which we

[26] See Gottfried, *Black Death*; Shrewsbury, *Bubonic Plague*.
[27] Allen, 'Volume of the English Currency'.

have evidence for the years 1300-1500, have estimated a much bigger maximum population of 6 to 6.5 million people.[28]

Figure 3 shows that in 1600-19 when population averaged 4.6 million the MPL was nearly 50 percent higher than in 1300. If England in 1300 had a population of only 4 million then there were substantial agricultural efficiency gain between 1300 and 1600. If, however, the population in 1300 was 6 million then possible there were no efficiency gains over this long interval of 300 years.

Below population trends for the medieval period for the years 1200-1530 are estimated from the records of 21 medieval communities. When we compare this population trend to the MPL series for the years 1250-1530 the two series correlate highly. This suggests these "micro" population estimates are correctly capturing the general population trend, and that agricultural technology was static in these years. To get a long run estimate of population levels in England we still need to fix the level of population at some point before 1530. By making the modest assumption of no change in agricultural technology between the end of the "micro" level population evidence in the 1520s and the start of national population estimates in the 1540s we can fix earlier populations using the MPL. With just this assumption the MPL, national population levels of the 1540s to 1610s and community level estimates for 1250-1529 all fit together and imply a static technology from 1250 to at least 1600.

Evidence for population trends in communities in the medieval period comes in two main forms. The first type of estimate, favored by Ambrose Raftis and his "Toronto School," is the numbers of individuals appearing on manor court rolls. Such estimates were made by Raftis and others for Brigstock, Broughton, Forncett, Godmanchester, Halesowen , Hollywell-cum-

[28] Campbell, *English Seigniorial Agriculture*, pp. 403-5; Smith, 'Human Resources', pp. 189-91.

Needham, Iver, and Warboys.[29] The second type of estimate is based on the totals of tithing penny payments by males aged 12 and above. Such a series was derived for Taunton 1209-1330 by J. Z. Titow.[30] Larry Poos more recently tabulated these payments for a group of 13 Essex manors from the 1270s to the 1590s.[31] Both these methods have their partisans, and there have been debates about the validity of the first approach. The court rolls clearly will tend to miss some individuals but may well show relative population well. But the results in terms of population trends in the years 1270-1469, when the data are most plentiful, are not wildly dissimilar. Thus I have combined the individual estimates by decade for these 21 communities into a common population trend for the medieval period from the 1200s to the 1520s using a regression of the form

$$\ln(N_{it}) = \sum_i a_i LOC_i + \sum_t b_t DEC_t + e_{it}$$

N_{it} is the population of community i in decade t. LOC_i is a set of 21 indicator variables which are 1 for observations from community i, 0 otherwise. DEC_t is a similar set of 33 indicator variables for each decade. The estimation is terminated in the 1520s even though there is some community evidence after because it is for such a small number of people as to be of little evidentiary value.

This specification thus assumes a common population trend across these communities, estimated by the b_t coefficients. The regression weights observations by average community size to allow larger populations to have a correspondingly larger weight. The resulting estimate of the medieval population trend is shown in table 9, column 2, with population in 1310-9 set to 100. Also shown in columns 3 and 4 are the numbers of communities with population estimates in each decade and the total number of persons reported.

[29] Bennett, *Women*, pp. 13, 224; Britton, *Community of the Vill*, p. 138; Davenport, *Economic Development*; de Windt, *Land and People*; Raftis, Warboys; Raftis, A *Small Town*; Razi, *Life, Marriage and Death*.
[30] Titow, 'Some Evidence'.

This "micro" population estimate for the years 1250-1529 correlates well with the newly derived series on the MPL (1200-49 was excluded since there was only one place, Taunton, observed in these years, and here there is some deviation). Figure 6 shows this association for the decades from 1250-9 to 1520-9. The best fit for the coefficients of the regression

$$ln(MPL_t) = a + bln(N_t) + e_t \quad (4)$$

is

$$ln(MPL_t) = \underset{(0.274)}{9.593} - \underset{(0.066)}{1.231}\, ln(N_t).$$

$R^2 = 0.93$
$n = 28$

where again the estimate is weighted, this time by the number of communities which give the population estimates. There is no sign of any upwards trend in MPL at a given population. Thus if we add a time trend to equation (4), T measured in decades from the 1250s, the estimate becomes

$$ln(MPL_t) = \underset{(0.784)}{9.694} - \underset{(0.167)}{1.252}\, ln(N_t) - \underset{(.008)}{0.001}T.$$

The time trend is quantitatively and statistically insignificant. Thus based on the evidence of community trends the agricultural technology of the years 1250-1529 was static, with population alone determining MPL and output per worker.

This nice fit between the population trend estimated and the MPL does not prove that the population trend estimated is correct. But it does show that these population estimates can provide a parsimonious explanation of the movements in the MPL over these years. Ocham's razor tells us to prefer simple explanations over complex ones, and here we see a simple fit between two completely independently derived series.

[31] Poos, *A Rural Society*.

A very similar association between population and the marginal product of labour is also found from the 1540s to 1610s, years when the parish records first yield national population estimates. Estimating the coefficients of equation (4) for the decades from the 1540s to the 1610s, now measuring population, N_t, in millions we get as the best fit

$$ln(MPL_t) = \underset{(0.274)}{5.908} - \underset{(0.209)}{1.078} ln(N_t)$$

$R^2 = 0.82$
$n = 8$

Note that the estimated proportionate effect of population on the marginal product of labour, measured by the coefficient on $ln(N_t)$, is very similar to the previous estimate. It suggests that again in 1540-1619 agricultural efficiency was static.

The correlation between population and the marginal product of labour in both periods suggests that we can use the MPL in farming as a way of fixing the average level of the population before 1530. Because the "micro" estimates of population trends in the medieval period and the national estimates do not overlap the assumption that is crucial to this estimate is that the efficiency of production in English agriculture was unchanged from the 1520s to the 1540s. This does not seem a particularly strong assumption.

To estimate national population levels before 1540 in millions with the aid of the marginal product of labour in agriculture we can first estimate the coefficients of the regression

$$ln(N_t) = a + bIND_{1250\text{-}1529} + c\, ln(MPL_t) + e_t$$

for the decades of the 1250s to the 1520s, and the1540s to the 1610s, where $IND_{1250\text{-}1529}$ is 1 for the decades from the 1250s to the 1520s and 0 otherwise. Population, here the dependent variable, is measured as an index before 1530, and in millions after that. The coefficient *b* in the regression is a scaling factor that converts the population before 1530, measured as an index into millions. The connection between shifts in the marginal product of labour and population

changes is assumed to be the same throughout the years before 1600. The fitted values for this regression are

$$ln(N_t) = \underset{(0.178)}{4.703} + \underset{(0.030)}{2.830IND_{1250\text{-}1529}} - \underset{(0.039)}{0.755\, ln(MPL_t)}$$

$R^2 = 0.996$
$n = 36$

If the estimate is done allowing a different coefficient on the log of population in the later decades 1540s to 1610s the two coefficients do not differ quantitatively or statistically.[32]

Column 5 of table 9 shows the national population totals implied by the sample of medieval communities with population estimates using this scaling procedure. We can also estimate the population in each decade before the 1540s from the marginal product of labour in agriculture using the coefficients of the above expression. These estimates are shown in table 9, column 6. The final column of the table shows a "best" estimate of population for the decades before 1540, which is just the average the average of the estimates from the sample of communities and from the MPL.

Figure 7 shows this "best" estimate, as well as the underlying estimates from the sample communities, and from the marginal product of labour. All this suggests that with a very small amount of interpolation we can interpret the years before 1600 as being ones where the technology was static and the MPL was determined solely by population. In the decades before 1240 there is a deviation between the direct population trend and the MPL trend. This might be either technological advance in these years, or just problems with the data since the population trend in these years is based on estimated population in one town only (Taunton), and the MPL data is weakest here also.

[32] This regression was again fitted weighting the earlier observations by the number of people in the popula

On the "best" estimate population is estimated to have peaked just below 6.0 million in the years 1310-16 just before the Great Famine of 1316-7. The low point of population is in 1440-1520 when it is estimated at 2.45 million.[33] The famine of 1315-17 is estimated to have reduced population by 11 percent. The onset of the Black Death in 1348-9 is implied to have carried away 31 percent of the population. It is interesting to note that in the two decades after the plague, at the time when there is some indication wages may have been underreported, the population estimated from wages is larger than that estimated from the sample communities.

A high for pre-plague population of as much as 6 million has been rejected by Bruce Campbell and others on the grounds that agriculture then had insufficient yields to have supported this number of people.[34] However, a close reading of the Campbell argument shows that it is based on one assumption for which there is very little support – that is that the total arable acreage in England circa 1300 must have been at maximum 10.5 m. acres, compared to a total cultivated area in England in the 1880s of 26.5 m. acres.[35] Yet the Inquisitiones Post Mortem suggest income from arable land was fully 61 percent of all landlords' income.[36] Given that meadow, pasture, and even wood, on average had a higher assessed value per acre than arable, this implies that the total cultivated area in England in 1300 was less than 17.3 m. acres. What was preventing the use for agriculture of the 9.2 million acres later cultivated?

Some undoubtedly lay as waste, undrained, unreclaimed and with minimal output. Some lay in unimproved forest or Royal Forests. But these factors will not account for more than 10 to 20 percent of land in cultivation in the 1880s. The amount of land which lay as common waste in England as early as 1600 was extremely small, being definitely less than 5 percent of the area

[33] Since the Great Famine of 1316-17 produced a likely sharp decline in population I use the years 1310-16 before the famine for the 1310s, and 1318-29 after the famine for the 1320s.
[34] Campbell, *English Seigniorial Agriculture*, pp. 386-410.
[35] Campbell, *English Seigniorial Agriculture*, pp. 289-90. Wrigley, 'Transition', adopts this assumption from Campbell.
[36] Campbell, *English Seigniorial Agriculture*, pp. 66.

of cultivated land in the nineteenth century.[37] Most of this land lay at sea level or at altitudes greater than 250 metres. Given the absence of population pressures on land for most of the period 1350-1600 the extent of waste enclosure between 1300 and 1600 was presumably small. Wild forest lands, as opposed to the managed forest counted in the Inquisitions Post Mortem, in 1300 must have accounted for much less than 10 percent of the area later cultivated. So overall it is hard to imagine more than 4 million of acres in England in 1300, leaving at least 5.2 million acres unaccounted for under the Campbell story.

If that land was actually in use and cultivated in 1300, so that the cultivated area in 1300 was 85 percent of that in the 1880s, then with Campbell's estimates of grain output per acre and consumption per person there would be a grain supply in 1300 to feed 5.75 million people, which is the population estimated above for England around 1300 in table 9 above. Thus the MPL estimates above provide estimates of output per worker, and of population totals, which are both feasible given what we know of medieval yields and land resources.

The MPL, Population, and Agricultural Development

Figure 8 shows the marginal product of labour for English agriculture by decade from the 1200s to the 1790s versus the national population, with the estimates from before the 1540s coming from the community trends adjusted to national levels as described above. Throughout these years England was largely self-sufficient in terms of agricultural produce. The static tradeoff between higher population and a lower MPL which persists from 1250 to 1600 or later is broken after the 1640s. Thus the seventeenth century was an era when efficiency advances appears clearly for the first time after 1250 in English agriculture. By the early eighteenth century the MPL in agriculture is double what would be expected, based on population, from the medieval relationships. The very high MPL of the fifteenth century, and of the early thirteenth

[37] Clark and Clark, 'Common Rights'.

century are attributable based on this picture to the strong effects of pre-industrial population levels on the marginal product of workers. The figure also suggests that if the population trends for the years before 1250, which are based on Taunton alone, are correct then that period may also have witnessed some efficiency advances. Thus the growth of population in the thirteenth century may owe in part to gains in the efficiency of agriculture.

Note that this implies the dynamism of the economy in the years before 1600 stemmed largely from demographic shocks. The economy was fundamentally Malthusian. The expansion of the English economy in the later thirteenth century, for example, was the product of increased birth rates and or falling death rates rather than technological or commercial advances.

Figure 9 repeats the exercise of figure 8, but this time with real wages on the vertical axis. As we go over 600 years from 1200 to 1800 we see confirmation of one of the basic tenets of the Malthusian model of pre-industrial society. Gains in efficiency in activities such as agriculture do not lead to any sustained increase in living standards but instead to a growth in population. Living standards for farm workers were about the same in 1200 as in 1800, but the population of England was nearly four times as large by 1800. Again we see that from the 1250s to the 1600s there seemed to be a stable trade off between real wages and population, assuming no sudden gains in efficiency between the 1520s and 1540s when my two population sources begin and end. Sometime around 1600, and the decadal variation in real wages from harvest shocks makes fixing any precise date impossible, there was a period of efficiency growth, fueled in part as we saw by advances in agriculture, that allowed population to grow without depressing real wages. We see potentially this same phenomena in the early thirteenth century, though with many, many caveats about the quality of the data then.

The real day wage in the fifteenth century is much less when measured against all consumption goods compared to when we measure it in wheat only, or even in all agricultural

output. But it still was about 15 percent above the farm day wages of the 1860s at the end of the Industrial Revolution. Thus under the right conditions material living standards in pre-industrial Europe could be very high. The Malthusian world was net necessarily one where people were pressed to the limits of physical subsistence.

Conclusions

This paper shows that using day wages we can build a picture of English agricultural history that presents an internally consistent picture of the real wage, the MPL, output per farm worker, national population, the share employed in agriculture and agricultural efficiency in general from 1200 to 1869. The only major feature of early England this picture cannot incorporate is the low urbanization share. But as noted, Dyer argues this low apparent urbanization share may stem from England having a town size distribution unusually weighted towards small towns. The picture is one of a static agricultural technology before 1600, but a technology that produced relatively high output per worker even in 1300, and that supporting a substantial population in the years before 1349.

Appendix – Estimating Day Wages in a Regression Framework

The basic model of wages that was fitted to the data is

$$\ln(Wage_{it}) = \sum_i a_i LOC_i + \sum_t b_t D_t + \sum_j c_j DSEAS_j +$$
$$\sum_k d_k DTYPE_k + \sum_l f_l DTH_l + gDWIN + \sum_m \sum_n h_{mn} DPER_m DREG_n + e_{it}$$

The dependant variable is the logarithm of wage payments. Nominal day wages increased by 15-20 fold over the years 1209-1869. By using the logarithm of wages the various

controls on the right hand side of the equation, such as for location, have the same proportional influence on wages across all years.

LOC_i is an indicator variable, 1 when the observation is from parish i, 0 otherwise. t indexes the year. D_t is 1 in year t, 0 otherwise. $DSEASj$ is an indicator for the season of the year the wage payment comes from. In addition to the five basic categories (winter, summer, hay, harvest, and unknown) an indicator was included for harvest wages drawn from counties where by 1866 70 percent or more of land was in arable cultivation. The harvest wage premium in such areas tended to be much greater. $DTYPE_k$ is a set of 21 indicator variables for the type of wage payment. The first was a regular day wage, and the other 20 were for payments for threshing a given different grains (such as wheat, rye, barley, and oats) or combinations of grains. The threshing payments are mainly those for threshing wheat, barley and oats.

To allow for variations in the ratio of the payment for threshing a bushel of grain to the day wage over time a set of 21 indicators DTH_l was added. This allowed the ratio of threshing payments to day wages to vary from that of the pre-plague years 1209-1349, which was used as the base period. The other periods were each 25 year intervals starting in 1350, ending with the 26 year interval 1825-50. Sometimes threshing payments were combined with those for winnowing the grain. The indicator $DWIN$ was set to 1 in these cases, 0 otherwise. To control for differences in regional wage movements a separate regional indicator was included for the north, midlands and south west for the periods 1209-1499, 1500-99, 1600-99, 1700-49, 1750-99, 1800-49, 1850-69. There were not sufficient observations of farm wages in the north before 1500 to estimate this indicator for 1209-1499. Instead the relative wages of building workers in the north versus the south east for 1209-1499 from Clark (2005) was used to estimate this value.

Table A1 shows the estimated values of the more important control variables, their standard errors and t-values. In the last column is shown the importance of the control in terms

of its percentage effect on the wage level, where applicable. Table A2 records the estimated national day wage by year outside hay and harvest, once the raw series was adjusted

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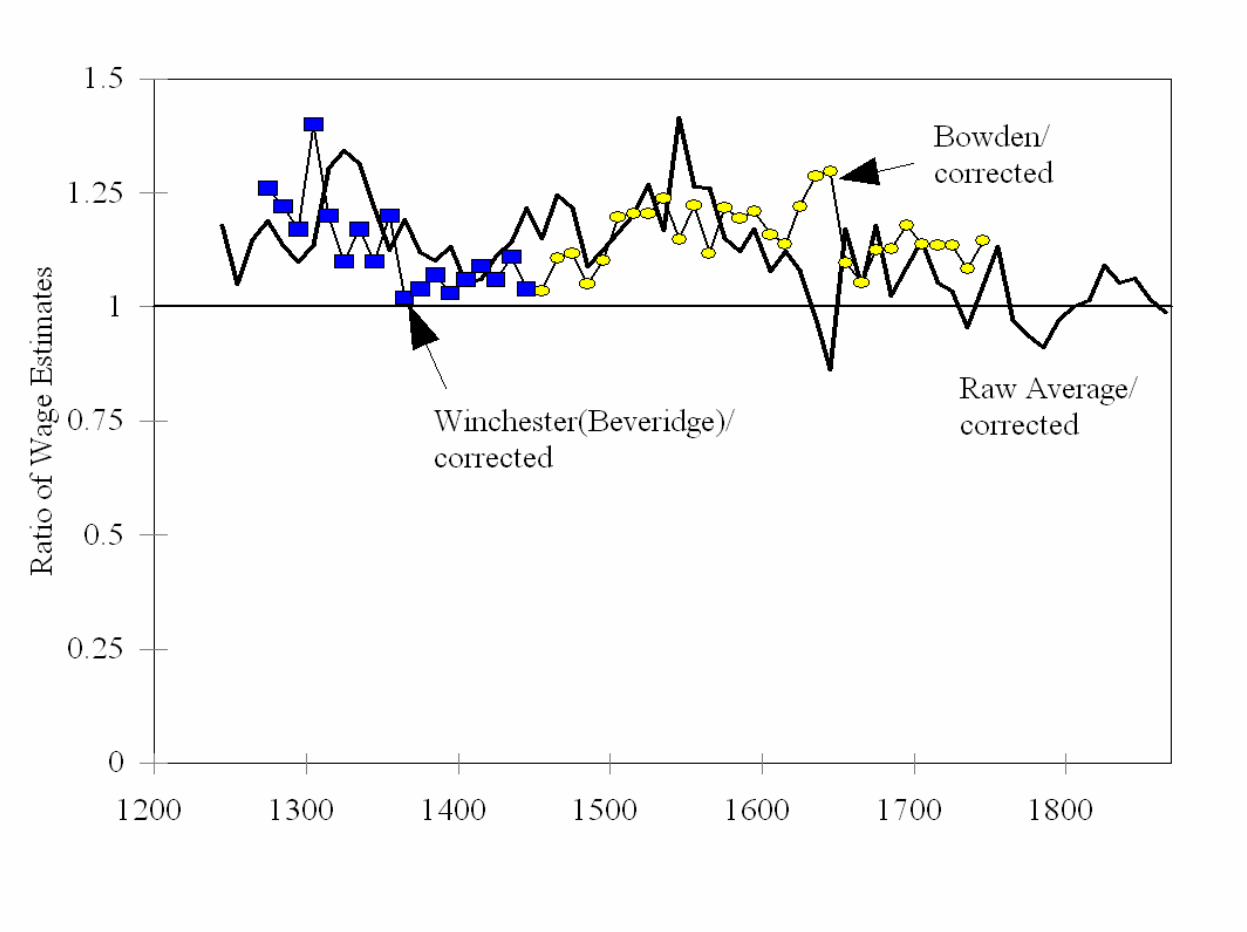
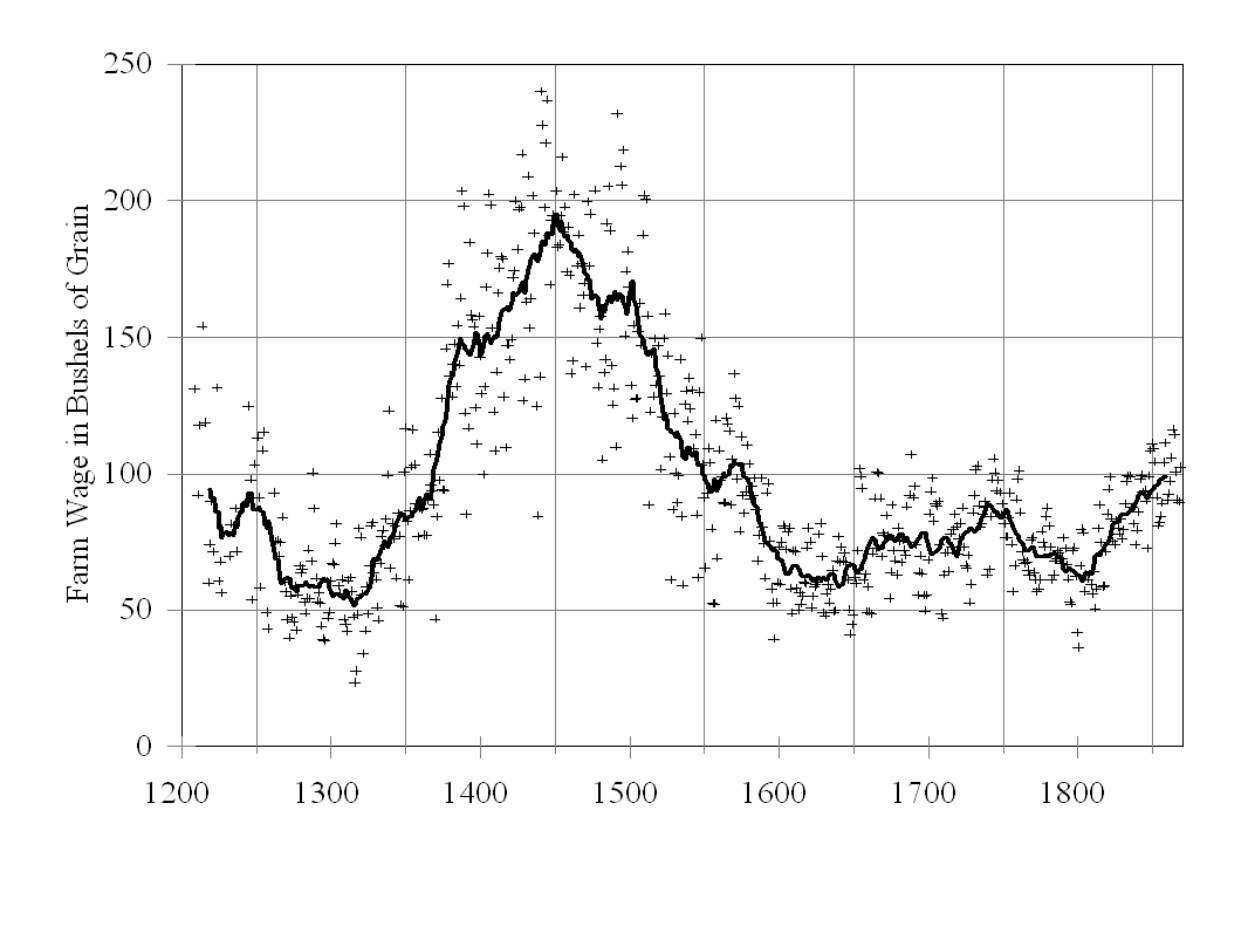
Figure 1: Estimated Day Wages by Decade compared to Raw Day Wage Averages



Note:

Sources: Beveridge, 'Winchester Wages'; Bowden, 'Statistical Appendix.'

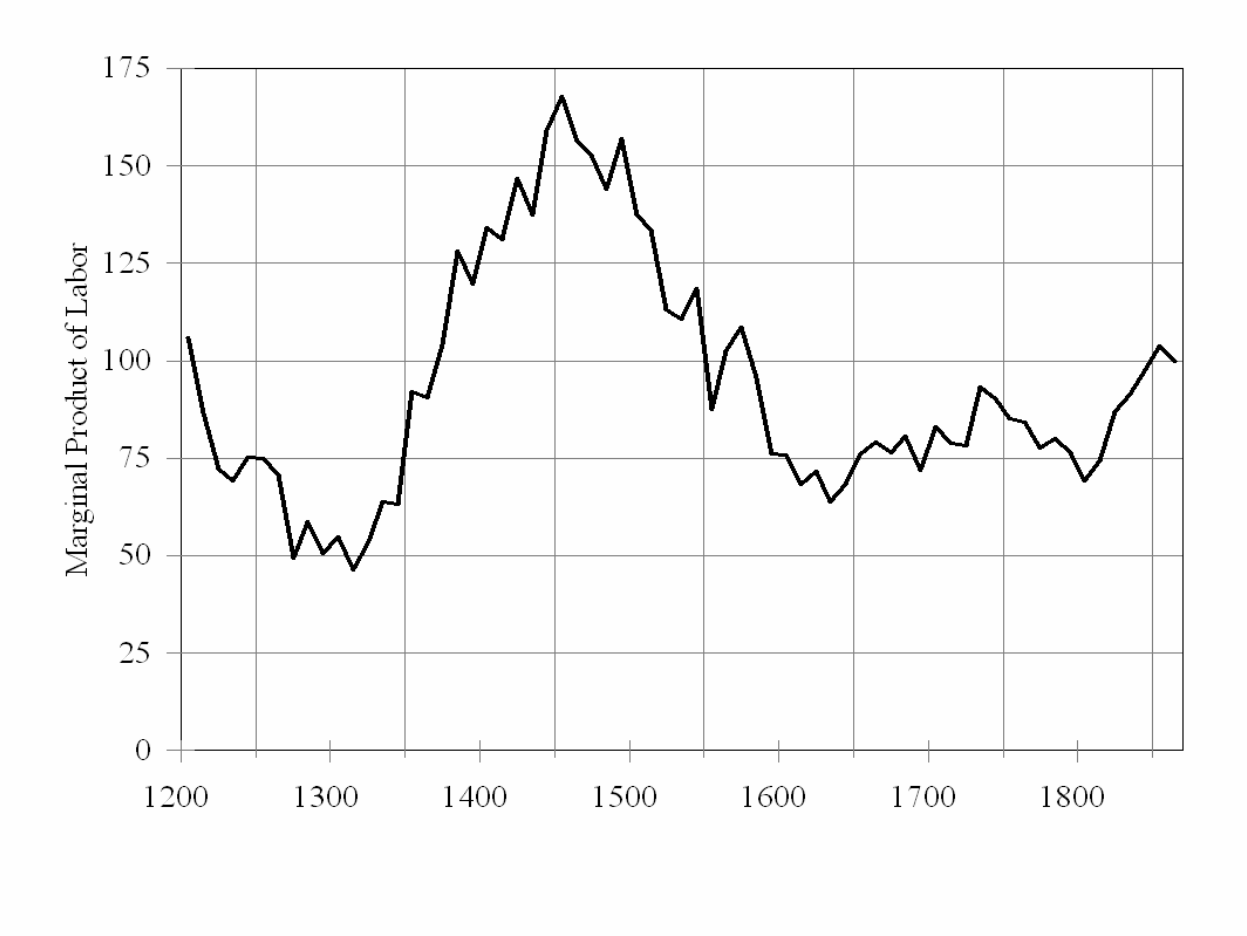
Figure 2: Real Day Wages Measured in Terms of Grain (Wheat, Barley, Oats)



Note: The wage in grain units is indexed at 100 on average for the years 1860-9.

Sources: The grain prices are from Clark, 'Price History'.

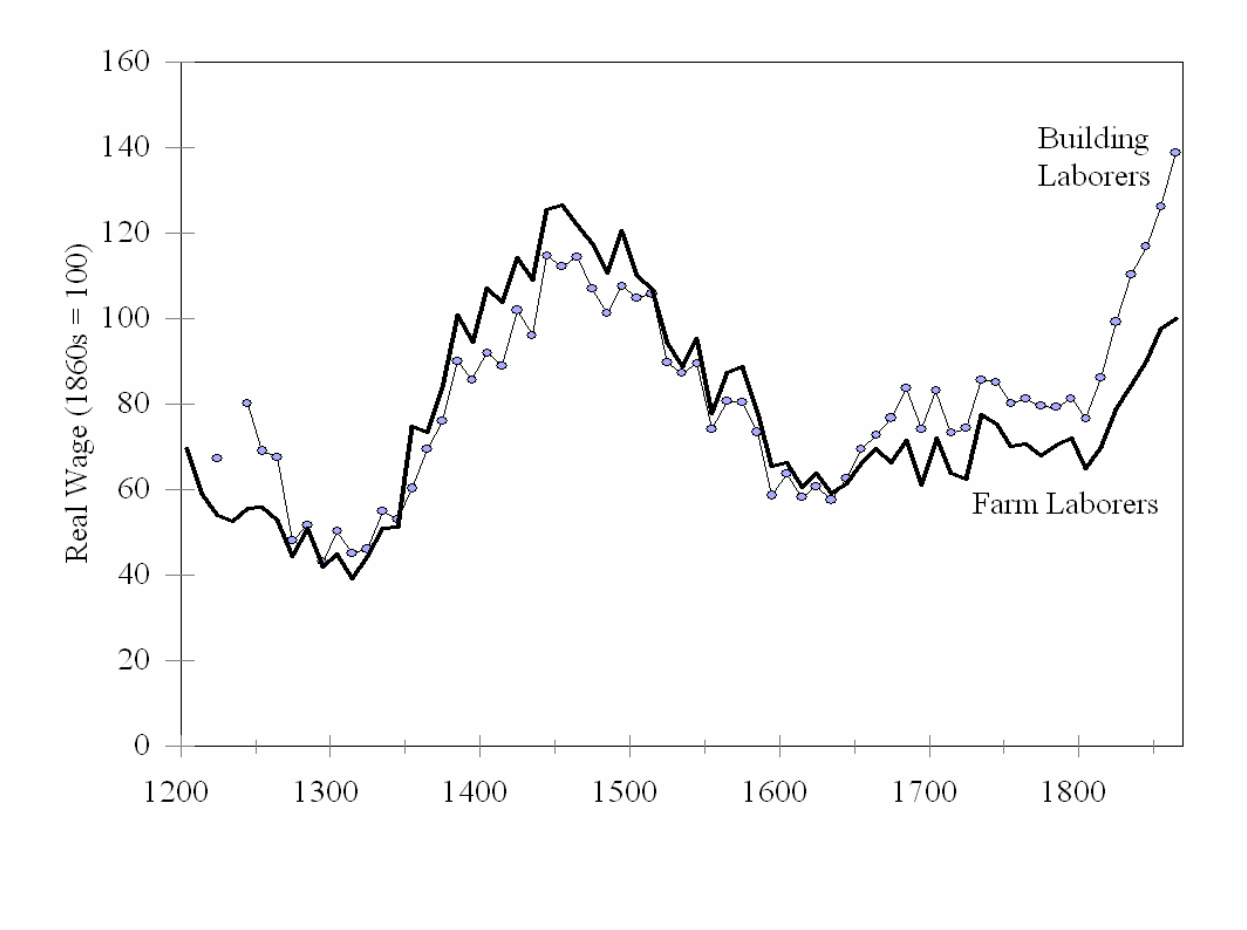
Figure 3: The Implied Marginal Product of Labour in English Agriculture, 1209-1869



Note: The MPL is indexed at 100 on average for the years 1860-9.

Sources: The farm prices are from Clark, 'Price History'.

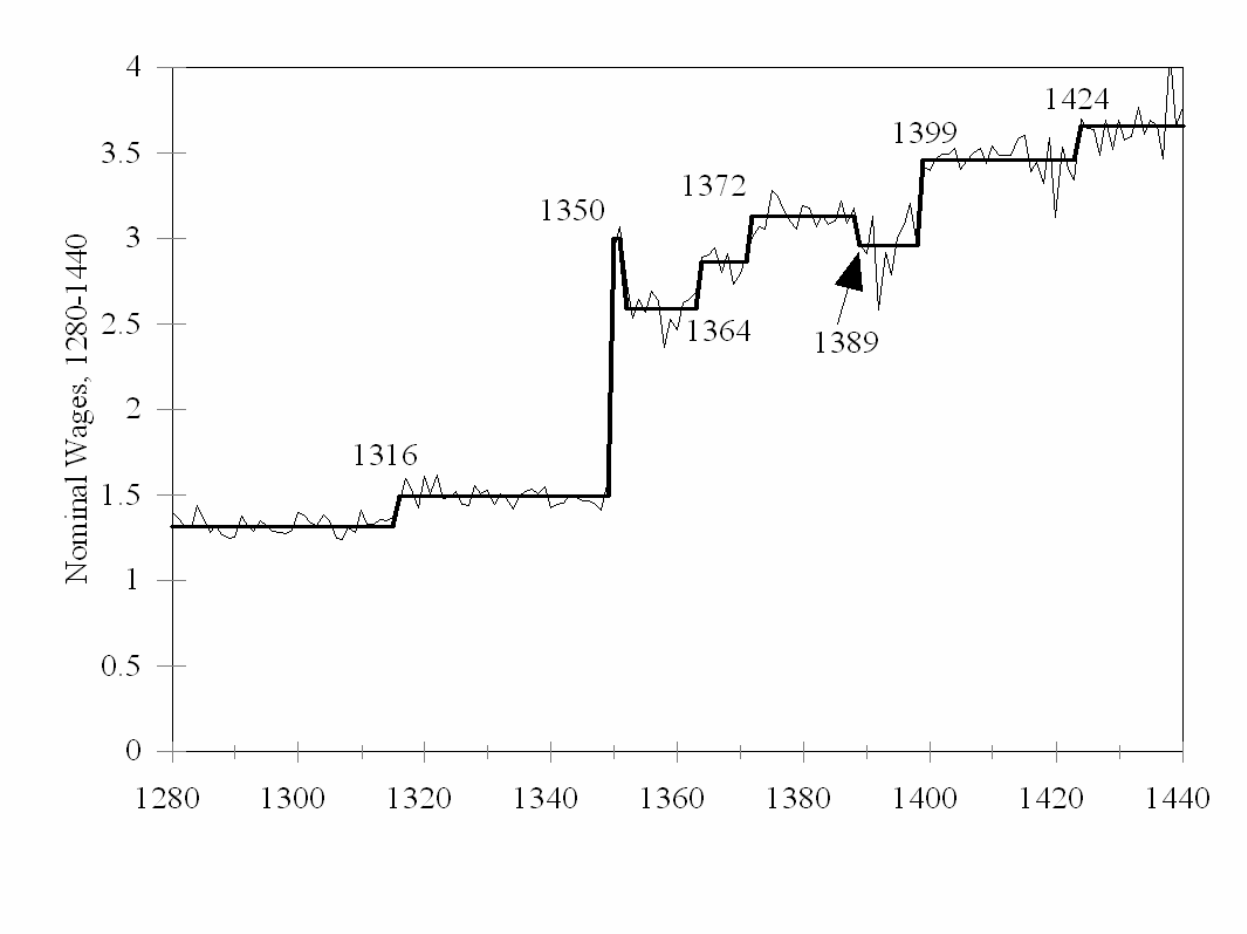
Figure 4: Real Agricultural Day Wages, 1209-1869



Notes: The figure shows decadal averages of real farm wages from 1200-9 to 1860-9, with 1860-9 set to 100. In comparison the wage of building laborers is shown.

Sources: Table 1. Clark, 'Condition of the Working Class'.

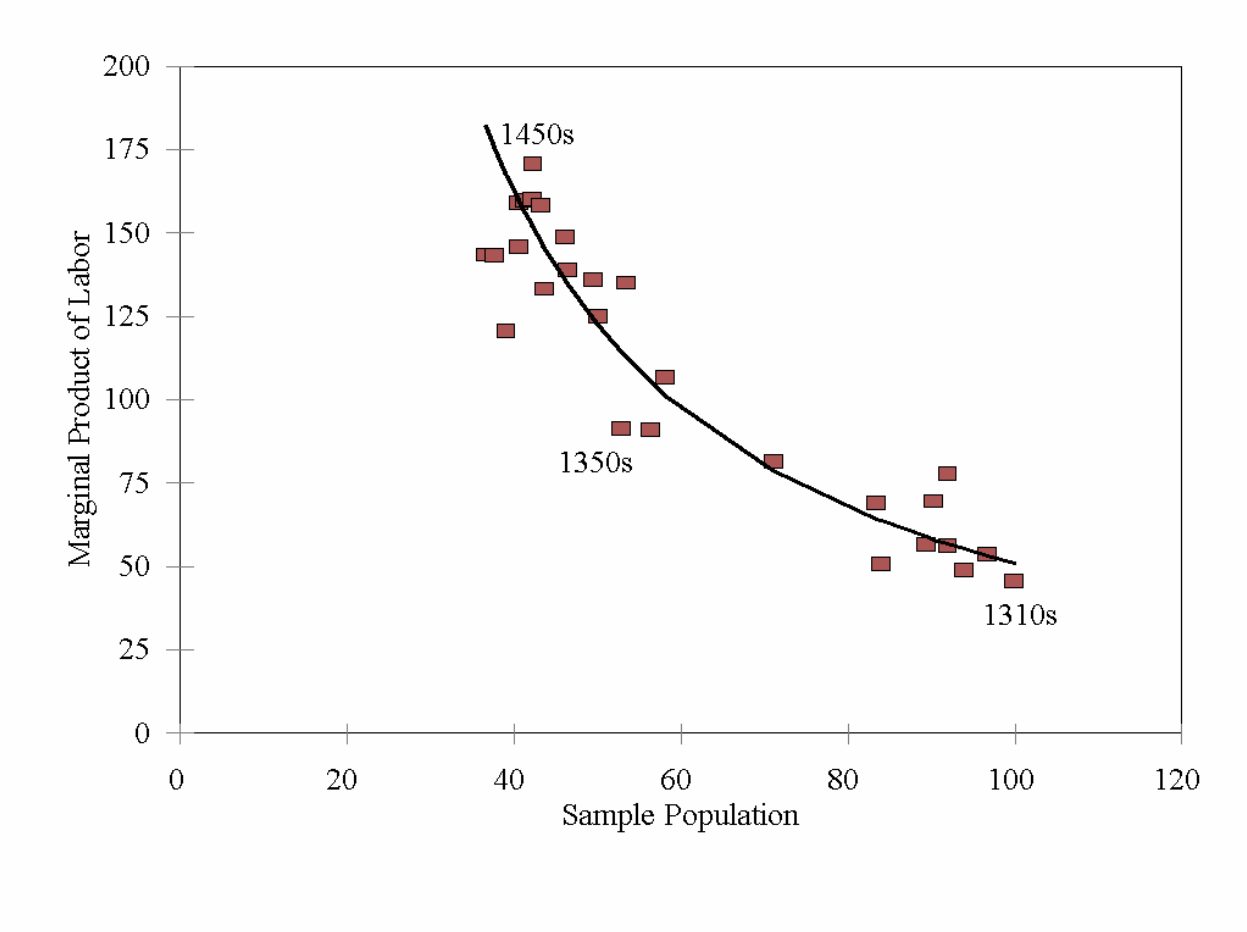
Figure 5: Changes in the Nominal Wage Series, 1280-1440



Notes: The breaks in the series seem to come in 1316, 1350, 1352, 1364, 1372, 1389, 1399, and 1424.

Source: See text.

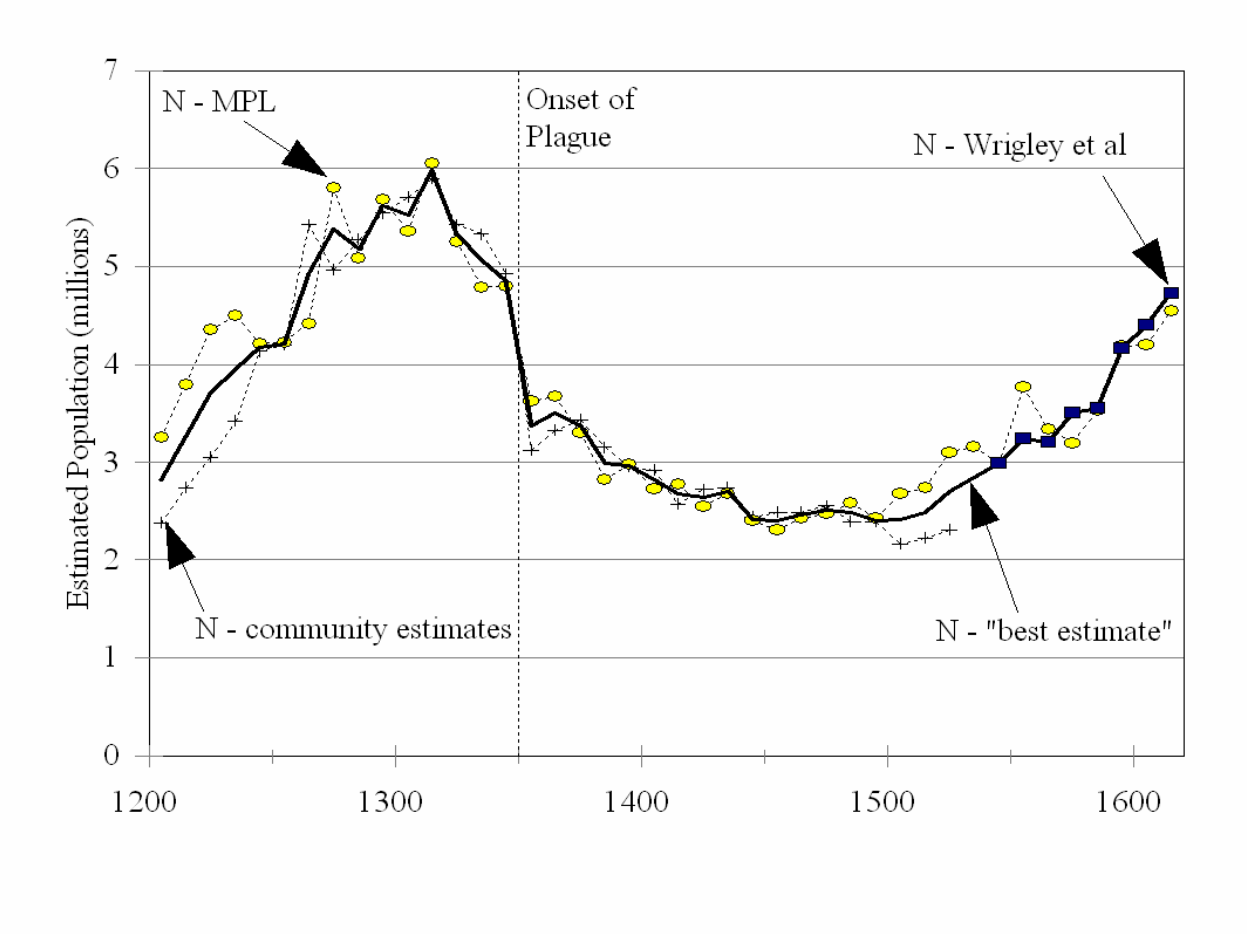
Figure 6: The Marginal Product of Labour vs Population, 1250-1529



Notes: The fitted curve uses a weighted regression, weighting on the number of people recorded in each decade.

Source: Tables 1, 9.

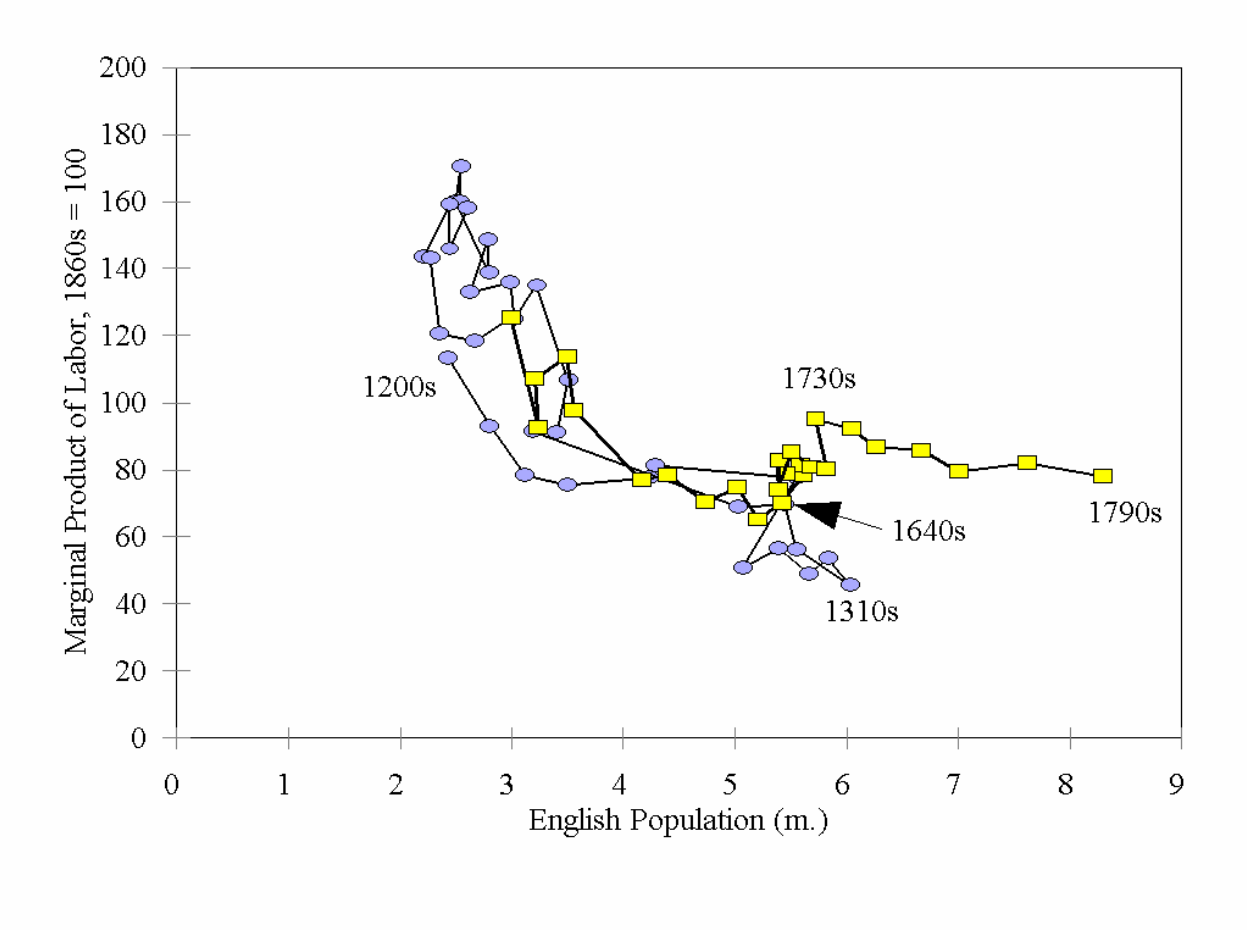
Figure 7: Estimated Medieval English Population



Notes:

Sources: Table 9.

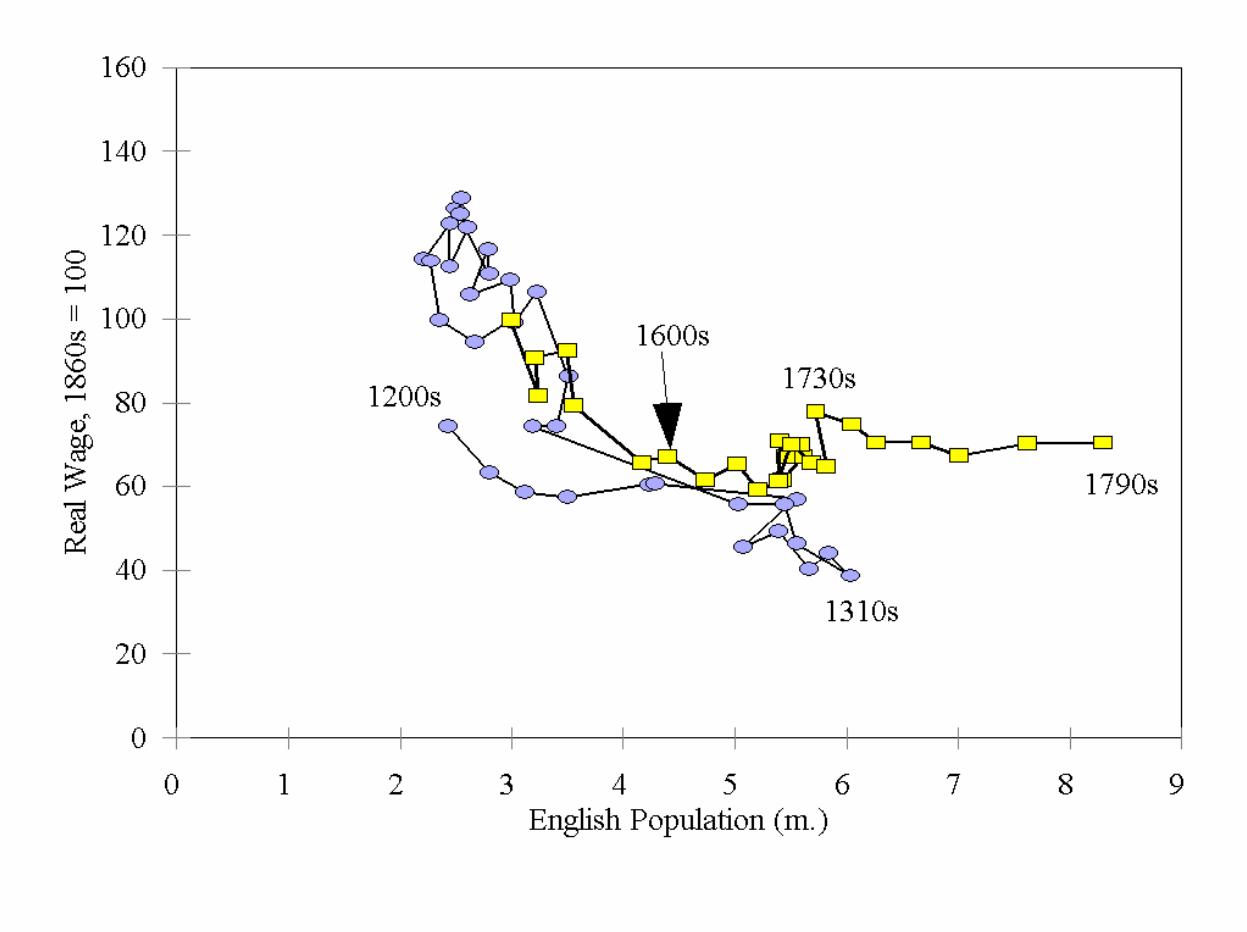
Figure 8: Suggested Pattern of Agricultural Progress in England



Notes: The population estimates used for this figure for the decades before the 1540s are those suggested by the trend in the sample communities, scaled up to national levels as suggested in the paper. They are shown by the oval markers.

Sources**:** MPL from table 1. Population 1200s-1520s from table 9, column 5. Population, 1540s-1790s, Wrigley et al., *Population History*. Population 1530s average of 1520s, 1540s.

Figure 9: Suggested Pattern of All Economic Gains in England



Sources**:** Real wage from table 1. Population as for figure 8.

Table 1: The Day Wages of Agricultural Workers by Decade, 1209-1869

Decade	Day Wage Quotes (Place-Years)	Threshing Rates (Place-years)	Raw Average Day Wage (d./day)	Estimated Day Wage (d./day)	Marginal Product of Labour (1860-9 = 100)	Purchasing Power, Day Wage (1860-9 = 100)
1200-9	-	3	-	1.35	106	69
1210-9	-	23	-	1.24	86	59
1220-9	-	29	-	1.22	72	54
1230-9	-	33	-	1.15	69	53
1240-9	1	41	1.45	1.22	75	55
1250-9	5	47	1.38	1.28	75	56
1260-9	1	66	1.50	1.30	71	53
1270-9	6	119	1.50	1.25	49	44
1280-9	16	165	1.51	1.32	59	51
1290-9	28	195	1.44	1.30	51	42
1300-9	50	196	1.50	1.32	55	45
1310-9	56	197	1.85	1.41	46	39
1320-9	30	180	2.04	1.51	54	44
1330-9	43	194	1.97	1.49	64	51
1340-9	51	236	1.79	1.46	63	51
1350-9	74	224	3.00	2.65	92	75
1360-9	67	131	3.29	2.74	90	74
1370-9	53	149	3.44	3.04	104	84
1380-9	63	144	3.44	3.09	128	101
1390-9	49	128	3.40	2.97	119	95
1400-9	67	101	3.66	3.44	133	107
1410-9	90	101	3.71	3.46	131	104
1420-9	75	58	3.90	3.47	146	114
1430-9	52	31	4.21	3.65	137	109
1440-9	56	56	4.45	3.63	158	125
1450-9	40	38	4.44	3.82	167	126
1460-9	20	20	4.50	3.58	156	122
1470-9	17	6	4.36	3.55	152	117
1480-9	17	6	3.89	3.53	143	111
1490-9	15	9	4.08	3.60	156	121
1500-9	19	13	3.89	3.35	138	110
1510-9	16	18	3.99	3.33	135	107
1520-9	24	17	4.39	3.47	114	94
1530-9	19	15	4.09	3.51	111	89
1540-9	36	9	5.74	4.07	120	95
1550-9	33	18	6.54	5.19	88	78
1560-9	32	9	7.89	6.26	103	87
1570-9	42	8	7.72	6.71	109	89
1580-9	55	16	7.52	6.71	96	78
1590-9	40	9	8.39	7.18	77	66

Table 1: The Day Wages of Agricultural Workers by Decade, 1209-1869 (cont.)

Decade	Day Wage Quotes (Place-Years)	Threshing Rates (Place-years)	Raw Average Day Wage (d./day)	Estimated Day Wage (d./day)	Marginal Product of Labour (1860-9 = 100)	Purchasing Power, Day Wage (1860-9 = 100)
1600-9	53	14	8.1	7.6	77	66
1610-9	73	18	8.9	8.0	69	61
1620-9	80	22	8.8	8.3	73	64
1630-9	62	10	8.6	8.9	65	59
1640-9	62	8	8.0	9.4	70	61
1650-9	52	10	11.7	10.1	78	66
1660-9	70	16	10.9	10.6	81	70
1670-9	108	26	11.5	9.9	78	66
1680-9	70	20	10.1	10.2	84	71
1690-9	119	15	10.4	9.7	74	61
1700-9	164	19	11.2	10.2	88	72
1710-9	134	17	10.5	9.9	78	64
1720-9	125	24	10.1	9.6	77	62
1730-9	135	56	10.2	10.8	95	77
1740-9	182	58	11.1	10.8	93	75
1750-9	196	49	12.2	10.9	86	70
1760-9	227	32	11.2	11.7	86	71
1770-9	155	30	11.4	12.5	80	68
1780-9	128	23	11.8	13.2	82	70
1790-9	157	34	14.5	15.6	80	72
1800-9	240	42	19.1	19.0	69	65
1810-9	274	39	23.2	23.0	75	70
1820-9	267	23	22.2	20.6	89	79
1830-9	345	33	21.3	20.3	92	84
1840-9	236	23	22.5	21.2	99	90
1850-9	180	17	22.4	21.9	104	98
1860-9	124	-	23.3	23.4	100	100

Sources: See text.

Table 2: The Types of Data Used in Estimating Day Wages

Type of wage quote	Numbers of Observations
Day Wage:	8,511
Winter (October-March)	2,074
Summer (April-September)	1,608
Harvest	726
Hay	616
Season unknown	3,675
Threshing Payment:	10,521
Wheat	2,447
Rye	545
Barley	2,262
Oats	2,024
Peas	967
Other	2,661

Source: Wage Payment Database.

Table 3: Comparison of Wages with Benchmark Estimates

Period	Source	Locations	Average Day Wage outside Harvest	Wage from Regression	Final Wage Estimate
1767-1770	Young	140	12.0	11.3	11.8
1832	Poor Law Report	931	20.9	19.9	20.9
1850	Gardeners' Chronicle	123	18.6	18.0	18.9
1860	Gardeners' Chronicle	70	22.0	21.0	22.0

Sources: See Clark, 'Farm Wages' for sources on the benchmark estimates.

Table 4: The Percentage of Expenditure by Category for Farm Labourers before 1869

Category of Expenditure	1787-96 (Horrell)	1840-54 (Horrell)	Assumed here
Food and Drink:	**77.0**	**68.6**	**73.0**
Bread and flour	40.1	33.5	0.0
Wheat	0.0	3.0	40.0
Barley	1.0	1.4	3.0
Oats and oatmeal	3.6	2.2	2.5
Peas	-	-	2.5
Potato	2.0	6.0	4.0
Farineous	**46.7**	**46.1**	**44.0**
Meat	9.2	3.4	10.5
Fish	0.0	0.0	0.0
Bacon	1.3	2.8	1.0
Eggs	0.0	0.0	0.5
Meat	**10.5**	**6.2**	**9.0**
Milk	4.0	3.2	4.3
Cheese	3.5	2.6	2.3
Butter	3.9	3.3	5.1
Dairy	**11.4**	**9.1**	**10.0**
Sugar and Honey	**3.6**	**3.1**	**3.0**
Beer	0.0	0.0	4.7
Tea	2.4	2.6	3.3
Coffee	0.0	0.0	0.0
Drink	**2.4**	**2.6**	**8.0**
Salt	**-**	**-**	**0.5**
Other Food	1.4	1.6	0.0
Housing	**6.0**	**10.1**	**6.0**
Fuel	**4.0**	**4.5**	**5.0**
Light	-	-	3.5
Soap	-	-	0.5
Light and Soap	**4.8**	**3.3**	**4.0**
Services	**0.1**	**0.7**	**0.5**
Tobacco	0.0	1.0	0.0
Other (Clothing, Bed linen)	**8.2**	**11.7**	**10.0**

Sources: Horrell, 'Home Demand', pp. 568-9, 577.

Table 5: Farm Labourers' Living Costs, 1209-1869

Decade	Grain and potato	Dairy	Meat	Drink	Fuel	Light	Housing	Clothing	Cost of Living
1200-9	4.2	5.8	3.9	-	-	14.8	-	16.7	**8.3**
1210-9	5.7	6.0	4.2	10.5	-	14.9	-	17.0	**9.2**
1220-9	6.5	6.3	5.6	12.0	-	23.1	-	15.8	**9.8**
1230-9	6.1	6.9	4.2	9.4	-	17.3	-	14.4	**9.4**
1240-9	6.6	7.2	6.1	12.0	-	24.5	-	18.4	**9.5**
1250-9	7.4	7.0	6.7	14.3	9.3	21.2	-	18.2	**10.1**
1260-9	7.0	7.8	7.0	16.2	-	27.0	-	19.2	**10.6**
1270-9	10.4	8.7	7.5	20.4	12.2	31.7	-	18.9	**12.1**
1280-9	8.7	8.0	7.8	20.7	13.4	28.9	10.5	21.2	**11.3**
1290-9	11.1	8.6	8.0	20.8	14.5	31.8	24.0	19.2	**13.3**
1300-9	8.8	8.8	8.9	22.7	15.0	39.2	21.2	23.0	**12.6**
1310-9	13.6	10.6	10.8	22.5	17.6	43.3	19.7	26.0	**15.8**
1320-9	11.3	10.7	10.0	36.1	17.7	44.8	16.2	22.5	**14.8**
1330-9	8.9	9.4	9.1	31.8	16.6	39.1	16.0	22.0	**12.7**
1340-9	8.6	9.1	8.9	27.3	18.9	38.8	14.6	20.0	**12.3**
1350-9	11.7	9.6	11.2	30.2	26.0	42.9	8.8	29.1	**15.3**
1360-9	11.7	10.0	11.0	39.5	24.2	45.5	10.1	30.2	**15.9**
1370-9	12.3	9.5	11.2	34.0	25.4	44.0	11.5	31.0	**16.0**
1380-9	8.5	8.7	10.6	28.8	23.5	42.3	10.0	30.8	**13.2**
1390-9	9.2	9.1	11.1	33.2	21.7	38.6	9.9	27.5	**13.6**
1400-9	9.8	8.5	11.6	28.2	20.5	39.2	11.1	27.0	**13.9**
1410-9	10.1	9.2	12.8	33.3	19.1	36.7	11.0	27.2	**14.4**
1420-9	8.4	9.1	12.4	27.6	19.7	34.0	10.3	27.6	**13.1**
1430-9	11.0	10.2	11.6	44.0	19.0	32.7	8.1	27.5	**14.5**
1440-9	8.2	9.2	10.6	31.8	17.6	32.5	7.9	26.9	**12.5**
1450-9	8.8	9.0	10.5	38.0	17.6	27.9	7.5	25.8	**12.9**
1460-9	9.0	8.0	10.2	29.5	17.5	29.5	7.8	27.2	**12.7**
1470-9	9.4	8.2	9.5	26.7	16.2	28.0	8.2	27.4	**12.8**
1480-9	10.7	8.9	9.3	29.7	14.2	27.6	8.4	27.2	**13.7**
1490-9	9.1	9.1	9.1	31.1	14.8	23.4	8.8	26.6	**12.8**
1500-9	10.3	8.1	8.5	29.8	15.3	22.6	8.1	28.1	**13.1**
1510-9	10.1	8.6	9.0	31.6	16.4	24.9	9.0	26.1	**13.5**
1520-9	13.9	9.4	10.1	32.3	17.7	25.9	8.8	28.0	**16.0**
1530-9	15.0	9.6	11.2	29.6	17.4	26.7	9.8	29.9	**17.0**
1540-9	16.6	12.4	15.7	27.5	18.3	29.9	9.3	31.1	**18.6**
1550-9	28.5	22.5	23.4	35.5	26.5	38.7	12.3	36.6	**29.0**

Table 5: Farm Labourers' Living Costs, 1209-1869 (cont.)

Decade	Grain and potato	Dairy	Meat	Drink	Fuel	Light	Housing	Clothing	Cost of Living
1560-9	25.7	26.6	26.0	39.8	30.8	50.7	19.5	43.2	**30.7**
1570-9	28.3	24.0	26.3	42.4	35.6	53.6	15.1	51.1	**32.5**
1580-9	33.6	25.7	28.8	43.6	38.6	58.7	19.9	54.3	**37.0**
1590-9	50.7	29.7	36.2	53.8	41.3	79.0	25.1	56.5	**47.7**
1600-9	48.2	31.5	37.2	62.4	46.9	80.6	26.0	61.7	**49.2**
1610-9	57.8	35.2	40.2	76.5	54.7	85.4	30.0	66.5	**56.5**
1620-9	56.0	35.1	41.3	78.7	55.3	86.3	27.2	71.7	**55.8**
1630-9	69.7	37.9	43.7	74.2	58.2	93.5	33.3	84.0	**64.6**
1640-9	68.8	42.6	47.4	75.9	73.4	101.9	28.8	92.9	**66.4**
1650-9	66.4	45.7	50.8	89.6	71.6	100.1	26.7	91.1	**66.3**
1660-9	64.3	47.1	51.0	94.0	76.9	102.2	31.7	90.9	**65.9**
1670-9	61.3	48.4	48.0	95.9	80.3	94.3	34.3	84.1	**64.2**
1680-9	54.2	47.9	48.7	103.9	80.3	88.0	38.3	81.9	**61.2**
1690-9	68.0	47.6	51.3	119.2	86.5	98.8	33.5	85.0	**69.1**
1700-9	52.7	43.1	48.4	120.9	88.8	90.7	39.7	84.2	**61.3**
1710-9	62.9	41.8	49.6	128.3	85.3	111.5	33.4	88.0	**66.6**
1720-9	60.7	43.5	48.9	133.8	84.2	106.2	35.6	87.6	**66.1**
1730-9	50.3	43.0	47.0	130.3	84.4	99.8	34.9	86.3	**59.9**
1740-9	51.5	45.8	49.0	128.6	95.1	120.2	30.2	89.0	**61.5**
1750-9	60.2	46.6	49.8	125.9	96.1	115.9	34.0	93.5	**66.8**
1760-9	66.0	47.9	54.2	127.9	96.4	125.0	34.7	97.2	**70.9**
1770-9	75.2	55.2	61.9	137.4	103.1	132.4	40.4	95.3	**78.7**
1780-9	77.0	57.3	64.1	132.2	103.2	138.4	39.5	94.9	**80.2**
1790-9	93.1	68.6	77.1	123.9	116.1	152.1	49.4	97.2	**92.9**
1800-9	133.4	96.9	109.9	161.1	146.4	196.6	72.1	110.9	**126.5**
1810-9	145.4	118.1	118.2	180.0	158.7	211.2	91.6	122.1	**141.2**
1820-9	102.7	103.7	95.5	163.4	142.5	129.3	91.9	115.7	**111.5**
1830-9	98.6	97.5	83.4	129.7	132.4	110.4	91.7	111.5	**103.3**
1840-9	100.9	95.3	83.5	115.9	117.7	104.5	85.0	108.8	**101.1**
1850-9	98.0	87.7	88.4	104.3	103.6	97.8	87.5	96.5	**96.2**
1860-9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	**100.0**

Notes: The index for each commodity and overall is set to 100 for 1860-9.

Table 6: Estimated Output per Man-Day from the Marginal Product of Labour

Period	Real Annual wage per male worker per 300 man-days (bu. of wheat equivalent)	Share of labour in farm costs (percent)	Output per acre (bu. wheat equivalent)	Output per 300 man-days (in bu. of wheat at 1860s prices)	Implied labor force (adult males m.)
1280-1349	58	38-49[a]	4.3	118-152	0.78-1.02
1400-99	152	(50-70)[b]	-	217-304	-
1770-9	79	39 [c]	8.4	202	0.75
1850-9	106	42 [d]	13.7	252	1.04
1860-9	102	41 [d]	13.7	249	1.01

Notes: [a]The high labor share comes from using rents estimated by Campbell from the Inquisitions Post Mortem. The low share comes from extrapolating back the series for rents and tithe in Clark, 'Agricultural Revolution'.

[b]This cost share by assumption only.

[c,d]These shares derived in Clark, 'Agricultural Revolution'.

Sources: Campbell, *English Seigniorial Agriculture*, Clark, 'Labour Productivity', Clark, 'Agricultural Revolution'.

Table 7: Task Specific Labor Productivities

Period	Threshing Wheat (bu/day)	Reaping Wheat – net output (bu/day)	Mowing Meadow (ac/day)
1300-49	5.1	4.5	0.51
1400-49	7.3	6.2	0.68
1768-71	4.2	7.9	0.94
1794-1806	4.3	8.6	1.02
1850	3.9	7.6	0.86
1860	-	7.9	0.83

Source: Clark, 'Labour Productivity', and the text.

Table 8: Male Workers Available and Required, Essex, Circa 1300

Place	Acres	Male Farm Workers, 1831	Expected Farm Workers, 1300	Males, 20+, circa 1300
Berden	1,771	64	53-72	45
Birdbrook	2,386	102	84-114	100
High Easter	4,725	210	173-235	225
Hatfield Broadoak	8,810	329	271-369	346
Margaret Roding	1,222	46	38-52	37
Great Waltham	7,335	364	300-408	232
Witham	3,633	223	184-250	63
Writtle	8,672	369	304-414	483
Total	38,554	1,707	1,407-1,913	1,532

Notes: The workers 12+ available in 1300 are calculated from tithe penny returns. Those aged 20+ in 1300 are estimated using the male age distribution of the 1851 census. The expected number of farm workers in 1300 in these villages is estimated by extrapolating back from the 1831 numbers assuming the ratio was the same as for the country as a whole between 1300 and 1831.

Sources: 1831 and 1851 Censuses of Great Britain. Poos, *A Rural Society*.

Table 9: Estimating Medieval English Population

Decade	Population of sample communities (1310s = 100)	Number of communities with population estimates	Number of people in sample	Sample population scaled to national levels (millions)	Population Implied by MPL (millions)	"Best" Population Estimate from MPL and sample communities (millions)
1200-9	40.3	1	506	2.38	3.26	-
1210-9	46.4	1	583	2.74	3.80	-
1220-9	51.7	1	649	3.05	4.36	-
1230-9	58.0	1	728	3.42	4.50	-
1240-9	70.1	1	880	4.14	4.21	-
1250-9	71.1	2	987	4.20	4.23	4.21
1260-9	92.0	3	1,667	5.43	4.42	4.92
1270-9	84.1	5	2,128	4.96	5.80	5.38
1280-9	89.4	7	3,013	5.28	5.09	5.18
1290-9	94.0	8	3,151	5.54	5.69	5.62
1300-9	96.7	10	3,516	5.71	5.36	5.53
1310-9	**100.0**	**12**	**4,020**	**5.90**	**6.06**	**5.98**
1320-9	91.9	12	3,464	5.43	5.26	5.34
1330-9	90.3	14	3,382	5.33	4.79	5.06
1340-9	83.4	11	2,414	4.92	4.81	4.86
1350-9	52.9	8	841	3.12	3.62	3.37
1360-9	56.4	8	986	3.33	3.67	3.50
1370-9	58.2	8	1,011	3.43	3.31	3.37
1380-9	53.4	9	1,400	3.15	2.82	2.99
1390-9	50.1	8	1,117	2.95	2.97	2.96
1400-9	49.5	7	992	2.92	2.73	2.83
1410-9	43.6	9	981	2.57	2.78	2.68
1420-9	46.2	11	762	2.72	2.55	2.64
1430-9	46.4	9	660	2.74	2.68	2.71
1440-9	41.4	8	731	2.44	2.40	2.42
1450-9	42.3	6	670	2.49	2.30	2.40
1460-9	42.2	6	634	2.49	2.43	2.46
1470-9	43.2	4	498	2.55	2.47	2.51
1480-9	40.6	4	468	2.40	2.59	2.49
1490-9	40.5	4	413	2.39	2.43	2.41
1500-9	36.6	3	175	2.16	2.68	2.42
1510-9	37.7	3	280	2.23	2.74	2.48
1520-9	39.1	4	308	2.31	3.11	2.71
1530-9	36.5	2	75	-	3.16	2.85
1540-9	44.0	1	70	-	2.99	[a] 2.99
1550-9	32.3	1	15	-	3.77	[a] 3.24
1560-9	47.3	1	22	-	3.34	[a] 3.21
1570-9	53.8	1	25	-	3.20	[a] 3.50
1580-9	53.8	1	25	-	3.52	[a] 3.55
1590-9	58.1	1	27	-	4.19	[a] 4.16

Notes: [a]Population from Wrigley et. al., *Population History*.

Table A1: The Values of the Control Coefficients in the Wage Regression

Variable	Coefficient Estimate	Standard Error	T-value	Percentage Effect
SUMMER	0.04	0.006	6.3**	+4
HARVEST – Pasture Ares	0.34	0.012	29.4**	+41
HARVEST – Grain Area	0.59	0.013	45.0**	+81
HAY	0.28	0.009	29.3**	+32
UNKNOWN SEASON	0.08	0.006	12.1**	+8
THRESH WHEAT (QU), 1209-1349	0.45	0.014	33.0	-
THRESH RYE (QU), 1209-1349	0.41	0.016	26.4	-
THRESH BARLEY (QU), 1209-1349	0.00	0.014	0.1	-
THRESH OATS (QU), 1209-1349	-0.35	0.014	-25.3	-
DWINNOW	0.11	0.008	14.0	11
$DTHRESH_{1350-1374}$	-0.28	0.020	-14.1	-24
$DTHRESH_{1375-1399}$	-0.32	0.021	-15.2	-27
$DTHRESH_{1400-1424}$	-0.35	0.020	-17.1	-30
$DTHRESH_{1425-1449}$	-0.35	0.024	-14.4	-30
$DTHRESH_{1450-1474}$	-0.38	0.034	-11.1	-32
$DTHRESH_{1475-1499}$	-0.41	0.065	-6.3	-34
$DTHRESH_{1500-1524}$	-0.29	0.052	-5.7	-25
$DTHRESH_{1525-1549}$	-0.11	0.042	-2.5	-10
$DTHRESH_{1550-1574}$	-0.04	0.041	-0.9	-4
$DTHRESH_{1575-1599}$	0.01	0.041	0.3	1
$DTHRESH_{1600-1624}$	0.02	0.033	0.7	2
$DTHRESH_{1625-1649}$	0.07	0.037	1.8	7
$DTHRESH_{1650-1674}$	0.25	0.030	8.3	29
$DTHRESH_{1675-1699}$	0.19	0.029	6.7	21
$DTHRESH_{1700-1724}$	0.18	0.027	6.8	20
$DTHRESH_{1725-1749}$	0.19	0.021	9.1	21
$DTHRESH_{1750-1774}$	0.21	0.023	9.1	23
$DTHRESH_{1775-1799}$	0.28	0.022	12.7	33
$DTHRESH_{1800-1824}$	0.24	0.020	12.2	27
$DTHRESH_{1825-1850}$	0.11	0.021	5.3	12

Notes: **= significantly different from 0 at the 1 percent level, *=significantly different from 0 at the 5 percent level.

Table A2: Nominal and Real Wages by Year, 1209-1869

Year	Nominal Wage	Real Wage	Year	Nominal Wage	Real Wage	Year	Nominal Wage	Real Wage
1209	1.36	70	1256	-	-	1303	1.32	48
1210	-	-	1257	1.31	49	1304	1.39	54
1211	1.15	53	1258	1.26	45	1305	1.35	45
1212	1.18	60	1259	-	-	1306	1.25	43
1213	-	-	1260	-	-	1307	1.24	44
1214	1.41	73	1261	1.32	-	1308	1.31	43
1215	-	-	1262	1.73	70	1309	1.28	37
1216	1.25	59	1263	1.28	51	1310	1.41	36
1217	-	-	1264	1.17	47	1311	1.33	35
1218	1.13	49	1265	1.26	51	1312	1.33	43
1219	1.36	60	1266	1.22	50	1313	1.35	44
1220	1.20	58	1267	-	-	1314	1.35	42
1221	1.28	54	1268	1.23	53	1315	1.37	39
1222	-	-	1269	1.26	48	1316	1.47	29
1223	-	-	1270	1.20	45	1317	1.60	32
1224	1.29	64	1271	1.24	42	1318	1.54	42
1225	1.25	50	1272	1.21	40	1319	1.43	53
1226	1.24	51	1273	1.28	48	1320	1.61	52
1227	1.12	46	1274	1.29	44	1321	1.51	44
1228	-	-	1275	1.29	42	1322	1.62	35
1229	-	-	1276	1.34	47	1323	1.48	36
1230	-	-	1277	1.24	40	1324	1.49	43
1231	-	-	1278	1.22	45	1325	1.52	41
1232	1.13	49	1279	1.30	50	1326	1.45	46
1233	1.19	54	1280	1.40	47	1327	1.44	53
1234	-	-	1281	1.36	50	1328	1.56	51
1235	-	-	1282	1.32	43	1329	1.51	44
1236	1.15	56	1283	1.31	43	1330	1.53	44
1237	1.18	52	1284	1.44	49	1331	1.45	38
1238	-	-	1285	1.37	56	1332	1.50	41
1239	-	-	1286	1.28	47	1333	1.48	51
1240	-	-	1287	1.32	54	1334	1.42	50
1241	-	-	1288	1.27	65	1335	1.50	54
1242	-	-	1289	1.24	57	1336	1.52	51
1243	-	-	1290	1.26	46	1337	1.53	56
1244	-	-	1291	1.38	44	1338	1.51	60
1245	1.17	61	1292	1.33	46	1339	1.55	66
1246	1.24	57	1293	1.29	43	1340	1.43	47
1247	1.24	48	1294	1.35	39	1341	1.44	56
1248	1.22	-	1295	1.32	36	1342	1.45	53
1249	1.27	56	1296	1.29	37	1343	1.50	57
1250	1.13	-	1297	1.28	45	1344	1.49	49
1251	1.48	66	1298	1.28	40	1345	1.47	57
1252	1.25	54	1299	1.30	41	1346	1.47	54
1253	1.26	50	1300	1.40	44	1347	1.45	43
1254	1.32	66	1301	1.38	46	1348	1.41	40
1255	1.28	61	1302	1.34	46	1349	1.59	58

Table A2 (cont.)

Year	Nominal Wage	Real Wage	Year	Nominal Wage	Real Wage	Year	Nominal Wage	Real Wage
1350	2.94	89	1397	3.21	91	1444	3.71	133
1351	3.07	81	1398	2.95	87	1445	3.64	138
1352	2.73	64	1399	3.42	106	1446	3.71	123
1353	2.53	75	1400	3.40	102	1447	3.54	111
1354	2.64	88	1401	3.47	98	1448	3.67	123
1355	2.57	73	1402	3.50	88	1449	3.70	121
1356	2.69	75	1403	3.50	101	1450	3.74	122
1357	2.64	70	1404	3.53	118	1451	4.36	135
1358	2.37	63	1405	3.41	117	1452	3.87	124
1359	2.53	72	1406	3.46	126	1453	3.69	117
1360	2.47	68	1407	3.50	121	1454	3.86	128
1361	2.62	71	1408	3.53	107	1455	3.71	133
1362	2.64	77	1409	3.44	97	1456	3.69	129
1363	2.69	69	1410	3.54	87	1457	3.76	132
1364	2.89	70	1411	3.49	100	1458	3.78	121
1365	2.90	78	1412	3.49	112	1459	4.12	127
1366	2.94	85	1413	3.49	116	1460	3.58	111
1367	2.81	79	1414	3.58	121	1461	3.64	104
1368	2.91	74	1415	3.61	119	1462	3.75	109
1369	2.73	68	1416	3.39	95	1463	3.58	135
1370	2.80	51	1417	3.44	90	1464	3.70	145
1371	2.90	73	1418	3.32	98	1465	3.73	140
1372	3.01	85	1419	3.59	104	1466	3.66	131
1373	3.07	78	1420	3.12	102	1467	3.43	117
1374	3.06	89	1421	3.53	107	1468	3.58	116
1375	3.28	79	1422	3.41	112	1469	3.48	114
1376	3.25	77	1423	3.34	118	1470	3.59	114
1377	3.17	99	1424	3.70	127	1471	3.18	97
1378	3.10	104	1425	3.65	117	1472	4.25	139
1379	3.06	108	1426	3.64	122	1473	3.34	117
1380	3.19	93	1427	3.49	120	1474	3.78	139
1381	3.18	95	1428	3.69	129	1475	-	-
1382	3.07	98	1429	3.52	95	1476	-	-
1383	3.14	99	1430	3.69	101	1477	4.05	137
1384	3.08	99	1431	3.58	116	1478	3.34	105
1385	3.10	103	1432	3.60	126	1479	3.12	96
1386	3.22	97	1433	3.77	108	1480	3.06	101
1387	3.09	102	1434	3.61	117	1481	3.27	106
1388	3.18	114	1435	3.69	121	1482	3.26	91
1389	2.97	112	1436	3.66	116	1483	4.77	124
1390	2.91	86	1437	3.47	111	1484	3.65	106
1391	3.13	79	1438	4.10	99	1485	3.94	132
1392	2.59	82	1439	3.66	80	1486	3.66	123
1393	2.92	109	1440	3.77	106	1487	4.22	137
1394	2.79	98	1441	3.63	141	1488	2.95	98
1395	3.01	104	1442	3.59	133	1489	2.92	93
1396	3.08	106	1443	3.66	129			

Table A2 (cont.)

Year	Nominal Wage	Real Wage	Year	Nominal Wage	Real Wage	Year	Nominal Wage	Real Wage
1490	2.76	88	1537	4.19	102	1584	6.59	82
1491	2.51	78	1538	3.51	95	1585	6.39	75
1492	5.40	174	1539	3.34	91	1586	6.82	67
1493	-	-	1540	4.01	108	1587	7.64	74
1494	3.86	133	1541	4.36	108	1588	7.21	85
1495	3.57	131	1542	4.20	109	1589	6.21	70
1496	3.68	138	1543	4.04	100	1590	7.21	73
1497	3.24	100	1544	4.11	95	1591	6.47	64
1498	3.69	122	1545	3.61	72	1592	6.95	78
1499	3.96	125	1546	3.88	69	1593	7.27	79
1500	3.19	113	1547	4.24	104	1594	7.27	69
1501	3.36	99	1548	4.00	97	1595	7.87	65
1502	3.30	94	1549	4.14	81	1596	7.72	60
1503	3.82	118	1550	5.46	82	1597	7.25	51
1504	3.33	103	1551	4.72	66	1598	7.68	57
1505	3.07	100	1552	5.27	82	1599	5.93	54
1506	3.38	114	1553	5.20	93	1600	7.52	68
1507	3.38	112	1554	5.31	92	1601	7.21	64
1508	3.33	109	1555	5.18	74	1602	6.68	63
1509	3.26	133	1556	5.40	65	1603	7.20	68
1510	3.44	133	1557	6.10	67	1604	7.42	69
1511	3.44	127	1558	5.17	87	1605	7.54	67
1512	3.39	109	1559	4.02	63	1606	7.92	71
1513	3.00	82	1560	6.12	87	1607	8.38	72
1514	3.24	100	1561	6.22	81	1608	8.00	59
1515	3.03	95	1562	6.17	81	1609	6.89	50
1516	3.59	105	1563	5.91	77	1610	8.22	67
1517	3.17	109	1564	6.29	79	1611	8.37	67
1518	3.37	100	1565	6.27	95	1612	7.90	60
1519	3.51	102	1566	6.66	95	1613	7.26	52
1520	4.14	110	1567	6.55	98	1614	8.33	61
1521	3.70	91	1568	5.83	87	1615	7.14	53
1522	3.51	97	1569	6.53	89	1616	7.76	57
1523	3.70	104	1570	7.31	109	1617	8.16	59
1524	3.82	108	1571	6.04	93	1618	7.86	58
1525	3.01	92	1572	5.83	82	1619	8.05	64
1526	3.10	100	1573	7.94	104	1620	7.77	66
1527	3.03	87	1574	7.04	78	1621	7.99	66
1528	3.35	65	1575	7.10	95	1622	7.54	53
1529	3.22	81	1576	6.08	79	1623	8.20	59
1530	4.21	102	1577	6.35	73	1624	7.49	56
1531	3.60	87	1578	6.50	82	1625	8.25	61
1532	3.22	78	1579	6.90	89	1626	8.62	62
1533	3.61	85	1580	6.23	84	1627	8.36	66
1534	4.23	116	1581	6.75	78	1628	8.84	70
1535	2.89	71	1582	6.88	81	1629	8.82	68
1536	2.23	54	1583	6.29	78			

Table A2 (cont.)

Year	Nominal Wage	Real Wage	Year	Nominal Wage	Real Wage	Year	Nominal Wage	Real Wage
1630	8.14	53	1677	9.33	64	1724	9.56	66
1631	8.91	54	1678	9.93	65	1725	9.23	59
1632	8.41	56	1679	9.24	60	1726	9.63	60
1633	8.83	61	1680	9.82	67	1727	9.97	64
1634	8.39	59	1681	10.44	68	1728	9.85	55
1635	8.77	59	1682	9.58	64	1729	9.98	58
1636	9.84	66	1683	9.86	67	1730	10.67	72
1637	8.54	56	1684	9.83	65	1731	10.66	77
1638	8.90	54	1685	9.88	62	1732	10.50	82
1639	9.25	63	1686	10.99	78	1733	10.87	83
1640	9.24	68	1687	8.77	64	1734	10.50	74
1641	9.52	64	1688	9.50	73	1735	10.73	72
1642	9.55	70	1689	10.17	80	1736	10.94	74
1643	9.14	64	1690	9.42	71	1737	10.88	76
1644	8.79	61	1691	9.42	72	1738	10.87	78
1645	8.73	61	1692	9.82	64	1739	10.72	75
1646	8.90	59	1693	9.36	55	1740	10.15	61
1647	9.80	56	1694	10.05	60	1741	10.45	61
1648	9.56	49	1695	9.41	60	1742	10.55	72
1649	9.30	49	1696	9.89	56	1743	10.43	79
1650	9.78	52	1697	9.19	52	1744	10.37	82
1651	10.45	60	1698	9.57	51	1745	10.45	79
1652	9.29	58	1699	9.64	55	1746	10.63	74
1653	9.81	66	1700	9.56	61	1747	10.51	75
1654	9.97	79	1701	9.66	68	1748	10.92	75
1655	9.38	75	1702	10.06	72	1749	10.92	75
1656	12.32	85	1703	10.06	76	1750	10.67	74
1657	9.13	59	1704	9.85	68	1751	10.63	71
1658	10.75	65	1705	9.52	71	1752	10.80	69
1659	9.29	53	1706	9.87	74	1753	10.77	70
1660	9.65	59	1707	9.80	74	1754	10.93	72
1661	9.04	52	1708	10.03	69	1755	10.98	75
1662	9.91	54	1709	9.23	51	1756	10.45	66
1663	11.28	71	1710	9.29	49	1757	11.01	59
1664	13.39	84	1711	9.76	58	1758	10.97	64
1665	9.61	65	1712	9.78	63	1759	11.01	73
1666	11.49	81	1713	9.72	62	1760	11.47	80
1667	10.46	77	1714	10.16	62	1761	11.25	77
1668	10.17	74	1715	10.20	70	1762	11.20	72
1669	9.48	65	1716	10.13	66	1763	11.09	68
1670	9.97	68	1717	10.49	69	1764	11.03	66
1671	9.75	67	1718	10.23	71	1765	11.34	65
1672	9.83	70	1719	9.75	70	1766	11.53	66
1673	9.92	66	1720	10.11	66	1767	12.86	67
1674	9.54	56	1721	9.83	67	1768	11.47	62
1675	10.10	62	1722	9.38	66	1769	11.45	68
1676	10.22	74	1723	10.50	73			

Table A2 (cont.)

Year	Nominal Wage	Real Wage	Year	Nominal Wage	Real Wage	Year	Nominal Wage	Real Wage
1770	11.5	69	1810	21.8	63	1850	18.9	94
1771	12.0	65	1811	22.6	68	1851	19.0	98
1772	12.1	62	1812	24.5	65	1852	19.6	100
1773	11.7	60	1813	25.4	67	1853	20.9	93
1774	12.2	62	1814	24.1	73	1854	23.5	94
1775	12.2	64	1815	22.6	75	1855	23.9	91
1776	12.7	73	1816	21.2	72	1856	24.3	95
1777	12.5	68	1817	22.5	68	1857	23.4	96
1778	12.3	66	1818	21.8	66	1858	22.9	104
1779	12.1	71	1819	22.1	72	1859	23.8	109
1780	12.4	72	1820	22.7	79	1860	22.0	91
1781	13.3	70	1821	20.9	80	1861	22.7	94
1782	13.4	69	1822	18.0	77	1862	23.4	97
1783	13.4	66	1823	18.7	78	1863	22.5	102
1784	13.0	67	1824	19.6	75	1864	22.3	106
1785	12.7	68	1825	21.2	75	1865	22.7	104
1786	12.5	68	1826	21.0	78	1866	24.0	100
1787	12.6	68	1827	20.5	78	1867	25.0	98
1788	12.9	70	1828	20.3	76	1868	25.7	102
1789	12.8	67	1829	20.6	80	1869	24.7	106
1790	14.4	72	1830	20.0	77			
1791	15.1	76	1831	21.3	82			
1792	14.1	74	1832	20.9	87			
1793	14.6	73	1833	20.4	88			
1794	14.1	67	1834	19.7	88			
1795	14.2	59	1835	19.1	89			
1796	15.4	61	1836	19.3	84			
1797	15.7	70	1837	20.2	82			
1798	16.1	72	1838	20.4	81			
1799	16.5	67	1839	21.2	77			
1800	17.6	54	1840	21.5	81			
1801	17.7	51	1841	21.7	84			
1802	17.6	67	1842	21.5	89			
1803	18.1	71	1843	20.6	96			
1804	19.0	73	1844	20.8	94			
1805	19.7	66	1845	20.8	93			
1806	19.8	68	1846	21.1	88			
1807	19.4	65	1847	21.9	80			
1808	20.6	67	1848	21.4	95			
1809	21.8	65	1849	20.5	95			