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Interpreting English Economic History 1200-1800: Malthusian Stasis or Early Dynamism?

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Abstract

The paper outlines the Malthusian theory of income determination in pre-industrial society, and asks how successfully it can explain economic life in England 1200-1800. The paper finds that the core prediction of the Malthusian model is borne out empirically for pre-industrial England 1200-1640. Population was seemingly the sole determinant of living standards, with no sign of any gain once population is controlled for between 1250 and 1640. Although after 1640 the tradeoff between population and living standards is no longer evident, there is no evidence that efficiency gains in the economy are strong enough to have broken the Malthusian equilibrium before 1800.

However, a more searching test that involves measuring the efficiency of the economy directly finds a puzzle. Efficiency on average increased little between 1200 and 1800, which fits nicely with the Malthusian interpretation. But in the Malthusian era there should be a positive connection between efficiency and population. Instead, before 1640 the correlation is clearly negative. Periods of lower population were those of higher efficiency. The majority of the gains in income per person between 1300 and 1450, for example, seem to be caused by efficiency advances rather than as a direct result of the great decline in population. Thus population up to 1650 did control living standards, but by mechanisms not foreseen in the simple Malthusian model.

The Malthusian View of the Pre-Industrial World

The paper tests whether the English economy in the years 1200-1800 was still Malthusian, and whether most economic developments in this interval should be understood within this framework. In particular were the most important developments within the economy were accounted for by demographic changes, with technological and institutional changes having little impact? It thus tests a stark version of the "Neo-Malthusianism" that Brenner famously accused M.M. Postan and his students of having applied to the medieval era in England.[1] Here the model is first set out, and its predictions explained. In the next section we test if the model correctly predicts developments in England 1200-1800.

In its simplest version there are just three assumptions in the Malthusian model:

1. The BIRTH RATE was a socially determined constant, independent of material living standards.

2. The DEATH RATE declined as living standards increased.

3. MATERIAL LIVING STANDARDS declined as population increased.

With these assumptions, pre-industrial economies will typically experience an equilibrium like the one described in figure 1 below. *y* in the figure measures material living standards. The top panel shows assumptions (1) and (2), with B the birth rate and D the death rate. These together ensure that there is an equilibrium living standard y*, which is the "subsistence income" where births just equal deaths. Notice that this subsistence income is determined without any reference to the production technology of the society. It depends only on the factors which determine the birth rate and those that determine the death rate. Once we know these we can determine the

[1] Brenner, 1976. M.M. Postan and John Hatcher went out of their way in a reply to Brenner to deny the "Neo-Malthusian" label, and insist that population was only one element in explaining medieval economic change (Postan and Hatcher, 1978). So this paper effectively adopts the position Brenner was accused of setting up as a straw man!

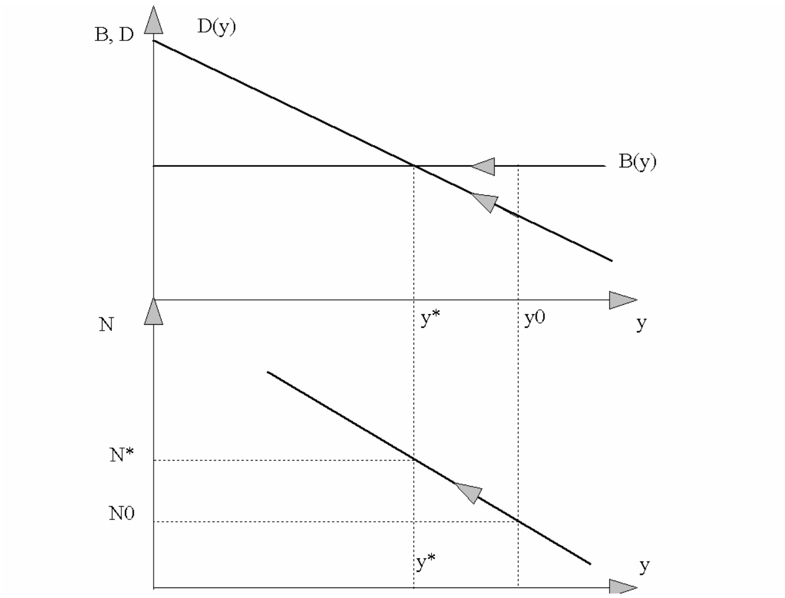

Figure 1 Long Run Equilibrium in the Malthusian Economy

subsistence income.

Suppose we start at an arbitrary initial population: N_0 in the diagram. This will imply an initial income: y_0. The income will in turn imply particular birth and death rates. In figure 4 these have been drawn so that births exceed deaths, and y_0 exceeds the subsistence income. Population will thus grow. As it grows, income declines. As long as the income exceeds the subsistence level population growth will continue, and income continue to fall. Only when income has fallen to the subsistence level will population growth cease, and the population stabilize.

The terminology "subsistence income" can lead to the confused notion that in a Malthusian economy people were all living on the brink of starvation, like the inmates of some particularly nasty Soviet Era Gulag. In fact in almost all Malthusian economies, and in particular in England 1200-1800, the subsistence income considerably exceeded the income required to allow the population to feed itself from day to day. Differences in the location of the mortality and fertility schedules generated very different subsistence incomes. What was subsistence for one society was extinction for others.

Thus the Malthusian model does not, as is sometimes vulgarly assumed, imply one fixed subsistence living standard at the brink of starvation. Malthusian societies can be relative rich. The key point is that the level of income has nothing to do with the production technology.

Both 1400 and 1650, for example, were periods of population stability in England, and hence periods where by definition the income was at subsistence. But the wage of the poorest workers, unskilled agricultural laborers, was equivalent to about nine pounds of wheat per day in 1650, compared to eighteen pounds in 1400. Even the lower 1650 subsistence wage was well above the biological minimum of about 1,500 calories a day. A diet of a mere two pounds of wheat per day, supplying 2,400 calories per day, would keep a laborer alive and fit for work.

The bottom panel of figure 1 illustrates the third assumption. That panel has on the vertical axis population. The downward sloping curve shows the assumed inverse connection between population and material incomes. This can be called the "technology schedule" since its location will depend of the level of the technology in the economy. The justification for the decline in material incomes with higher population is the existence of an important fixed factor in the pre-industrial world, land. This limited supply implied that average output per worker fell as the labor supply increased in any society, as long as the technology was static. Consequently the average amount of material consumption available per person fell with population increases.

If the society experiences a long run upward shift in birth rates, then as figure 2 shows, the population will grow and the level of material income fall. If alternative the death rate at any given level of income increases, then the population will fall, and the subsistence income will be higher at the new equilibrium.

While the real income was determined from the birth and death schedules, the population size depended on the connection between population and real incomes. Above I labeled this the "technology" schedule, because in general, as we shall see the major cause of changes in this schedule has been technological advances. But other things could shift this schedule: a larger capital stock, improvements in the terms of trade, climate changes, and a more productive organization of the economy.

Figure 4 shows a switch from an inferior technology, represented by curve T_0, to a superior technology, represented by curve T_1. Since population can only change slowly, the short run effect of a technological improvement is an increase in real incomes. The increase in real incomes reduces the death rate, so that now births exceed deaths and population grows. The growth of population only ends when the income has returned to the subsistence level. At this equilibrium the only effect of the technological change has been to increase the population supported. There has been no lasting change in the living standards of the average person. The path of adjustment to a one time improvement in technology is shown in the figure.

A steady rate of technological advance, or any other souce of efficiency advance, would imply that there was steady growth in population in the pre-industrial world. In fact if g_A is the growth rate of technology, g_N the growth rate of population, and c the share of land rents in

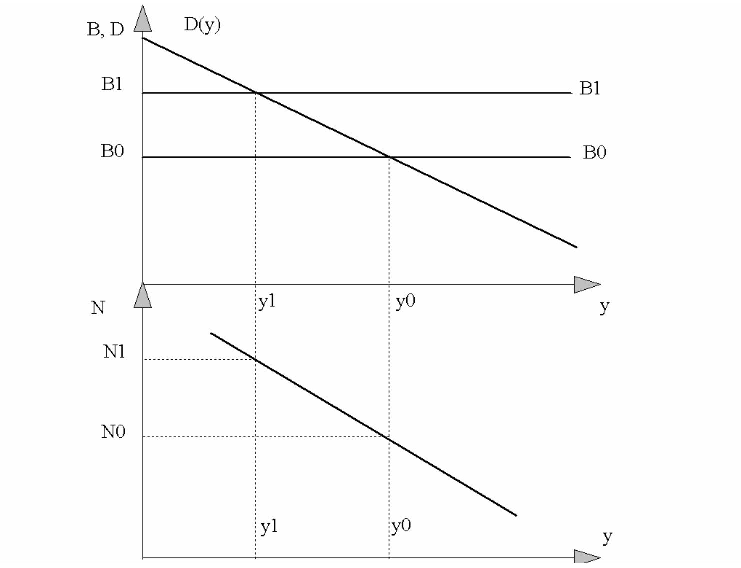

Figure 2 Changes in the Birth Schedule

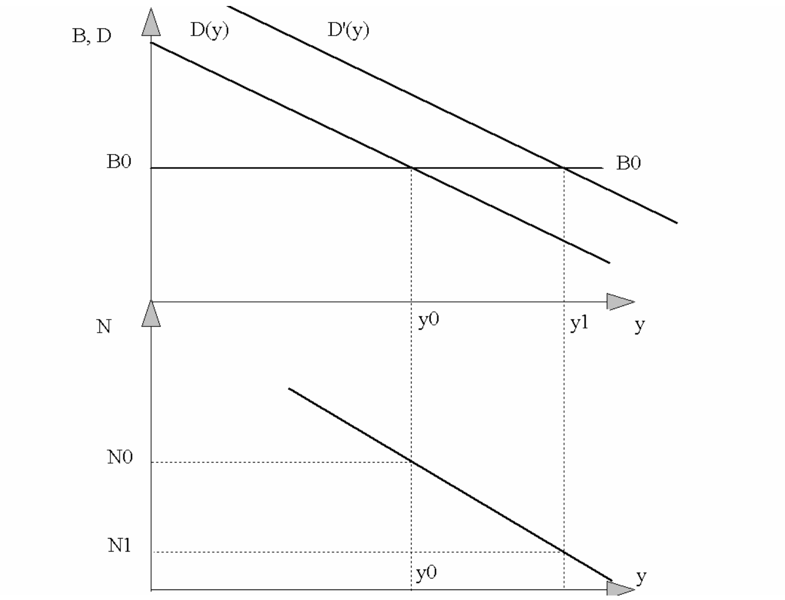

Figure 3 Changes in the Death Schedule

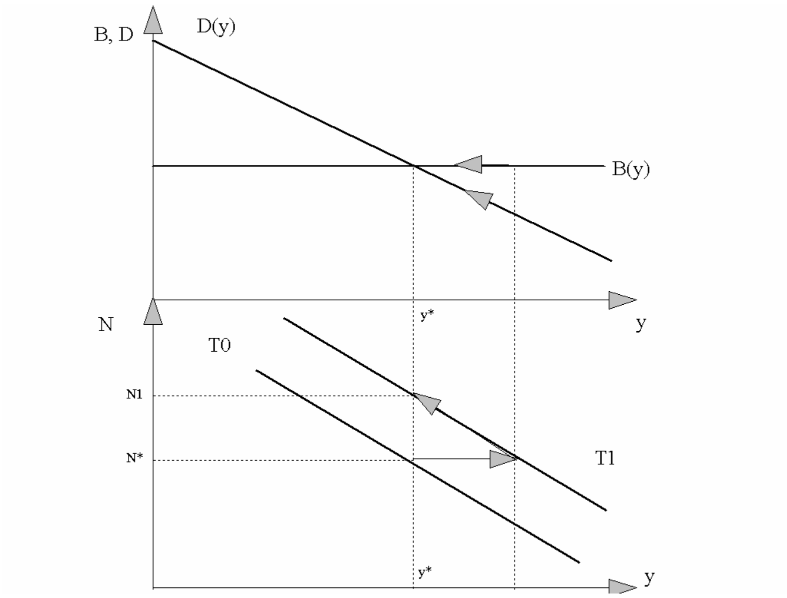

Figure 4 The Effects of Technological Advance

income, then

$$g_N = \left(\frac{1}{c}\right) g_A$$

Thus a steady rate of technological advance will raise living standards. But unless the death rate changes very little with income, then this increase with slow technological advance will be very modest. The major determinant of living standards will instead be the location of the birth and death schedules.

Political Economy in a Malthusian World

In the Malthusian period the only determinants of high and low income societies were the location of the birth and death schedules across different societies, and across different time periods. Thus good government in the modern sense – stable institutions, well defined property rights, low inflation rates, low marginal tax rates, free markets, free trade, avoidance of armed conflict – would all either make no difference to living standards in the Malthusian Era, or would indeed lower livings standards. Thus if England 1200-1800 was truly Malthusian incomes were raised by disorder, and lowered by good government.

To take one example, suppose that the King were to have levied a poll tax on every person in the economy equivalent to ten percent of average income. Suppose also that, as was the wont of such sovereigns, the proceeds of the tax were simply frittered away: on palaces, cathedrals, mosques, or temples, or armies. Despite the waste, in the long run this would have no effect on the welfare of the average person. To understand why refer back to figure 4. The tax would act like a shock to the technology of the economy, shifting the lower curve left by ten percent uniformly. In the first instance, with the existing stock of people, the tax reduces incomes per person by ten percent, thus driving up death rates above birth rates. But in the long run after tax incomes must return to their previous level to stabilize population again. At this point population is sufficiently smaller so that everyone earns a high enough wage that after paying the tax they have sufficient left over to equal their old pre-tax earnings. In the long run exactions by the state have no effect in the Malthusian economy on welfare or life expectancy. Luxury, waste, extravagance by the sovereign all had no cost to the average citizen in the long run! Similarly restrictions on trade and obstructive guild rules were again costless.

So far we have just considered actions by government that shift the effective consumption possibilities for a society. Governments could also through their policies directly affect birth rates and death rates. War, banditry, and disorder all increased death rates at given levels of income (though war often killed more through the spread of disease than from the direct violence). But all increases in death rates make societies better off in material terms. Here "bad" government not only does not hurt people, it makes them better off. Good governments, those that, for example, as in some periods in Imperial Rome and Imperial China, stored grains in public granaries against harvest failures, just make life more miserable by reducing the periodic death rate from famines at any given average material living standard.

The Malthusian Model and English Economic Growth, 1200-1800

In the millennia leading up to 1800 there were significant improvements in some production technologies, though these improvements happened slowly and sporadically. The technology of England in 1800, which included cheap iron and steel, cheap coal for energy, canals to transport goods, firearms, and sophisticated sailing ships, was in some ways significantly advanced on the technology of England in 1200.

But though technology was advancing before 1800, the rate of advance was always slow relative to the world after 1800: so slow that economies like England could not escape the Malthusian dictates. Efficiency advances should have resulted only in population growth. In particular we shall see that after 1650 the technology curve does shift upwards, but not at a rate fast enough to cause any sustained increase in output per person beyond what was seen in earlier years in the decades before 1800. Instead technological advance, as predicted, resulted mainly in a larger and larger English population. In particular in the later eighteenth century all technological advance was absorbed immediately into higher population. Before 1800 the rate of technological advance in any economy was so low that incomes were condemned to return to the Malthusian Equilibrium.

Thus the paper argues that most of the changes in population and living standards in England between 1200 and 1800 must have purely demographic roots. In particular, England's emergence by 1750 as the richest society in Europe, and possibly also the richest society in the world, did not owe much to England's technological or institutional advances in the years 1650-1750, but instead to the low birth rate which kept English living standards high.

Testing the Malthusian Explanation: Wages versus Population

Was the economy in England from 1200 to 1800 technologically stagnant? Did population determine living standards? In particular was there a fixed trade off between wages and population?

To carry out this particular test we need an estimate of English population before 1540 when parish registration of baptisms and deaths allow for an estimation of a national series. Existing 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 suggested 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 have evidence for the years 1300-1500, have estimated a much bigger maximum population of 6 to 6.5 million people.[2]

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

Below population trends for the medieval period for the years 1200-1530 are estimated from the records of 21 medieval communities, as described in detail in Clark (2006). 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 national populations from these micro studies.

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-Needham, Iver, and Warboys.[3] 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.[4] Larry Poos more recently tabulated these payments for a group of 13 Essex manors from the 1270s to the 1590s.[5] 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

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

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3 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*.

4 Titow, 'Some Evidence'.

5 Poos, *A Rural Society*.

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 1, 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. Column 5 of table 1 shows the national population totals implied by the sample of medieval communities with population estimates. Note, however, that the population trend in the before 1250 is based on estimated population in one town only (Taunton).

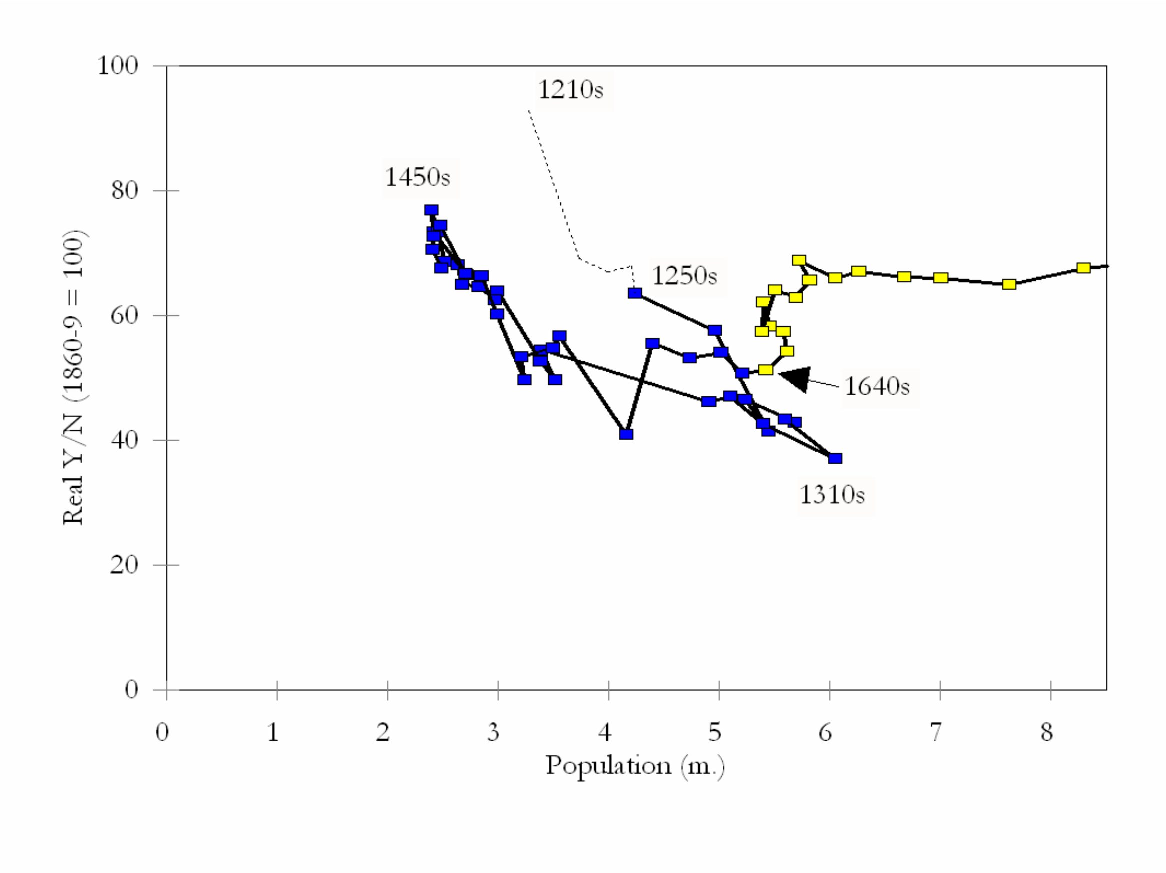
Figure 5 shows, by 10 year intervals, estimated real income per person in England versus the estimated population from the 1200s to 1790s. The estimation of real income is described in the appendix. The decades from the 1270s to the 1630s, shown by the darker markers, essentially fall along one curve. Thus for nearly 400 years from the high middle ages to the early seventeenth century the economy seems caught in a stasis where the only determinant of living standards is population. The decades from the 1210s to the 1260s, however, lie above this curve implying that there was some regression of the economy in the thirteenth century. However, the

Table 1: 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)
1200-9	40.3	1	506	2.38
1210-9	46.4	1	583	2.74
1220-9	51.7	1	649	3.05
1230-9	58.0	1	728	3.42
1240-9	70.1	1	880	4.14
1250-9	71.1	2	987	4.20
1260-9	92.0	3	1,667	5.43
1270-9	84.1	5	2,128	4.96
1280-9	89.4	7	3,013	5.28
1290-9	94.0	8	3,151	5.54
1300-9	96.7	10	3,516	5.71
1310-9	100.0	12	4,020	5.90
1320-9	91.9	12	3,464	5.43
1330-9	90.3	14	3,382	5.33
1340-9	83.4	11	2,414	4.92
1350-9	52.9	8	841	3.12
1360-9	56.4	8	986	3.33
1370-9	58.2	8	1,011	3.43
1380-9	53.4	9	1,400	3.15
1390-9	50.1	8	1,117	2.95
1400-9	49.5	7	992	2.92
1410-9	43.6	9	981	2.57
1420-9	46.2	11	762	2.72
1430-9	46.4	9	660	2.74
1440-9	41.4	8	731	2.44
1450-9	42.3	6	670	2.49
1460-9	42.2	6	634	2.49
1470-9	43.2	4	498	2.55
1480-9	40.6	4	468	2.40
1490-9	40.5	4	413	2.39
1500-9	36.6	3	175	2.16
1510-9	37.7	3	280	2.23
1520-9	39.1	4	308	2.31

Source: Clark (2006).

Figure 5 Real Income per person versus Population, 1210s-1790s.



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.

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

population estimates for these decades are extremely weak. After the 1630s there is sign that if there was a tradeoff between population and living standards, that tradeoff was advancing outward, though at a modest rate until the late eighteenth century. The decline of population from 5.9 million in the 1310s to 2.5 million in the 1450s is associated with a slightly more than doubling of real income per person. Population is thus not only linked to income per person, but seems to have a very profound effect on income.

Figure 5 thus suggests that the Malthusian model is the correct description for England until at least the seventeenth century, and perhaps indeed to 1800. Figure 5 also supports the key Malthusian idea that living standards were independent of the level of technology. Living standards were higher in the 15th century than in the 18th century, despite the seeming advance in technology over the interval.

Testing the Malthusian Explanation: Efficiency

The empirical results above are consistent with the Malthusian model, but they are only indirect tests of the idea of slow efficiency growth. An alternative approach is to directly estimate the level of efficiency of the economy: the output per unit of input, in a way that is independent of the size of the population. To measure the efficiency of the economy before 1800 the paper uses a key set of prices in the economy: farm wages, building wages, returns on capital, farmland rents, the average price of the output of the economy as a whole, and the average price of the output of the farm sector. The appendix details how these indexes were constructed.

With these price indexes we can construct measures both of the efficiency of the economy as a whole, and of the farm sector specifically. The efficiency of any competitive economy, or indeed of any sector within the economy, can be estimated simply as the ratio between the average cost of the production inputs - capital, labor and land - per unit and the average output price per unit. That is

$$A = \frac{\text{average cost of a unit of inputs}}{\text{average price of a unit of output}} \quad (1)$$

More efficient economies produce more output per unit of input. Since the value of payments to inputs has to equal the value of outputs, in more efficient economies output prices are low relative to input prices. The exact details of this computation are given in the appendix, but the concept itself is simple. Indirect taxes can drive a wedge between the costs per unit of inputs and the price of output, but in the calculations we make an allowance for these also.

The basic measure of productivity reported in the figures, A, is an index

$$A_t = \frac{(r_t + \phi)^a \, p_{Kt}{}^a w_t{}^b s_t{}^c}{p_t(1-\tau_t)} \quad (2)$$

where, r = real interest rate on safe assets, ϕ = an allowed rate for depreciation, p_K = index of the price of capital, w = index of nominal wages , s = index of nominal farmland rents, τ = share of national income collected in indirect taxes.). *a, b, c* are the shares in factor payments of capital, labor and land respectively. These shares are changed every 10 years to reflect changes in the earnings of the different factors over time.[6] Despite its more complicated form, (2) is just a particular way of implementing equation (1).

Equation (2) can be rewritten also as

[6] Thus though the index has the Cobb-Douglas form, the changing weights imply that there is no underlying assumption of a Cobb-Douglas technology. In fact the index is agnostic on the form of the production function, except for an assumption that the capital share is unchanging.

$$A_t = \left[\frac{(r_t+\phi)p_{Kt}}{p_t(1-\tau_t)}\right]^a \left[\frac{w_t}{p_t(1-\tau_t)}\right]^b \left[\frac{s_t}{p_t(1-\tau_t)}\right]^c = MP_K{}^a MP_L{}^b MP_{land}{}^c$$

The efficiency of the economy is thus a weighted average of the implied marginal products (MP) of capital, labor and land. MP_L is just the amount of output the last worker hired must produce in order that the value of his production equals his wage. MP_K and MP_{land} have similar interpretations. Thus a gain in efficiency corresponds to a gain on average in the payment of each factor relative to output prices (corrected for indirect taxes).

Figure 6 shows the calculated level of efficiency, using this measure, for the English economy as a whole 1200-1800. The dotted lines show the estimates for individual years, the solid line a 10 year moving average. While there are significant swings up and down there is little or no overall upwards movement of efficiency in the years 1200-1800. The improvements in efficiency that are evident in the years 1600-1800 were preceded by an equivalent decline in the measured efficiency of the economy 1450-1600. If the data is correct, amazingly there was no gain in efficiency in the English economy between 1200 and 1800! The data for the early 13th century is the most limited and uncertain, but certainly the 15th century had efficiency levels as high or higher than England in the 1790s.

The shorter term movements in efficiency before 1600 are, however, puzzling. For the efficiency measure is designed to purge the influence of such factors as the population size, and measure the performance of the economy in a way that is independent of the particular mix of inputs. Yet efficiency correlates negatively with the level of population, at least before 1600. If

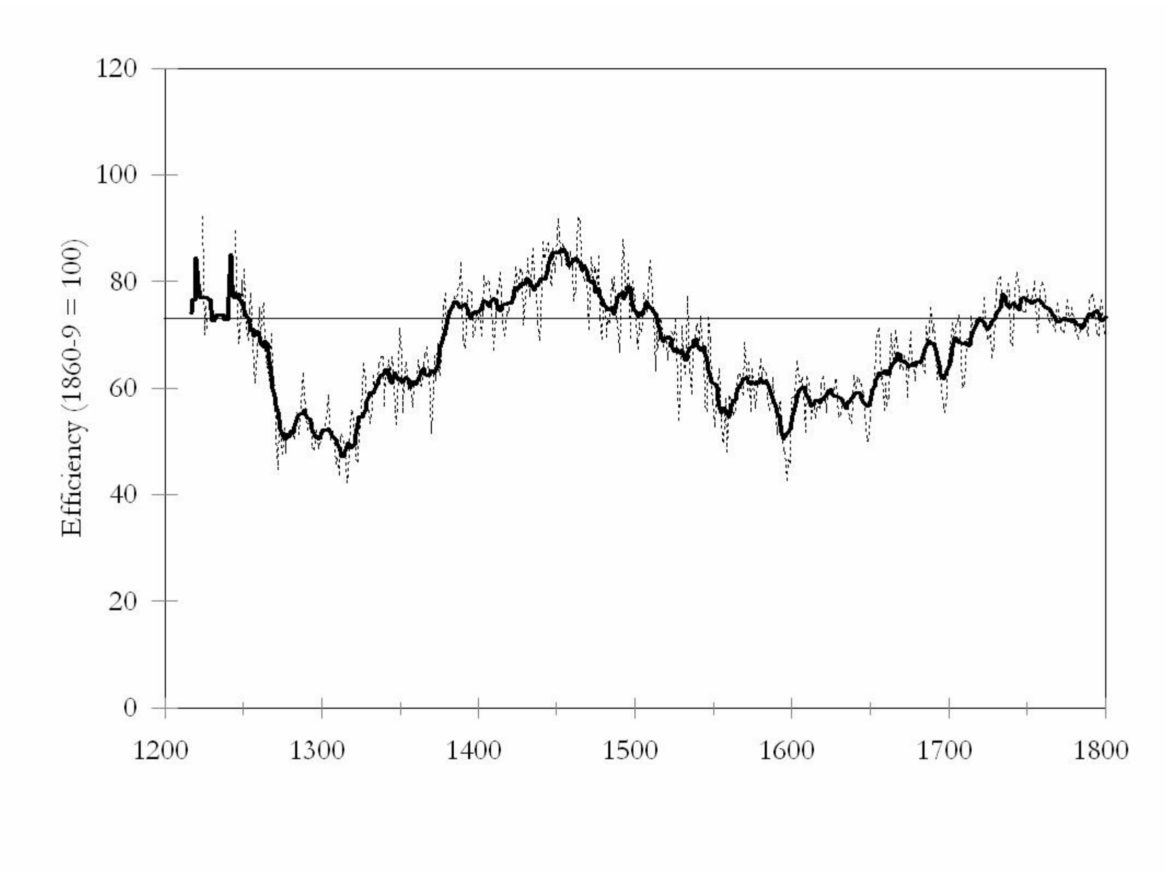


Figure 6 The Calculated Efficiency of the English Economy 1200-1800

we refer to figure 4 and the associated discussion above, then we would expect that if anything efficiency levels and population would be positive correlated, since with unchanged birth and death rate schedules, higher efficiency would lead to higher population. If demographic changes were much more dramatic than efficiency changes, as with the arrival of the Black Death, then we would expect no correlation between measured efficiency and population. But there is no theory that would explain a negative correlation between measured efficiency and population. Figure 6 shows the actual correlation. After 1600 the world behaves as we would expect in a

Malthusian framework. The upward move in efficiency from the 1600s to 1790s results in modest gains in living standards, but a substantial gain in population.

The efficiency levels reported in figures 6 and 7, if correct, have profound implications for the interpretation of English history before 1600.

First the great growth of population and urban communities across Europe in general, and England in particular, in the years 1100-1300 has been widely interpreted as resulting from a much better functioning of the European economy. Gains came mainly from the Smithian mechanisms of expansion of markets through trade, fostered by improved institutions, rather than identified technological breakthroughs. But nevertheless this has been regarded as a period of significant economic advance. There have been many studies focusing on the increasing commercialization of the economy, and the assumed benefit of this economic reorientation. Some have even seen this as a precursor of modern economic growth. England shared in this expansion, with the population probably doubling between the 1210s and 1310s. But figure 7 suggests that this population growth was not a response to any improvement in the efficiency of the economy. Instead economic efficiency actually declined in this interval. Thus the growth of population, and the urbanization, would have to have come from either an increase in fertility or a decline in mortality. The 13th century expansion was thus not a precursor of modern economic growth, at least in England. Indeed the earlier views of M. M. Postan who saw England in these years as entering an ecological crisis driven by trying to feed an ever growing population find some credence in these data.

The expansion of the economy from 1200 to 1315 was a period of efficiency decline because the decline in real wages in these years, from quite high levels in the early 13th century, to very low levels by the years 1290-1315, is not countered by any offsetting gain to land owners.

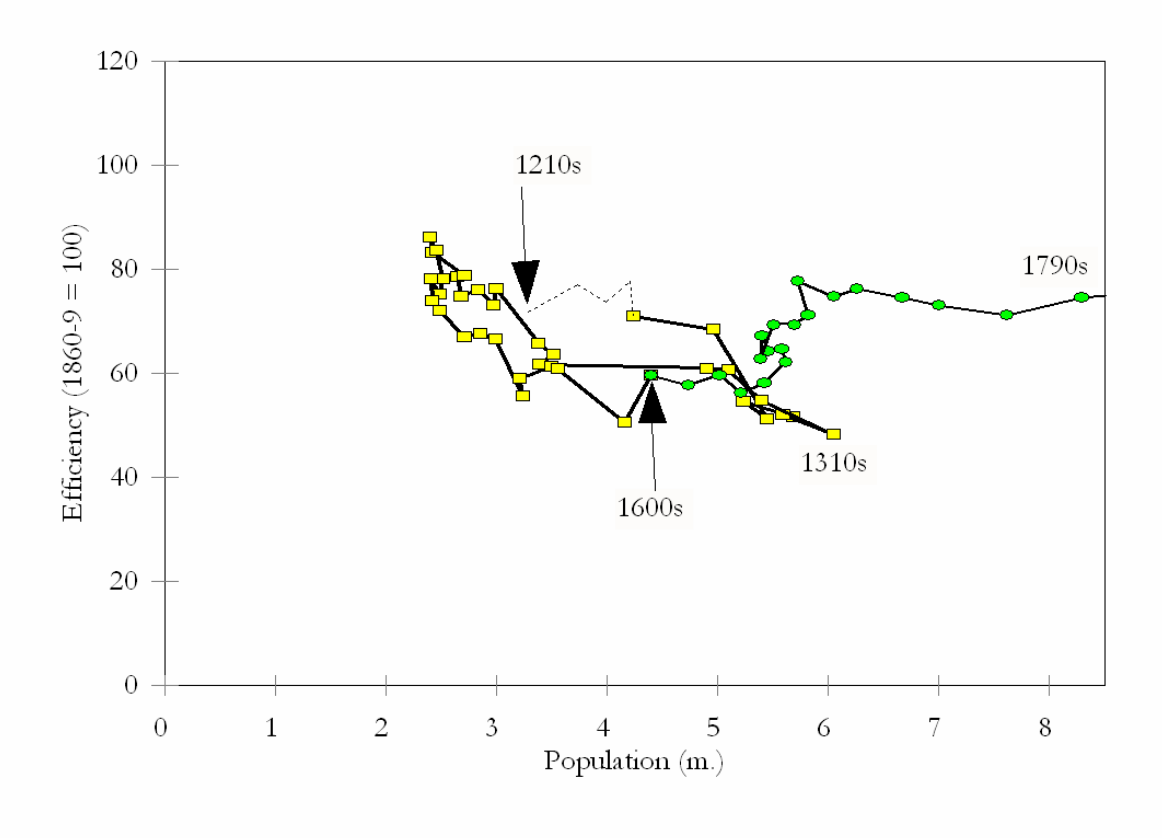


Figure 8: The Efficiency of the English Economy, versus Population, 1210-1800

Efficiency is just the weighted average of MP_L, MP_{land}, MP_K, which are just wages, land rents, and the rental cost of capital measured in terms of the price of output. Figure 8, 9 and 10 show the calculated levels of each of these partial measures of productivity. The path of real wages is clear in figure 8.[7] These declined in the 13th century, rose to a peak in 1450, declined again to around 1600 then rose modestly towards 1800. The maximum real day wage circa 1450 was about 2.5 times the minimum circa 1315. But these variations in wages were at least partly

[7] Annual observations of the real wage are measured by the dotted line. The solid line shows the 10 year moving average of the real wage.

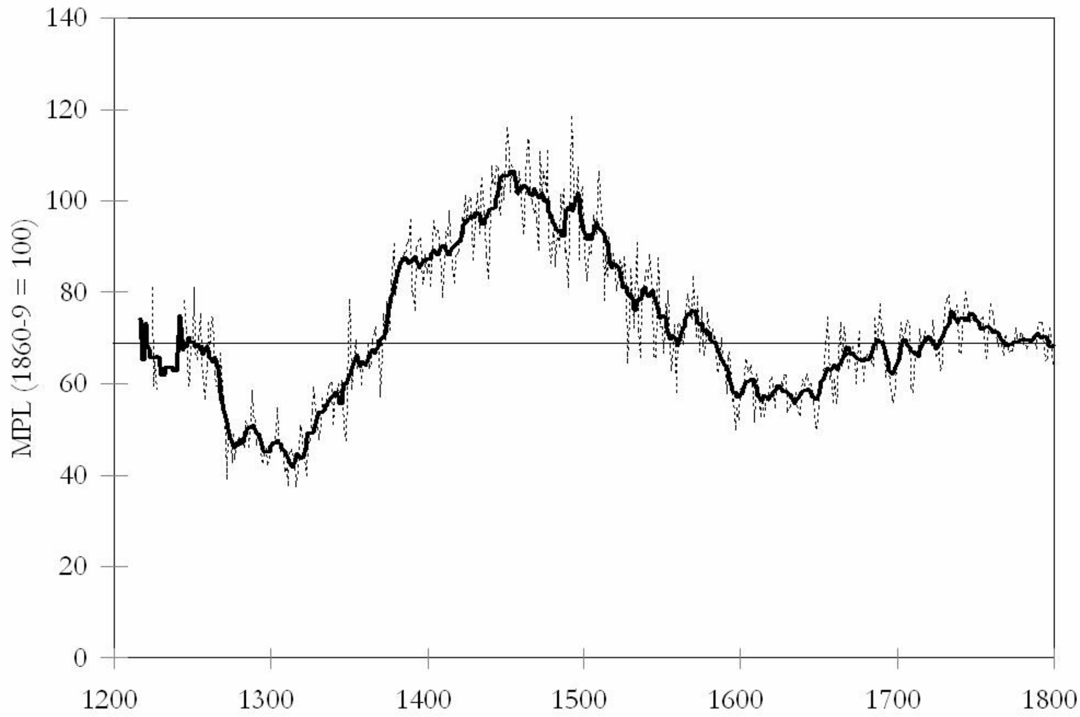


Figure 8 Real Day Wages (MPL) measured in expenditure prices

the product of changes in the size of the population. 1450 when real wages were at their maximum was a period of extremely low population. 1315 was a period of relatively high population.

If efficiency levels were independent of population then the high real wages of 1450 would be counterbalanced by low real land rents. The reason overall productivity moved in the same direction as real wages was that the expected countervailing trends in the real rent of land and the real return on capital were either weak in the case of rents, or absent in the case of capital.

Figure 9 Real Land Rents, England, 1200-1800

The real rent series shown above in figure 9 is based on market rates of new leases on land, or on the sale prices of land, whenever possible. It attempts to measure the sum of rent, tithe, and taxes on land occupants such as the poor rate on a consistent basis over time. For the years before 1450 this was largely based on short term leases of demesne lands, all in the south east of England. Around 1300 average estimated rent and tithe on this series was about 13 d. per acre.

Over the years 1210-1530 nominal rents changed by relatively small amounts. Thus from 1210-1310 real rents declined because of price increases. Given the decline in real wages, had efficiency been constant in the years 1210 to 1310, then real rents should have risen with

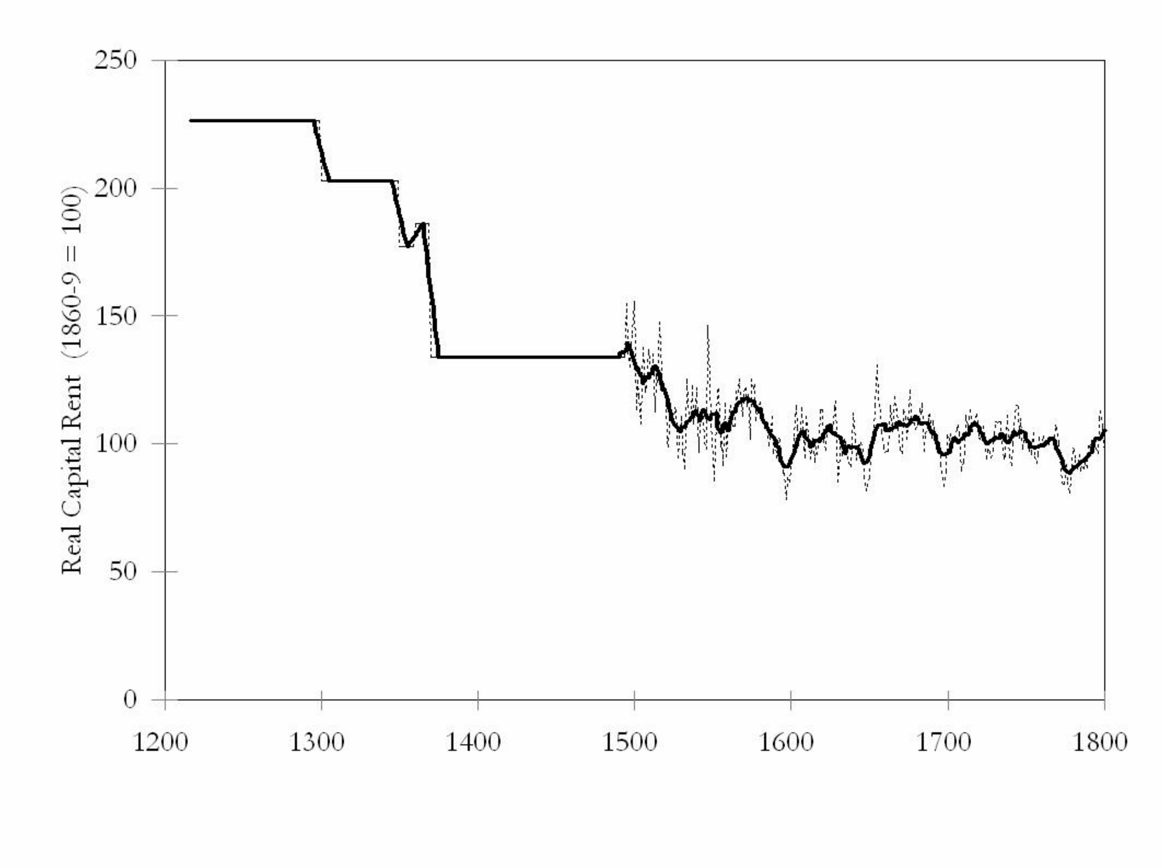


Figure 10 Real Capital Rents, England, 1200-1800

growing population. Instead they declined. Similarly from 1350 to 1450 to keep efficiency constant there would have to be very substantial declines in real rents. In this later case epoch declines were modest. That is the main reason the Black Death period shows up as one of increasing economic efficiency.

The real rental on capital generally declined from 1200 to 1800, being highest in the 13^{th} century. This return was caculated assuming the return on capital was the average implied rate of return on land and rent charges, plus 3% as an allowance for depreciation. Returns on both land and rent charges average 10% or more in the thirteen century, even though as we shall see in figure 11, land was a very safe asset whose real value did not change much over time between 1200 and 1350. Capital in England in these years would be mainly houses and other properties, so the depreciation rate would be low.

There is another source on land values in the years 1200-1350 that we can use to check the demesne rent series, which is purchases price of plots of land by religious institutions (and some private owners) recorded in cartularies. Real land prices, drawn mainly from Norfolk, Essex and Kent, declined modestly between the early 13th century and the early 14th century, as figure 11 shows. The decline in prices was not as significant as the decline in real rents, but since rates of return declined in the early 14th century, then by implication land rents must also have declined in real terms in that interval, at the time of maximum population pressure.

Thus overall the failure of real land rents to move in a strong opposite way to real wages in the years 1200-1500 explains the strong negative association between population and the measured efficiency of the economy. Also, because the implied share of wages in national income was nearly double the share of rents the amplitude of the counteracting swing of real land rents that was necessary for constant measured efficiency would be twice as great as the swings in real wages.

Thus the great 13th century expansion was not a response to a growing efficiency in the medieval economy. Demographic changes, not economic changes, must have been the primary driver. But the economy actually experienced an efficiency decline in response to the population growth. And the Black Death seemingly set in motion a period of efficiency growth within the economy that was important in helping explain the high living standards of the 15th century. It was because demographic changes were amplified by efficiency changes that they had such a profound impact on living standards in the years 1200-1650.

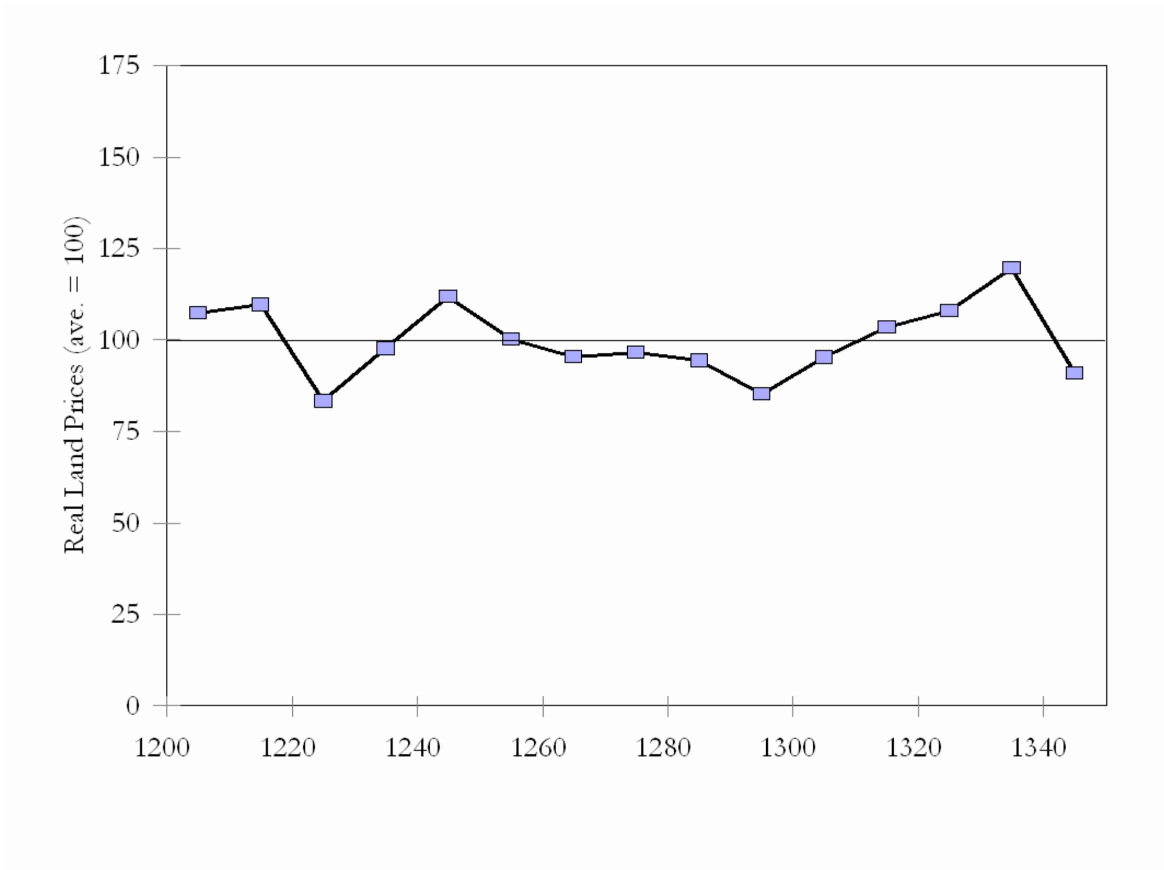


Figure 11 Real Farmland Sale Prices, England 1200-1349

Why did population drive efficiency levels?

The empirical evidence above on population and efficiency levels suggests that demographic shocks, like the Black Death, by reducing population also had positive effects on the efficiency of the economy. Similarly periods of population growth such as 1200-1315 or 1530-1630 made people poorer not just by reducing the land/labor ratio, but also by reducing the level of efficiency at which the economy operated. What could possibly be the mechanism of such a link?

One feature of these swings in efficiency levels with population is that they are particularly pronounced in the agricultural sector, and less evident in industrial production. Since I have measures of farm wages and farm output prices as well as general wages and output prices, I can also calculate the efficiency of the agricultural sector in England for 1200-1800 relative to the 1860s. This is shown in figure 12. This figure contains several surprises. The overall estimated level of farm efficiency circa 1210 and 1450 is as high as in the 1860s! Also the estimated efficiency in farming drops much more than efficiency in the economy as a whole from 1200 to 1300, and then rises much more from 1300 to 1450. Given the substantial share of farming in all output in the pre-industrial economy, the implication here is that the swings in the efficiency of the early economy are largely created by movements in agricultural efficiency.

The very high levels of efficiency suggested for late medieval agriculture are again a product of the very high implied real wage for farm workers measured in terms of output prices (the MP_L). Figure 13 shows these estimates by decade all the way to the 1860s. The extraordinarily high level of the implied marginal product of labor in the 15th century, even by the standards of the 1860s, is clear. Output per man-day, the average product of labor (APL), is connected to the MPL, by the simple formula

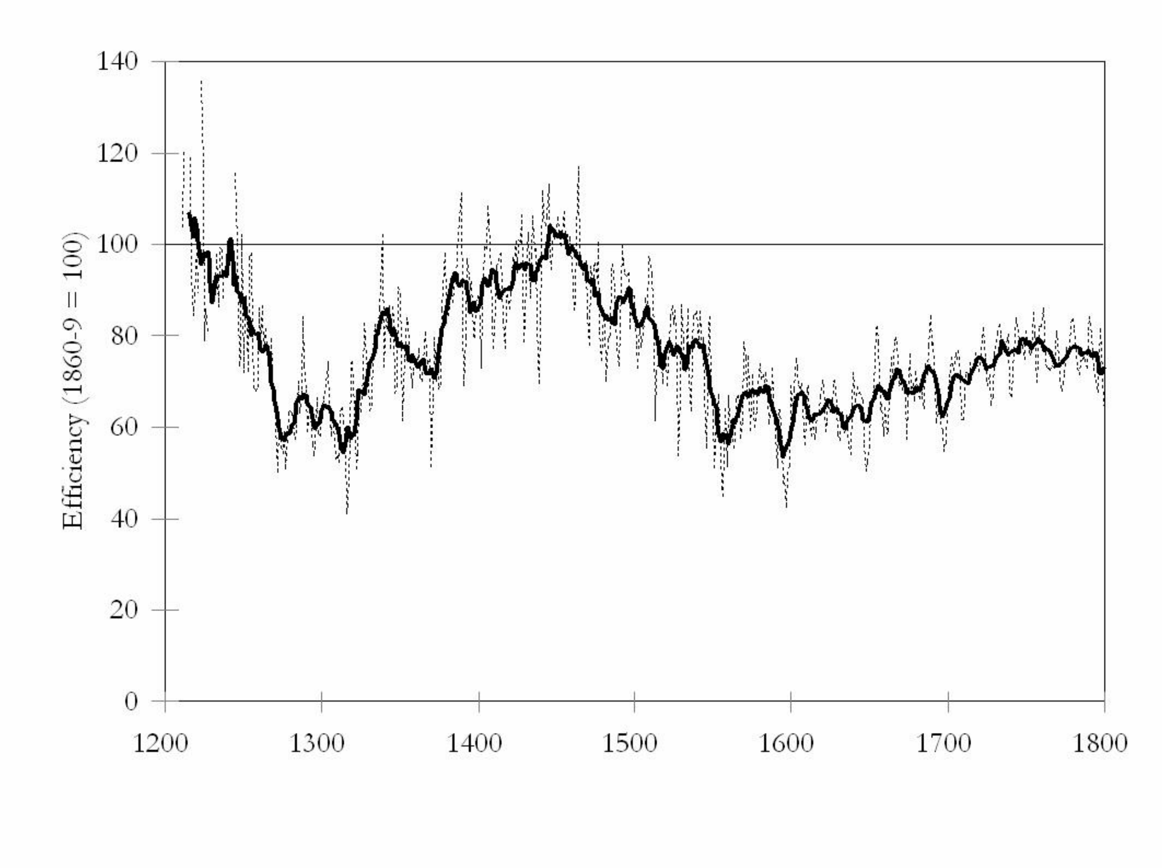


Figure 12 Farm Sector Efficiency, 1200-1800

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

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. Thus the data presented in figure 13 on MPL will not directly show output per worker. But if the share of

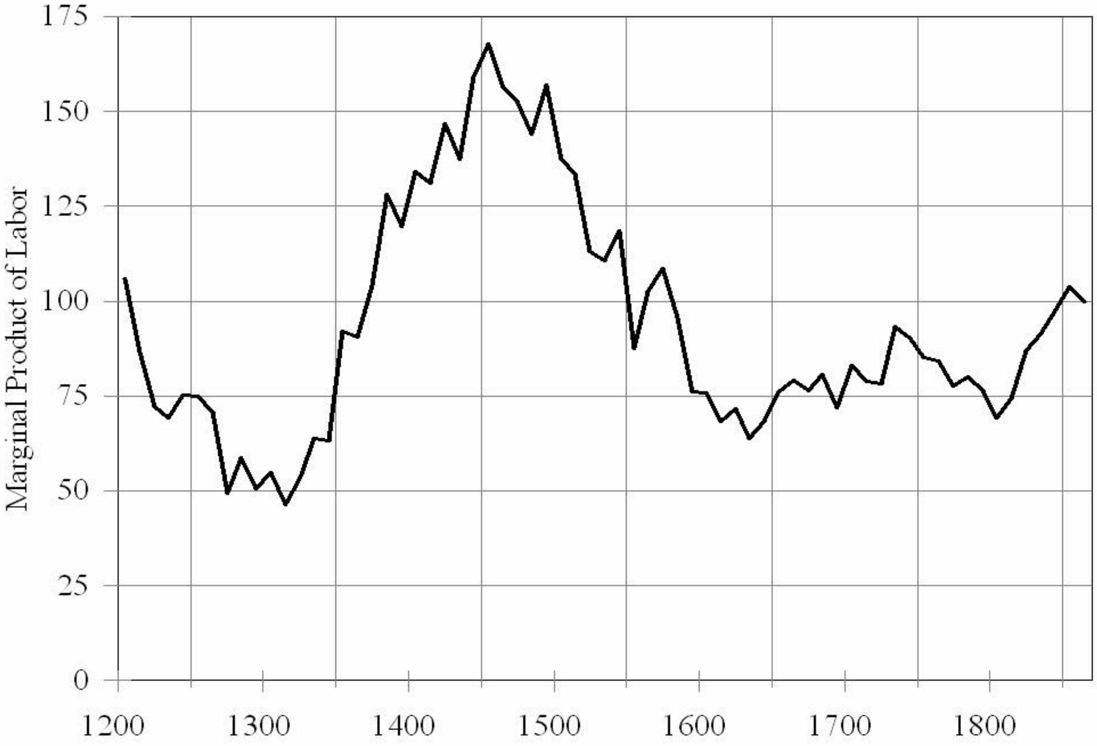


Figure 13 The Implied Marginal Product of Labor in English Agriculture, 1209-1869

Note: The MPL is indexed at 100 on average for the years 1860-9. Sources: The farm prices are from Clark, 'Price History'.

labor, *b,* is relatively constant, then the MPL will correlate highly with labor productivity.[8] Also since *b* is at maximum 1, the wage is a lower bound on the output per day of farm workers. If

8 If the production function is Cobb-Douglass, then the MPL will vary one to one with output.

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 2 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.[9] For the pre-plague years the estimated share of labor 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.[10] Tithe would be about 5 d. per acre if collected in full. Land rents 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.[11] An alternative estimate, based on the rent series reported above, 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 MP_L gives estimate of output per worker circa 1300-49 and 1400-99 shown in table 2. From 1300 to 1400 output per worker probably doubled, even if we assume that the labor share in costs was as high as 50-70 percent in 1400-99. It is very hard to envisage an output per worker in 1400-99 that was any lower than in 1850-60.

9 That is, the production function may be close to Cobb-Douglass.

10 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).

11 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*.

Table 2: Estimated Output per Man-Day from the Marginal Product of Labor

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[b]	-	(304)	(0.51)
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 IPMs, the low share from extrapolating back the rents and tithe in Clark, 'Agricultural Revolution'. [b]Cost share by assumption only. [c,d]These shares derived in Clark, 'Agricultural Revolution'.

Sources: Clark (2006)

These estimates suggest 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.[12]

Are these estimates feasible, and why do they not match the earlier estimates of Clark, and the recent ones of Wrigley? We know for the medieval period that such things as grain yields

[12] Clark, 'Labour Productivity', gives estimates for these other countries circa 1850.

were not changing very much over the long run. Grain yields in the years 1250-1450 were largely trendless, and were surprisingly unaffected by the losses of population after the onset of the Black Death. But output per worker seems to have risen sharply after the onset of the Black Death. One sign of this is the rate at which various farm tasks were performed. The rate for threshing can be calculated as the day wage of farm laborers divided by the payment for threshing grains in each period (on the assumption that there was a fixed relationship between the day wage of threshers and that of day laborers). Figure 13 shows the resulting estimates of threshing rates by 25 year periods from 1300-24 to 1825-49. Thus it seems plausible that efficiency rose in the agricultural sector in the period 1350 to 1500 because while output per acre was unchanged, output per worker was much higher.

Task specific labor productivities can be estimated also for reaping wheat and mowing meadow using piece rates for reaping an acre of wheat or mowing an acre of meadow. As Clark, 'Labour Productivity' pointed out, it is puzzling that the task specific estimates of labor productivity for these 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 3, for example, shows estimated gross output per worker in threshing wheat, reaping wheat, and mowing meadow in 1300-49, 1400-49, 1768-71, 1794-1806, 1850 and 1860. The last column gives an index of implied task labor productivity. It is highest in 1400-99. Even between 1300 and 1850 it increases only very modestly. Measures of net output per worker would show a greater increase. The study of output per worker on arable agriculture for 1300-49 by Karakacili similarly finds very high labor productivities.

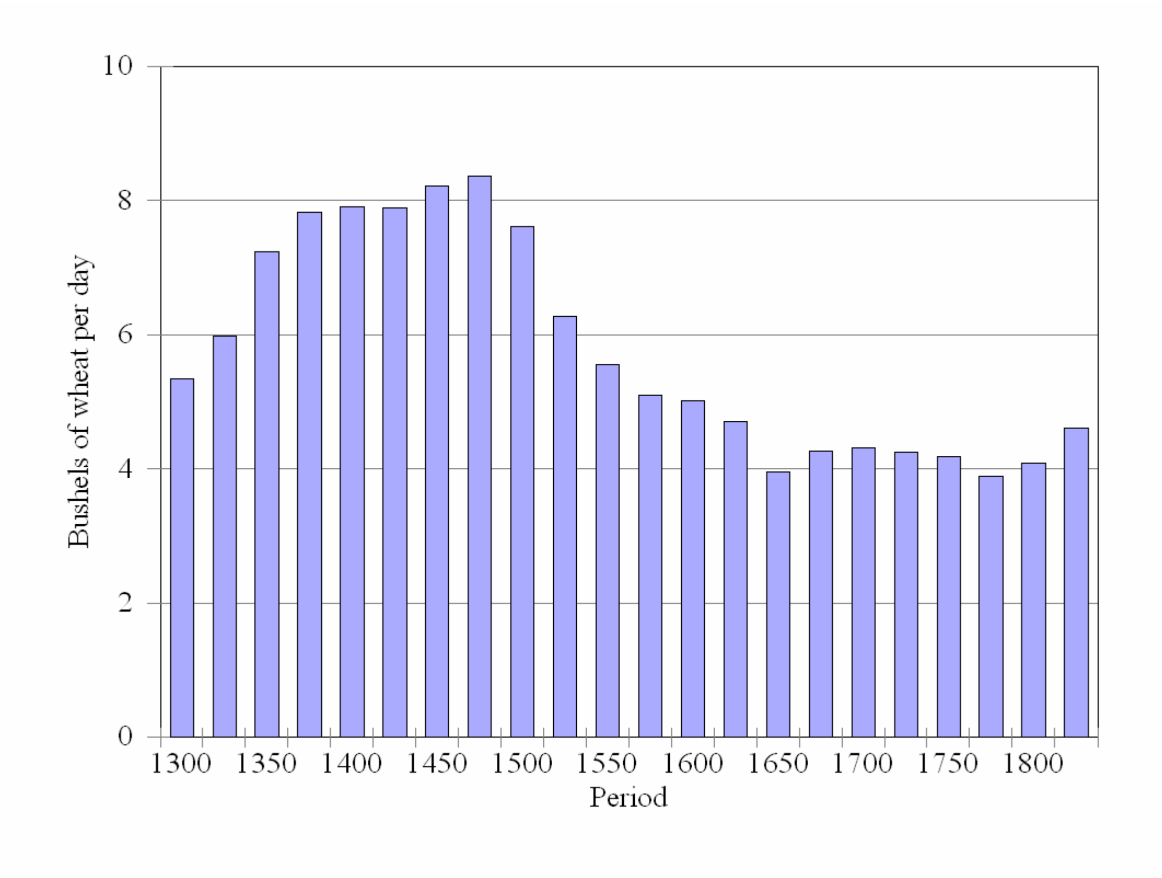


Figure 13 Threshing Rates measured in bushels of wheat per day, 1300-1850

The second check of the MP_L 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 2 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.[13] The last column of table 2 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, and of about 0.5 m. in 1400-99, compared to 0.75 m. in 1770 and 1 m in 1850 and 1860, though since work days per year were potentially less before 1500, the earlier labor force was likely higher. At the average population calculated for medieval England in 1300-49 below, 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 in 1300 that are not implausible.

If these new medieval labor productivity estimates seem plausible, though surprisingly high, 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 assumed here. But he has a low estimate of total output because he follows Campbell (2000) in assuming only 6.7 million sown acres out of a total cultivable area in England of 26.5 million acres.[14] Campbell assumed that arable occupied only 40 percent of potential farmland in 1300. Yet the Inquisitiones Post Mortem suggest rental income from arable land was fully 61 percent of all landlords' rental income pre plague.[15] Suppose 10

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

14 Campbell (2000), 289-90. Wrigley (2006) adopts this assumption from Campbell.

15 Campbell (2000), 66.

Table 3: Task Specific Labor Productivities

Period	Threshing Wheat (bu/day)	Reaping Wheat (bu/day)	Mowing Meadow (ac/day)	Average (index)
1300-49	5.1	6.0	0.51	93
1400-49	7.3	8.3	0.68	130
1768-71	4.2	8.8	0.94	107
1794-1806	4.3	9.6	1.02	114
1850	3.9	8.4	0.86	100
1860	-	8.8	0.83	102

Notes: In the index threshing and reaping were given a weight of .4, mowing a weight of .2.

Source: Clark (2006).

percent of land in 1300 was common access waste with no value to landlords, or Royal Forests. That still leaves 24 million acres. Given that meadow, pasture, and even wood on average had a higher assessed value per acre than arable, this implies that arable was more than 61 percent of land use, and thus more than 14.6 m. acres.

Only if significant pastures or woodlands were not valued by the Inquisitiones would this conclusion be misleading. Could lands that had no value to landlords have amounted to the 9.3 million acres out of 26.5 in 1300 necessary for Campbell's assumption to be compatible with the Inquisitiones Post Mortem? I allow above for 10 percent of the land being either Royal Forest or common access waste with no defined common rights to be value - undrained, unreclaimed, and with minimal output. But Campbell's assumption requires this area to be 35 percent of farmland in 1300. That is implausibly large. 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 of cultivated land in the nineteenth century.[16] 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.

Alternatively we get evidence on the relative output of arable versus other land use from sales by manors. Campbell himself showed for 100 manors in the London region in the years 1288-1315 that sales of arable products provided 58 percent of income.[17] If the net value of yield of arable was that same as for pasture, then again 14 million acres would have to be arable. There is no reason, given the labor requirements for milking, cheese making, and butter production, to expect labor inputs, and hence the value of net output, on medieval pasture were much lower in total than on the arable. Thus these sales again point to 14 million acres of arable as opposed to 10.5 million.

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 MP_L 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.

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16 Clark and Clark (2001).

17 Campbell (1995). Since tithe was collected at an effective rate of 15 percent or more of net output on arable, the share of total output from arable would actually be 60 percent based on these figures.

All the above supports the idea that labor productivity was high in 1270-1349, and even higher in 1350-1500. It does not explain, however, why these gains in labor productivity were apparently achieved without much in the way of declines in land productivity. That mystery remains in the data.

Figure 14 shows the estimated level of output per person from the 1240s to the 1790s, against English population, where the actual output per person has been adjusted so that efficiency is the same in all decades. It thus tries to estimate the relationship between output per person and population, had population movements not been associated with changes in efficiency. For the years 1240-1600 there is still a significant negative connection between population and output per person, though the size of the effect is much less. The 2.4:1 difference in the level of population between the 1310s and the 1450s is associated only with an estimated fall in income per person of about 15%.

In this picture the ability of the economy to sustain both real incomes and significant population expansion in the years 1600-1800 seems less impressive. The costs from larger population in income per person were not so great as the raw figure 8 would suggest, since figure 8 does not disentangle the effects of efficiency and population size on incomes.

But the problem remains that we do not know why earlier gains in population were associated with efficiency declines. So the failure of efficiency to decline with the population growth of the 18th century may represent a new development in the economy, or just the expected pattern which was being obscured for some reason in the years before 1600.

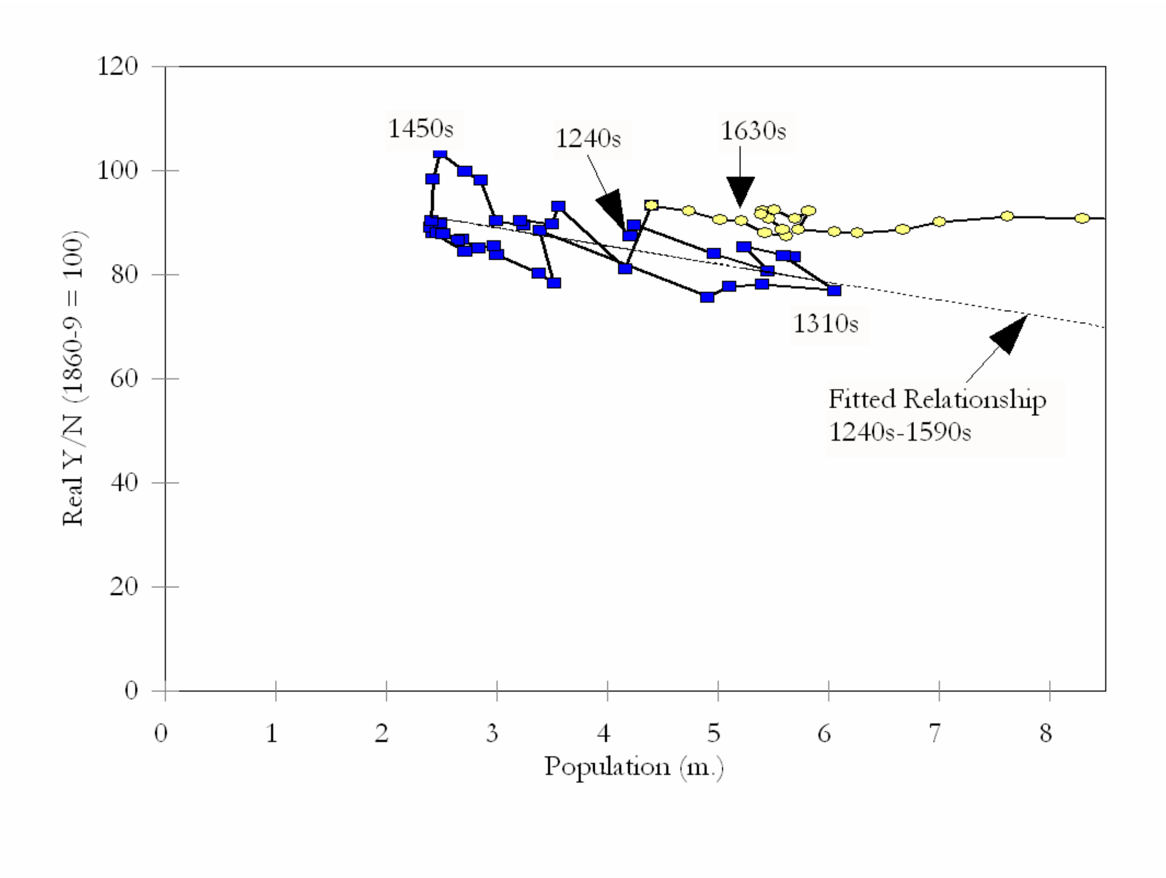

Figure 14 Income per person (constant efficiency) versus population.

English history 1200-1800 without efficiency advance

Can the picture that presents itself above of an English economy that in some periods such as the 15th century achieved efficiency levels above that of the 18th century be reconciled with other features of the medieval period, such as the low urbanization rates of 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 3 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.[18] Dyer thus argues that England had an unusual urban structure in the medieval period with many more small urban locations than elsewhere in Europe. 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 is no compelling reason to reject the marginal product estimates for labor, land and capital, and the very optimistic picture they portray of the level of efficiency of the medieval economy in England.

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18 Dyer, *Everyday Life*, p. 302.

Appendix: The Data

Appendix table 1A shows the seven series used in equation (1) to calculate the productivity indices by decade, each given as an index with the 1860s = 100. Below we discuss some of the conceptual and data problems in constructing these indices.

The Wage Index

Wages are the most important cost in the index given by (1), with a weight of 60-70 percent. Wages are calculated as a geometric index of the wages of male building craftsmen, male building labors, and male farm workers. The wages of the building workers are assumed to give a measure of wages in the non-farm sector. The length of day for the farm workers is assumed unchanged throughout this interval. For building workers, where wages in the nineteenth century were given by the hour, they were converted into day wages by assuming a 10 hour day. Independent evidence shows that the length of the work day for building workers seems to have averaged about 10 hours from the 1760s to the 1860s. The weights in this index are changed over time to reflect the changing share of employment in agriculture. Thus the weights were:

	Farm Laborers	Craftsmen	Building Laborers
Before 1680s	0.60	0.20	0.20
1760s	0.49	0.255	0.255
1860a	0.21	0.395	0.395

Table 1A: The Indices Underlying the Productivity Calculation

Decade	Wages (Index)	Capital Prices (Index)	Interest Rates (%)	Land Rents (Index)	Indirect tax share	Prices (expenditures) (Index)
1240	5.8	4.4	10.6	11.0	0.009	8.6
1250	5.9	3.3	10.6	10.8	0.009	8.5
1260	6.0	3.3	10.6	11.3	0.009	8.9
1270	5.3	2.9	10.6	13.4	0.009	10.6
1280	5.3	3.0	10.6	12.5	0.009	9.8
1290	5.2	3.2	10.6	13.3	0.009	10.5
1300	5.5	3.4	9.2	13.6	0.009	10.7
1310	5.9	3.7	9.2	16.2	0.009	12.8
1320	6.4	4.2	9.2	15.2	0.009	11.9
1330	6.5	4.3	9.2	13.9	0.009	11.0
1340	6.2	4.1	9.2	13.3	0.009	10.5
1350	9.6	3.6	7.6	17.5	0.009	13.8
1360	10.4	4.2	8.1	18.1	0.009	14.2
1370	11.6	3.8	5.0	18.4	0.009	14.5
1380	11.7	4.0	5.0	16.0	0.009	12.6
1390	11.3	3.5	5.0	15.9	0.009	12.5
1400	12.5	4.0	5.0	16.6	0.009	13.1
1410	12.6	3.7	5.0	16.9	0.009	13.3
1420	12.8	3.4	5.0	16.0	0.009	12.6
1430	13.4	3.7	5.0	16.9	0.009	13.3
1440	13.5	3.5	5.0	15.9	0.009	12.5
1450	14.0	3.5	5.0	15.7	0.009	12.4
1460	13.3	3.5	5.0	15.6	0.009	12.3
1470	13.3	2.7	5.0	15.8	0.009	12.4
1480	12.9	3.1	5.0	16.5	0.009	13.0
1490	13.4	2.8	5.0	16.5	0.009	12.6

Decade	Wages (Index)	Capital Prices	Interest Rates	Land Rents	Indirect tax share	Prices (expenditures)
1500	12.1	3.1	5.0	15.2	0.009	12.5
1510	12.5	2.9	5.0	16.3	0.009	12.8
1520	12.7	3.7	5.0	15.4	0.009	14.4
1530	13.1	4.8	5.0	16.7	0.009	15.4
1540	14.9	4.8	5.0	19.4	0.009	17.6
1550	19.2	4.6	5.0	26.0	0.009	26.1
1560	22.2	5.2	5.3	30.1	0.011	28.6
1570	23.6	7.2	5.6	31.8	0.010	30.6
1580	23.8	11.3	5.9	30.6	0.008	33.2
1590	24.8	10.1	5.9	32.0	0.007	40.2
1600	27.4	20.9	6.1	37.1	0.005	42.8
1610	29.1	23.7	5.9	41.9	0.006	47.8
1620	30.4	24.0	6.3	42.9	0.007	48.0
1630	32.4	26.3	5.9	45.9	0.008	54.8
1640	34.9	28.3	5.7	48.3	0.008	57.4
1650	38.3	28.9	5.6	54.8	0.010	58.4
1660	39.9	30.8	5.4	56.2	0.009	58.2
1670	38.8	27.3	5.5	54.6	0.017	57.0
1680	39.1	28.7	5.3	54.5	0.017	55.4
1690	38.5	27.8	5.0	53.7	0.029	59.8
1700	39.3	27.7	4.7	54.8	0.041	56.1
1710	39.9	30.5	4.9	58.1	0.048	59.5
1720	39.9	32.7	4.4	58.0	0.053	59.4
1730	41.8	31.6	4.3	57.3	0.054	55.9
1740	41.7	29.7	4.5	57.1	0.052	57.3
1750	42.6	37.3	4.3	58.2	0.057	60.0
1760	44.8	38.6	4.4	63.4	0.068	64.6
1770	47.7	44.7	4.1	63.6	0.067	70.4
1780	49.6	44.8	4.1	68.4	0.076	73.9
1790	57.0	55.9	4.1	84.9	0.082	84.0

Since the relative wages of farm and building workers changed little before 1700 the choice of weights is not too important under this index.

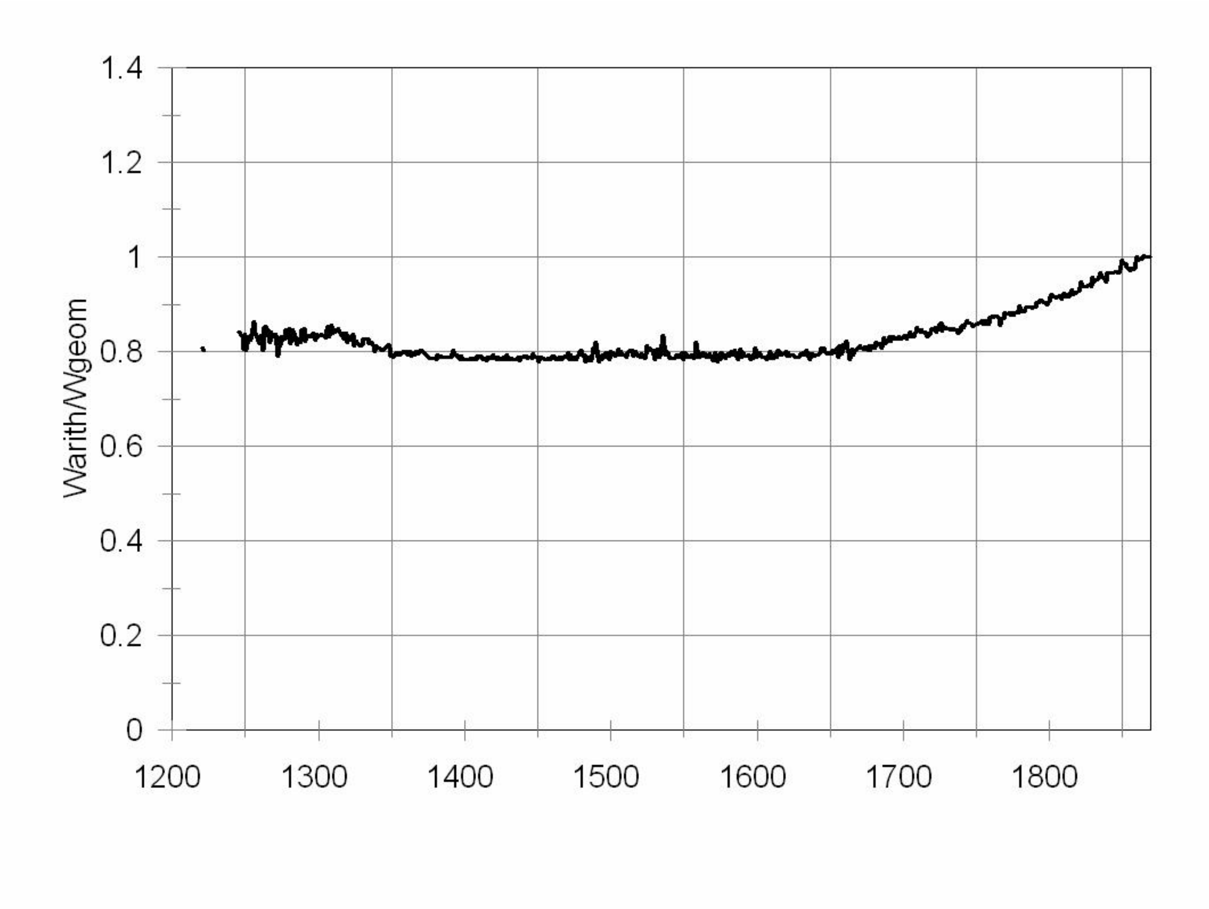
An alternative way of constructing this wage index, would define the wage as the weighted payment per day per worker for each type of worker,

$$W = b_a W_a + b_c W_c + b_l W_l$$

where b_a is the share of labor employed in agriculture, b_c the share of labor employed in skilled non-farm employments, b_l the share of labor employed in unskilled non-farm employments, W_a the farm wage, W_c the wage of craftsmen and W_l the wage of laborers. This index will be strongly affected by the share of the labor force assumed to be skilled, which we do not know. Since always $W_c > W_l$, and in later years $W_l > W_a$, it also assumes that these differential wages reflect costless economic gains. However the wage premium of building laborers in later years over farm laborers most likely reflected just higher urban living costs, and greater urban disamenities. The wage of farm laborers was sometimes higher than that of building workers in the fifteenth century when towns were much smaller. The wage premium of skilled labor in part represented a return on the investment in training, these workers traditionally being supposed to serve 7 year apprenticeships, so that again a rise in the share of such workers should not imply that the average return to labor has risen, unless we again assume some disequilibrium between the wages of skilled and unskilled workers. Thus I prefer the geometric index.

Figure 1A shows the ration of the arithmetic index to the geometric index of wages over time, with the 1860s set at 1. Switching to the arithmetic wage index would not affect the relative level of the wage index within periods before 1600, but would result in greater wage increases in the years after 1650. Between the 1650s and 1860s the productivity of the economy would rise by about 14 percent more than currently measured. So this is important for

Figure 1A The Arithmetic Wage Index Relative to the Geometric Wage Index



productivity growth measures when the structure of the economy was changing. But much of the structural change in employment in England after 1760 away from agriculture was driven by rising population, which given the limited land base forced England to switch towards producing manufactures in exchange for imported food and raw materials. So attributing advance in the economy to this population induced switch seems inappropriate.

The Return on Capital

Measuring real interest rates is not easy in the modern world of relatively high and variable inflation rates. But before 1900 generally prices showed little secular trend and measuring real interest rates was much easier. Table 2A, for example, shows the average rate of price inflation in England by century from 1200 to 1800: though it should be noted that England was known among pre-industrial societies for the sound currency management. As can be seen for the 600 years from 1200 to 1800 inflation was generally at very modest rates. Even in the 16th century, the period known as the Price Revolution, the average rate of inflation was less than is the norm in the 1990s in the UK, US and other industrialized countries.

For England evidence on interest rates goes back to about 1170. Figure 2A shows the rate of return on two very low risk investments in England from 1170 to 1900. The first is the gross return on investments in agricultural land, R/P, where R is the rental and P the price of land. This can differ from the real return on land,

$$r = \frac{R}{P} + (\pi_L - \pi)$$

where π_L is the rate of increase of land prices and π is the general rate of inflation. $(\pi_L - \pi)$ is the rate of increase of real land values. But the rate of increase in real land values in the long run has to be low in all societies, and certainly was low in pre-industrial England. If the rate of increase of real land prices was as high as 1% per year from 1300 to 1800, for example, it would increase the real value of land by 144 times over this period. Thus the rent/price ratio of land will generally give a good approximation to the real interest rate in the long run. Table 2A shows that in the long pre-industrial era the average rate of land price inflation differed little from that of price inflation (on average land prices rose at .24% per year more than the rate of

Table 2A Inflation Rates, England, 1200-1800

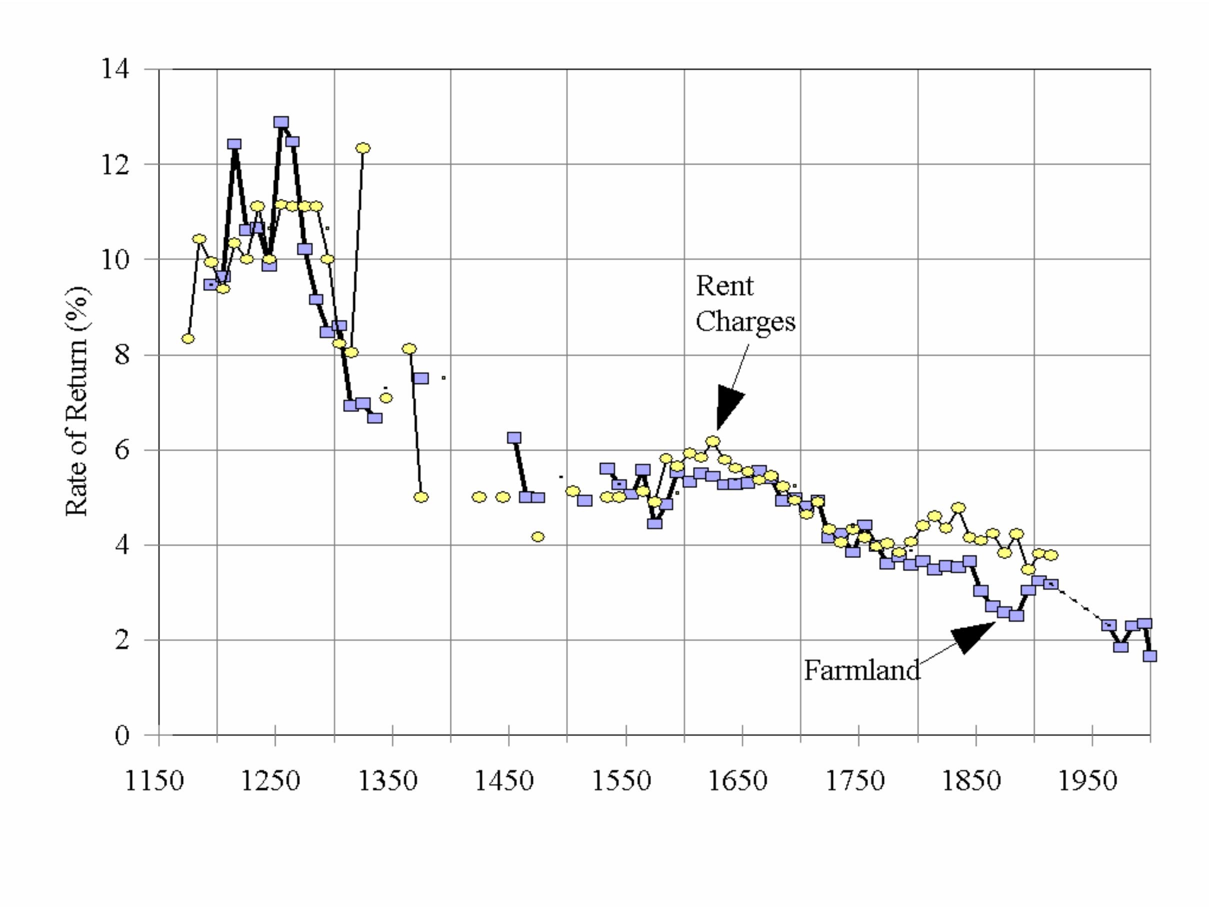
Period	Inflation Rate (%) π	Land Price Growth Rate (%) π_L	$\pi_L - \pi$
1200-1300	0.49	0.53	0.04
1300-1400	0.08	0.15	0.07
1400-1500	-0.06	-0.28	-0.22
1500-1600	1.32	1.97	0.65
1600-1700	0.36	0.53	0.17
1700-1800	0.50	1.21	0.71

price inflation in England from 1200-1800, despite the fact that the population in 1800 was about three times that in 1200).

The second rate of return is that for "rent charges." Rent charges were perpetual fixed nominal obligations secured by land or houses. The ratio of the sum paid per year to the price of such a rent charge gives the interest rate for another very low risk asset, since the charge was typically much less than the rental value of the land or house. The major risk in buying a rent charge would be that since it is an obligation fixed in nominal terms, if there is inflation the buyer gets a lower real rate of return. Again the gross rate of return shown is R/P, where R = annual payment, P = price of rent charge. The real rate of return, r, in this case is

$$r = \frac{R}{P} - \pi$$

Figure 2A The Return on Land and on Rent Charges, 1170-2003 (by decade)



Notes: For the years before 1350 the land returns are the moving average of 3 decades because in these early years this measure is very noisy.

Since the inflation rate before 1800 averaged 0.45% per year the gross rate of return on rent charges gives almost as good measure of the long run real rate of rate of return as the ratio of land rents to land prices.

Land Rents

The land rents are the estimated market rental values, including tithe and land taxes that fell on occupiers, of plots of unchanging area. The rent paid to the owner of land was only one claim on the site value of the land. In addition there was the tithe due originally to the church, but later to private owners of tithe rights. This was nominally 10 percent of the gross output of the land but was later collected at typically much lower rates. Also increasingly from 1600 on there were local parish levies to support the poor that by the nineteenth century were 6-10 percent of the rents paid by occupiers. The rent series used tries to index all these claims on farmland to give an overall picture of the true rental value of land.

To avoid problems of land quality and varying land measures the series is constructed by looking at what happens to the same plot over time, except in the medieval period where the less rigorous measure of the same type of land in the same village is used. The rent series thus incorporates and values in earlier years communal "waste" land only later brought into private cultivation.

Prices Series

Table 3A shows the coverage of the national price series. In the world before 1800 the most important set of prices are for food and drink, which are assumed to constitute 60 percent of domestic expenditure in 1700-1800, and 65 percent in the years before 1700. The price index for food at its maximum is composed of indices of the prices of 30 separate food items, though the number of series declines as we go back in time. But even in the 1300s there are 13 separate prices in the food series. Thus the coverage of foods is good throughout. Other series with good coverage for most years are energy (coal, firewood, peat, charcoal), housing, light (coalgas,

Table 3A The Shares of Expenditures

Category	Subseries (Max)	Shares before 1700	Shares, 1700-1800
Food	30	0.65	0.60
Energy	4	0.05	0.05
Housing	3	0.04	0.04
Light	4	0.04	0.04
Soap	1	0.005	0.005
Clothing	7	0.12	0.11
Services	1	0.06	0.065
Tobacco	1	-	0.01
Books, Paper	2	-	0.01
Manufactures	3	-	0.02
Net Investment	5	0.035	0.05

tallow candles, wax candles), and soap. Clothing prices in the form of finished clothing and shoes are only available for 1576 and later, but earlier I have the prices of linen and woolen cloth, the major components of clothing costs. Services in the form of servants were an important component of expenditures in the pre-industrial world. These I index using the average of construction wages. Capital goods prices are assumed to relate mainly to structures and machinery. They are thus indexed by construction wages (.5), bricks/tiles (.15), timber (.15), nails (.05), iron bars (.05), and spades/shovels (.10).

The price of capital goods is taken as being the same as the price of net investment expenditures. The prices of exports after 1730 are set as mainly the prices of cotton cloth, woolen cloth, iron and other manufactures and coal. Imports are the wholesale prices of foods and raw materials such as cotton, wool, and timber.

Indirect Taxes

In the eighteenth century indirect taxes became an important source of government income in England. Under the pressures of war finance demands the government introduced significant taxation of many commodities – beer, wine, candles, bricks, paper, etc. The revenue from these indirect taxes is known, so to calculate their share of expenditures we need just to know total factor incomes in England. The value of total GDP was estimated the sum of indirect taxes plus the sum of estimated wage payments plus rents for land, scaled up to allow for payments to capital. Thus

$$GDP = \text{Indirect taxes} + (1+\Phi)(\theta_1 Nw + \theta_2 \text{rents})$$

This assumes a constant share of income going to capital, but the income shares for wages and land are flexible. From this the share of indirect taxes in GDP is estimated.

Factor Weights

To calculate the shares of each factor over time I set the share of capital (net of depreciation) at 0.13 based on data for the 1860s. Then the other 0.87 is divided between labor and land rents based on relative wages and land rents and the size of the population. The population totals before 1540 came from Clark (2006).

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