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Economic growth in England, 1250-1850: some new estimates using a demand side approach

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ECONOMIC GROWTH IN ENGLAND, 1250-1850: SOME NEW ESTIMATES USING A DEMAND SIDE APPROACH*

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ABSTRACT

Using the demand side approach we construct a new set of estimates of per capita agricultural output and per capita GDP for England over the period 1250-1850. Our estimates of per capita GDP suggest that the pattern of long run growth of the English economy can be interpreted with a periodization in three historical stages. The first stage, covering the period 1250-1580, is a Malthusian phase with no positive growth. The second stage, comprising the period 1580-1780, is an intermediate phase where the English economy is able to relax some of the Malthusian constraints, attaining a positive growth rate (although our estimate of the growth rate for this period is lower than that proposed by Maddison and more recently by Broadberry, Campbell, Klein, Overton and van Leeuwen). The third stage covering the post 1780 period is represented by the industrial revolution and by the definitive consolidation of a development pattern characterized by a steady positive growth rate.

Key-words: GDP, Economic growth, England

JEL codes: N 13, O 47

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1. INTRODUCTION

Following the pioneering work of Angus Maddison (2001,2003,2007), economic historians have devoted significant research efforts to the construction of statistical appraisals of the performance of European economies since the end of the Middle Ages by attempting to work out more and more reliable estimates of GDP per capita. Just to name only a few of the most recent contributions: Broadberry et al (2011) have produced estimates of GDP per capita for England and Britain over the period 1270-1870; Clark (2010) for England for the period 1200-1870; van Zanden and van Leeuwen (2012) for Holland over the period 1347-1807; Malanima (2011) for central and northern Italy for the period 1300-1913; Alvarez-Nogal and Prados de la Escosura (2007) for Spain and Pfister (2011) for Germany over the period 1500-1850. As all these authors would readily admit, these estimates ought still to be considered as highly conjectural. Still one cannot avoid the impression, that these ongoing efforts of statistical reconstructions of GDP per capita have the potential to put our understanding of the patterns of economic growth during the pre-industrial revolution period on a more secure footing.

Broadly speaking, so far these contributions have produced two opposed accounts of European economic performance in the 1200-1800 period. In a recent paper, Clark (2011) has eloquently described these conflicting interpretations as a debate between "Malthus" and the "revolt of the early modernists". The Malthusian view, which has been fully articulated by Clark (2007a), contends that all societies (including England) before the industrial revolution were characterized by a Malthusian dynamics. The implication is that in these societies income per capita exhibited fluctuations around a subsistence income (defined as the level of income at which birth and death rates are equal), but without any systematic growth trend. The "revolt of the early modernists" interpretation, instead, argues that, since the end of the Middle Ages, it is possible to discern a small but steady acceleration in the rate of economic growth in at least two European countries: England and the Netherlands.[1] The current estimates suggest that the "cruising speed" for these two successful early modern economies was represented by an average compound growth rate of GDP per capita of about 0.2 per cent per year. Broadberry et al. (2011) estimate an average growth rate of GDP per capita of 0.17 per cent per year for England over the period 1270-1690 and van Zanden and van Leeuwen (2012, p. 123) reckon an average growth rate 0.19 per cent per year over the period 1347-1807 for Holland. These growth rates of GDP per capita may be seen as broadly consistent (albeit slightly lower) with those emerging from Maddison's comprehensive dataset on the historical development of the world economy (Maddison, 2007, p. 383: 0.27 per cent for the United Kingdom and 0.28 per cent for the Netherlands for the period 1500-1820). Interestingly enough, these estimates also resonate well with the early speculative assessment of David Landes (1969, pp. 13-14):

> Western Europe was already rich before the industrial revolution…it seems clear that over the near millennium from the year 1000 to the eighteenth century, income per head raise appreciably – perhaps tripled and that this rise sharply accelerated in the eighteenth century even before the introduction of the new industrial technology.

The present state of the debate can therefore be described as follows: we have two conflicting sets of estimates of GDP per capita for England, one consistent with the Malthusian view (Clark, 2010) and one supporting "the revolt of the early modernists" (Broadberry et al, 2011). It should be noted that these estimates of GDP per capita have been reconstructed using two different approaches and different types of data. Clark's estimates are based on an income approach (GDP is computed as the sum of all property incomes plus wages) whereas the estimates of Broadberry et al. (2011) have been constructed using an output approach (GDP is computed as the sum of the outputs of all economic sectors). The next step in the debate seems to be the analysis of the relative compatibility of these estimates with other pieces of empirical evidence. This, for example, is precisely the approach of Clark (2011). In this paper, however, we adopt a different and more modest research strategy. We take as a starting point the price and wage data that Clark

[1] The label "revolt of the early modernists" for this interpretation of the dynamics of growth in preindustrial Europe is due to de Vries (1994). The term was meant to define a new perspective challenging the traditional belief of the European economy before the industrial revolution as an inherently stagnating, growthless system (LeRoy Ladurie, 1977). For an insightful discussion of this view in the case of the Netherlands, see Van Zanden (2002).

(2010) has used for his estimates and we construct a new time series of GDP per capita for England over the period 1250-1850 using an alternative (indirect) method: the demand side approach. This approach has been effectively used by Malanima (2011) for constructing estimates of GDP per capita for central and northern Italy. Our aim is to check the consistency of Clark (2010) and Broadberry et al. (2011) series of per capita GDP with new estimates constructed using a different approach with the hope to contribute to their further refinement. Since the patterns underlying the GDP per capita series of Clark (2010) and Broadberry et al. (2011) are so strikingly divergent, it seems appropriate to provide a preliminary assessment of these contributions by reconstructing a new series of GDP per capita for England employing an alternative method. The remaining of the paper is structured as follows. In the next section we introduce the demand side method for estimating GDP per capita and we discuss its main advantages and limitations. Subsequently, we describe the data and sources we have used. In section 3 we set out our estimates and compare them with those of Broadberry et al. (2011) and Clark (2010). Section 4 concludes.

2. Methods and Materials

2.1 The demand side approach

Our approach to the estimation of GDP per capita follows the one developed by Malanima (2011) for central and northern Italy. The approach is based on a two-step procedure. The first step consists in the estimation of the output of the agricultural sector using the demand-side method. This method has been used, among others, by Allen (2000) and Federico and Malanima (2004) for constructing estimates of agricultural output in the early modern period respectively for a number of European countries and for Italy. The starting point is the following equation defining total agricultural output (Y_A):

(1) $Y_A = r \cdot c \cdot N$

In equation (1) $r = \frac{Y_A}{C_A}$ is the ratio of domestic agricultural production (Y_A) to agricultural consumption (C_A) in the country in question (if $r = 1$ the trade position of the country in agricultural goods is perfectly balanced), $c = \frac{C_A}{N}$ is the consumption per capita of agricultural goods and N is the total population. Dividing both sides of equation (1) by N we get per capita agricultural output y_A:

(2) $y_A = r \cdot c$

Next, we assume that per capita consumption of agricultural goods c will depend on the level of wages and prices according to the following equation (Allen, 2000, p. 13; Federico and Malanima, 2004, p. 438):

(3) $c = W^{\alpha} \cdot P_a^{\beta} \cdot P_m^{\gamma}$

Equation (2) is a demand function where W is the real wage, P_a a price index of agricultural products, P_m a price index of manufactures and α, β and γ are the elasticities of demand of agricultural products with respect to wages and prices. Standard microeconomic consumer theory suggests that $\alpha + \beta + \gamma = 0$ (Malanima, 2011, p. 171). By making sensible assumptions on the magnitudes of the elasticity coefficients, α, β and γ, and using the available data on wages and prices it is possible to get an estimate of c, and from here, after having made an evaluation of r, it is possible to obtain the value of the per capita agricultural output y_A.

The second step of the procedure consists in using the estimated values of per capita agricultural output to get to an estimate of real GDP per capita. In order to do this, it is necessary to formulate an assessment of the share of total agricultural output in aggregate GDP. In the case of Italy, Malanima (2011) estimates the share of agriculture output in total production using two different approaches. The first method is based on the extrapolation of the share of output in the secondary and tertiary sectors from urbanization levels on the basis of the results of regression relating the share of output in the secondary and tertiary sectors to urbanization levels in post unification Italy. The second approach consists in a backward extrapolation of the non agricultural output share for the period 1851-1860 using the trend displayed by the share of non-agricultural employment in the total working population. This second method relies on the assumption that the relative labour productivity in agriculture compared to that of the rest of the economy did not change. Here, we adopt a more simple procedure. We define the share of agricultural output in total output (Y) as

(4) $S_A = \frac{Y_A}{Y}$

Equation (4) can be written as:

(5) $S_A = \frac{\pi_A \cdot L_A}{\pi \cdot L}$

where L_A is the numbers of workers in agriculture, L is the total number of workers in the economy, $\pi_A = \frac{Y_A}{L_A}$ and $\pi = \frac{Y}{L}$ represent respectively the labour productivity of agriculture and of the entire economy, measured in terms of output per worker.

If we assume competitive labour markets, real wages in agriculture ($\frac{w_A}{P}$) and in the entire economy ($\frac{w}{P}$) will track closely labour productivity.[2] We can then use the ratio of real wages between the two sectors as a proxy for the relative productivity of agriculture with the respect to the entire economy ($\frac{\pi_A}{\pi} \cong \frac{w_A}{P} / \frac{w}{P}$). In other words, equation (5) is transformed into

(6) $S_A = \frac{\frac{w_A}{P} \cdot L_A}{\frac{w}{P} \cdot L}$

Using equation (6) we can estimate S_A provided that we have data on real wages in agriculture and in the total economy and the share of working population employed in the agricultural sector ($\frac{L_A}{L}$). It is worth noting, that the main difference between our approach and that of Malanima (2011) is that rather than assuming a constant level of relative labour productivity between agriculture and the rest of the economy, we have preferred to make the assumption of (nearly) competitive labour markets.

We shall adopt this method for estimating the share of agriculture in total output only for the period before 1690. For the more recent period, instead we will base our assessment on other existing estimates. Once we have estimated agricultural output per capita and the share of agriculture in aggregate output, we can calculate per capita GDP (y) using the formula:

(7) $y = \frac{Y}{N} = \frac{y_A}{S_A}$

Clearly, the demand-side approach is an indirect method of estimating agricultural output and GDP. Compared to the more conventional and "direct" output and income approaches, the main advantage of the demand side approach is represented by being less exacting in terms of the data necessary for constructing the estimates (as we have seen, the data needed for implemented the approach are time series of wages and prices). The main limitation of the approach is the need of relying on a number of rather stringent assumptions both for the computation of per capita agricultural consumption and of the share of agriculture in total income. It is also important to note that the geographical scope of the estimates constructed with this method will reflect the geographical scope of the original time series of wages and prices employed.

2.2 Data and sources

The average wage and the farm wage time series we employ are derived from Clark (2010, pp. 54-55).These wage time series are based, in turn, on Clark (2007b) for farm wages and Clark (2005) for non-farm wages.

[2] This assumption is also made in some recent formal models of pre-industrial European economies, see for example Sharp et al. (2012), and Voigtlander and Voth (2011).

Farm and non-farm wages are then weighted by their employment share to compute an aggregate average wage series (Clark, 2010). All these series are for daily wages and they are constructed as 10-year averages. Real wages are computed using the cost of living index proposed by Clark (Clark, 2010, pp. 98-99).

The estimation of per capita agricultural output (equation 3) is based on two time series of prices: agricultural goods and manufactures. The price index of manufactured goods is a geometric index constructed by Clark (2010, pp. 138-139) using as weights the expenditure shares and it covers the prices of products such as: pottery, glass, woodware, pewter goods, brass goods, cutlery, paper, etc.. The price index of agricultural goods is derived from Clark (2004). It is a geometric index employing output shares as weights and comprising the price series of 26 products: wheat, barley, oats, rye, peas, beans, potatoes, hops, straw, mustard seed, saffron, hay, beef, mutton, pork, bacon, tallow, eggs, milk, cheese, butter, wool, firewood, timber, cider and honey. The index has been constructed by aggregating these individual series in four main categories: arable products, pastoral products, wood products and cider/honey. These four main sub-components are then aggregated into a composite index of agricultural products. Also these series represent 10-year averages. Since we are interested in relative prices, both price series of agricultural products and manufactures have been deflated using the cost of living index constructed by Clark (2010, pp. 98-99).

The data on the share of agricultural workers in the total working population ($\frac{L_A}{L}$) are taken from Allen (2000, p.8). Allen constructs this estimate of the distribution of the labour force following the method originally developed by Wrigley (1985). This approach consists in assessing the size of population engaged in non-agricultural occupations on the basis of the rates of urbanization. This estimate is then adjusted in order to take into account the share of rural population engaged in non-agricultural occupations (Allen, 2000, pp. 4-13). Allen provides estimates for the following years: 1300, 1400, 1500, 1600, 1700, 1750,1800. Clark (2010,pp. 56-57) has also recently reconstructed alternative estimates of the share of employment in agriculture. Figure 1 compares Allen and Clark's estimates. Figure 1 shows that Clark's estimates for the period before 1700 are much lower than those of Allen's. In this paper, we use Allen's estimates as they seem to be consistent with those elaborated independently by Crafts using the social tables for 1688 and 1759 (Crafts, 1985, p. 14). Furthermore, in the Italian case, Malanima has also found Allen's estimates of the employment structure for the period 1300-1800 fairly plausible and consistent with other pieces of empirical evidence (Malanima, 2011, p. 184).

Figure 1 around here

Using Allen's estimates of the employment share in agriculture, we can estimate the share of agriculture in total output using equation (6) for the benchmark years 1300, 1400, 1500, 1600, 1700, 1750 and 1800. We calculate the intervening values between these benchmark estimates by interpolation. In this way, we are able to construct a complete time series of the agricultural share in total output. To check the reliability of our estimates, in figure 2 we compare them with alternative estimates of the agricultural share in total output constructed by Deane and Cole (1969, p. 156 for the years 1688 and 1770 and p. 166 for the period after 1800-1850) and Crafts (1985, p. 16 for the period 1690-1760; p. 45 for the period 1780-1801 and the period 1801-1831 and Crafts, 1983, p. 191 for the year 1780). We should note that these estimates of the sectoral share of agriculture developed by Crafts have been employed also for the construction of the revised estimates of real GDP growth proposed by Crafts and Harley (1992, p. 715).

Figure 2 around here

In figure 2 the series labeled "Ricci-Nuvolari" represents our estimation of the share of agriculture in total output computed using equation (6) whereas the series labelled "Deane & Cole" and "Crafts" represent Deane and Cole and Crafts estimates. Figure 2 shows that our estimates for the early years 1690-1700 are fully in line with those proposed by Crafts and Deane and Cole (in particular our calculation using equation (6) yields an estimate of the agricultural share in total output in 1700 of 36% while Crafts considers this to be 37%). For the period after 1700 instead the decline of the agricultural share in total output computed using equation (6) is more rapid than that shown in Crafts and Deane and Cole estimates. Allen (2009) has argued that in the period 1770-1840 real wages stagnated whereas output per worker increased: a prolonged divergence leading to a significant shift in income distribution. Clearly, this means that estimating the agricultural output share using equation (6) is not likely to be an accurate procedure for this historical period. For this reason we have decided to revise our estimates for the interval 1700-1850 adopting a series closer to the estimates of Crafts and Deane and Cole which are based on more direct assessments of the nominal value of output in different sectors in benchmark years. In particular, we have used the following procedure. We adopt as a "compromise" estimate of the agricultural share in total output in 1800 the average of the Crafts and Deane and Cole estimates. Then we compute the new estimates for the period 1700-1800 by interpolation between the value of our time series in 1700 and the new value of 1800. For the interval 1800-1830, we construct our estimates by interpolation between our new value of 1800 and the value for 1830 estimated by Deane and Cole. Finally the observations for 1840 and 1850 are derived directly from the Deane and Cole estimations. In this way we obtain a new series of agricultural share for the period 1700-1850 which in figure 2 is labeled as "Ricci-Nuvolari amended (1700-1850)". To sum up, our final estimates of the agricultural share in total output are represented by the "Ricci-Nuvolari" series for the period before 1700 and by the "Ricci-Nuvolari amended" series for the period after 1700.

The data on the ratio between agricultural production and the domestic consumption of agricultural goods (r) are taken from Crafts (1985, p. 127) for the period 1800-1850. Intervening values were obtained by interpolation. We should note that alternative estimates provided by Thomas (1985, p. 148) are also available for the period 1800-1850. However, they are very close to those proposed by Crafts. For the period before 1700, there are no sources of data readily available. However, according to Allen (2000, p.14), "[t]here is no indication that r differed from one before the middle of the seventeenth century". Here we follow the same type of assumption and consider $r = 1$ up to the year 1750.[3] Values for the period 1750-1800 were computed by interpolation.

The price and income elasticities of the demand function (3) are taken from Allen (2000, p. 14). Allen, on the basis of studies of modern developing countries, assumes the demand elasticity with the respect to the price of manufactures (γ) to be equal to 0.1. The demand elasticity with respect to the price of agricultural goods (β) is taken to be -0.6. As a result, the condition $\alpha + \beta + \gamma = 0$, suggests that α must be equal to 0.5. Experiments with alternative values of these elasticities have produced very similar estimates of agricultural output.[4]

Finally the data on population are taken from Wrigley and Schofield (1997) for the period after 1541. For the previous period the data are taken from Clark (2010, pp. 64-65).

3. ESTIMATING AGRICULTURAL OUTPUT AND GDP PER CAPITA.

The complete time series of our estimates of per capita agricultural output and of real per capita GDP calculated using the procedures explained in the previous section are presented in the Appendix. Figure 3 shows our estimates of per capita agricultural output (y_A) and of total agricultural output (Y_A). Total agricultural output has been computed by multiplying per capita agricultural output by total population. All these estimates are reported using the index 1700=100. Figure 4 compares our estimates of total agricultural output with those of Allen (2000) and Broadberry et al. (2011). The estimates of Broadberry et al. (2011) refer to England in the period 1270-1700 and to Great Britain for the period 1700-1850. Our estimates appear to be in broad agreement with those of Allen (2000). For the period before 1550, the estimates of agricultural output of Broadberry et al. (2011) are instead somewhat lower. The implication is that these estimates will display faster growth throughout this period. For the period after 1550-1750, our estimates and those of Allen (2000) and of Broadberry et al. (2011) appear to be broadly consistent. Taking into account that our estimates have been constructed following the same approach used by Allen (the only difference are the wages and prices series used in the computation), these findings are not completely surprising. The obvious implication is that a possible avenue for further research will be to search for the factors accounting

[3] For the period 1700-1750 the assumption of $r = 1$ is based on the consideration that England was a net exporter of corn and an importer of exotic foodstuffs such as sugar, coffee and tea. Overall the balance of this segment of trade appears to have been as roughly in equilibrium, see Davis (1962).

[4] Following Malanima (2011, p. 179), we have experimented with values of β ranging from -0.3 to -0.7 and values of α ranging from 0.2 and 0.6 (with $\gamma = 0.1$).

for this divergence in agricultural output estimates between the output and the demand side approach in the period before 1600.

Figure 3 around here

Figure 4 around here

Figure 5 contains our estimates of GDP per capita compared with those of Clark (2010), Broadberry et al. (2011) , Maddison (2001, p. 247) and Malanima (2011, p. 189). Again, all the series are reported using the index 1700=100. It is important to take into account that Maddison's estimates refer to England, Scotland and Wales, the estimates by Broadberry et al. (2011) refer to England for the period 1270-1700 and to Great Britain for the period 1700-1850, while the estimates of all the other authors concern only England. The yearly series of Broadberry et al. (2011) has been converted into 10-year averages centered on each decade (so that it is directly comparable with Clark's and our estimates). Overall, our estimates display a pattern that seems to be an intermediate case between the estimates proposed by Clark (2010 and those of Broadberry et al (2011).

Figure 5 around here

The different patterns of economic growth implicit in these time series estimations become apparent when we consider long run growth rates. Table 1 compares the average compound growth rates of GDP per capita of the different estimates using various subperiods. We have also included in the table the estimates of Crafts and Harley (Crafts and Harley, 1992; Harley, 1993, p. 178) covering the years 1700-1830. For the period 1250-1580, our estimates are consistent with those of Clark showing no positive growth. In particular, as it can be seen from figure 5, both our estimates and those of Clark exhibit a large "Malthusian cycle" of growth and decline beginning around 1300 and ending around 1600 (although the cycle is clearly more nuanced in our estimates than in Clark's) . The peak of the cycle occurs around 1450. This behavior of GDP per capita mirrors the fluctuations of the real wage series constructed by Clark (2007a, p. 41). For the interval 1580-1780, our estimates are instead consistent with those of Broadberry et al. (2011) indicating that the English economy was able to attain an annual growth rate of about 0.2 per cent. Hence our estimates suggest that by the end of the sixteenth century the English economy was probably already beginning to break away from the Malthusian constraints.[5] This is in contrast with the estimates of Clark (2010) showing the English economy attaining a "sizable" positive rate of economic growth only from the end of the eighteenth century. Thus, in terms of the overall pattern, our estimates appear consistent with those of Broadberry et al. (2011), suggesting the historical relevance of a three-stages periodization, rather than the two-stage one underlying Clark's estimates. In particular, our estimates show that the period 1250-1580 can be characterized as a "Malthusian-phase" with a generalized stagnation in GDP per capita; the period 1580-1780 can be perhaps be seen as a "Smithian-phase" of positive economic growth preceding the industrial revolution (although we should also note that our estimates of the rate of economic growth during this period are somewhat lower than those of Broadberry et al (2011)). Finally, all estimates are in broad agreement in indicating that the beginning of the process of "modern economic growth" with steady positive growth rates significantly above the threshold of 0.2 per cent per year should be probably located at the end of the eighteenth century.

Table 1 around here

Interestingly enough, we can note in figure 5 that both the Clark's series and, to a more significant extent, our series suggest a phase of relatively sluggish growth performance in the period of the revolutionary and Napoleonic wars (1790-1810). This is probably to be ascribed to the disrupting effects of the wars on prices. Of course since the approach adopted here is relying heavily on the wages and prices series, the erratic behavior of prices in this historical phase may introduce some spurious effects in our estimates for this specific period.

[5]It is worth noticing that our estimates are consistent with Wrigely's view who considers the late sixteenth century as a fundamental turning point marking the emergence in England of an "advanced organic economy" leading to an acceleration in the rate of economic growth lasting throughout the seventeenth and eighteenth centuries (Wrigley, 2004, pp. 44-67).

Figure 6 around here

Figure 6 contains our estimates of GDP per capita measured in 1990 "Geary-Khamis" PPP dollars, which is the unit of measurement adopted by Maddison (2001,2003,2007) and it is frequently used for international comparisons. This series has been computed projecting backwards Maddison's value of GDP per capita in England, Wales and Scotland for the year 1850 (Maddison, 2001, p. 247) using our estimated time series of per capita GDP. [6] In order to put our estimates in a comparative context, in figure 6 we have also plotted the series of GDP per capita (also expressed in 1990 PPP $) estimated by Malanima (2011). In order to be fully comparable with our series, the yearly series of Malanima has been converted into 10-year averages centered on each decade. As we have mentioned, also Malanima has constructed his estimates using a very similar approach to the one adopted here. There are two points of interest arising from figure 6. The first point is that our estimates show that England throughout the late middle ages and very early modern period was considerably richer than the picture emerging from Maddison's estimates. Our estimates suggest that over the period 1250-1500 income per capita fluctuated in an interval ranging from a minimum of about 1000$ to a maximum of about 1700$, whereas Maddison reckoned GDP per capita in England to be 400$ in year 1000 and 762 $ in year 1500. In fact, several authors (Federico, 2002; Clark, 2009) have argued that the basic "subsistence" income level of $ 400 per capita that Maddison considers as characteristic of not particularly sophisticated societies is far too low. Following this cue, Lo Cascio and Malanima (2009), on the basis of a number of considerations concerning the price of foodstuffs, clothing and fuel and the level of real wages, have proposed that 700 $ and not 400$ should be regarded as the minimal "bare bones" threshold for GDP per capita in pre-modern Europe. In this perspective, we can see that in figure 6 in the period 1250-1580, English per capita GDP is fluctuating in a range comprised between 1.5 and 2 times this basic level identified by Lo Cascio and Malanima. We should also note that the GDP per capita levels estimated by Broadberry et al. (2011) for the period 1250-1350 seems to fluctuate around the minimum "bare bones" threshold of 700$. The second point that is worth noting is that, even if our estimates show a relative high level of income per capita for England in the period 1250-1600, they still indicate the existence of a noticeable gap in GDP per capita between Italy and England lasting at least until the second half of the fifteenth century. Figure 6 shows that the moment in which England is decidedly overtaking Italy is the second half of the seventeenth century. This may perhaps be seen as consistent with interpretations that have pointed to the importance of international trade (in particular the successful challenge mounted by English traders to Italian producers in wool textiles during the seventeenth century) in accounting for the patterns of economic divergence in early modern Europe (Allen, 2002). [7]

Finally, it is possible to provide a rough assessment of the reliability of our estimates of GDP per capita, by computing the implied number of working days during the year that are "implicit" in our estimates of GDP per capita. Formally the number of working days during the year (d) is equal to:

$$(8)\quad d = \frac{GDP \cdot \sigma}{w \cdot L}$$

where GDP is the nominal GDP, σ the share of wages in total income, w the nominal wage and L the total number of workers. Equation (8) tells us how many days it is necessary to work in order to obtain an yearly earning corresponding to a certain level of GDP per capita (given the prevailing wage and patterns of income distribution). In order to implement empirically the formula we proceed as follows. First, we construct an index of nominal GDP by multiplying our estimates of real GDP per capita by the cost of living index constructed by Clark (2010, pp. 98-99) and by total population, again taken from Clark (2010, pp. 64-65). Then, following Clark (2010, p. 59) we assume that the nominal value of the labour share in total income around 1860 is equal to 420 millions of pounds.[8] We project backwards this estimate of the nominal value of the labour share in total income using the index of nominal GDP and assuming σ to be equal to 0.6. This value for σ is consistent with the dynamics of the labour share in total income emerging from Clark's

[6] Maddison does not provide an estimate for 1850, so the value for 1850 has been computed assuming a constant growth rate between the 1820 and 1870 observations.

[7] For a perceptive analysis of England's "forging ahead" and Italy's "falling behind" in this historical phase, see Malanima (1997).

[8] This estimate is actually based on Levi (1867).

estimates (2010, pp. 81-82). In this way, we are able construct a time-series of the nominal value of labour income (the numerator of formula 8). In order to estimate L we compute the share of working population in total population by dividing the total working population given by Deane and Cole (1969, p. 143) for the period 1801-1861 by total population (Clark, 2010, p. 65). For the period 1801-1861 we obtain an average value of 0.53. We use this value for calculating the number of workers in each period. We can now compute the denominator of formula (8) by multiplying the average daily wages (series taken from Clark (2010, pp. 54-55)) by the total number of workers.

Figure 7 compares the number working days during the year computed using equation (8) (the series is labeled "implied working days") , with a number of independent estimates of the actual working year for different periods assembled by Allen and Weisdorf (2011). The original sources for these estimates are Blanchard (1978), Clark and van der Werf (1998) and Voth (2001). Overall, figure 6 suggest that our estimates of the working days during the year implicit in our GDP per capita series are able to track rather closely the available independent estimation of working days. Given the admittedly crude procedures adopted for the computation of the working days, we consider this result as a promising preliminary corroboration of our GDP per capita estimates.

Figure 7 around here

4. Conclusions

In this paper we have presented a new set of estimates of agricultural per capita output and real per capita GDP for the English economy in the period 1250-1850 constructed using the demand-side approach. As we have seen, this approach to the statistical reconstruction of per capita GDP relies on a number of exacting assumptions and we believe that it should be regarded as nothing more than a useful framework of inquiry for formulating reasoned conjectural assessments of the historical performance of an economy. Still, we think that in the case in question, despite its inherent limitations, the implementation of the demand approach has performed reasonably well, generating some interesting findings and producing a rather plausible picture of the long run evolution of the English economy. Further, our estimates have received some further corroboration by being consistent with some empirical evidence concerning the number of working days in the year at different time periods.

Our estimates suggest that the growth experience of English economy over the period 1250-1850 can be suitably interpreted using a three-stage account. In particular, our estimates indicate the existence of a Malthusian phase covering the period 1250-1580. This phase is followed by an "intermediate"stage preceding the industrial revolution covering the seventeenth and eighteenth century during which the economy is able to dissipate some of the Malthusian constraints and attain a sustained positive growth rate. The third phase corresponds to the industrial revolution and by a further significant acceleration in the rate of economic growth. In this perspective, the pattern of economic growth underlying our estimates appears broadly consistent with the "revolt of the early modernists" view. However, it is important to take into account that our estimates also provide three important qualifications to this interpretation. The first is that the Malthusian phase of generalized stagnation is protracted well after the end of the Middle Ages lasting approximately until the end of the sixteenth century. The second is that the rate of economic growth reached after the conclusion of the Malthusian phase is somewhat lower than that emerging from the ongoing statistical reconstructions based on the output approach (Broadberry et al., 2011). The third is that the levels of GDP per capita during the late Middle Ages (1250-1400) estimated with the output approach by Broadberry et al. (2011) may be too low.

5. Appendix

Table 2 here

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Figure 1: Employment share in agriculture, 1300-1850

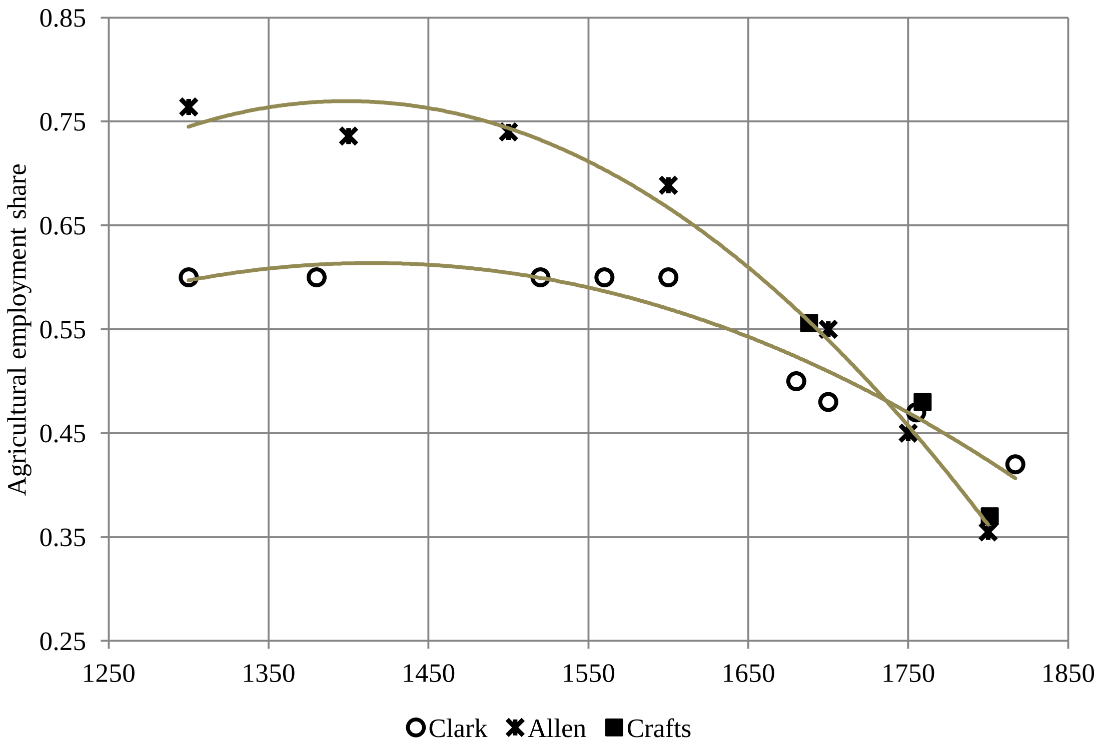

Figure 2: Agriculture share in total output, 1690-1850

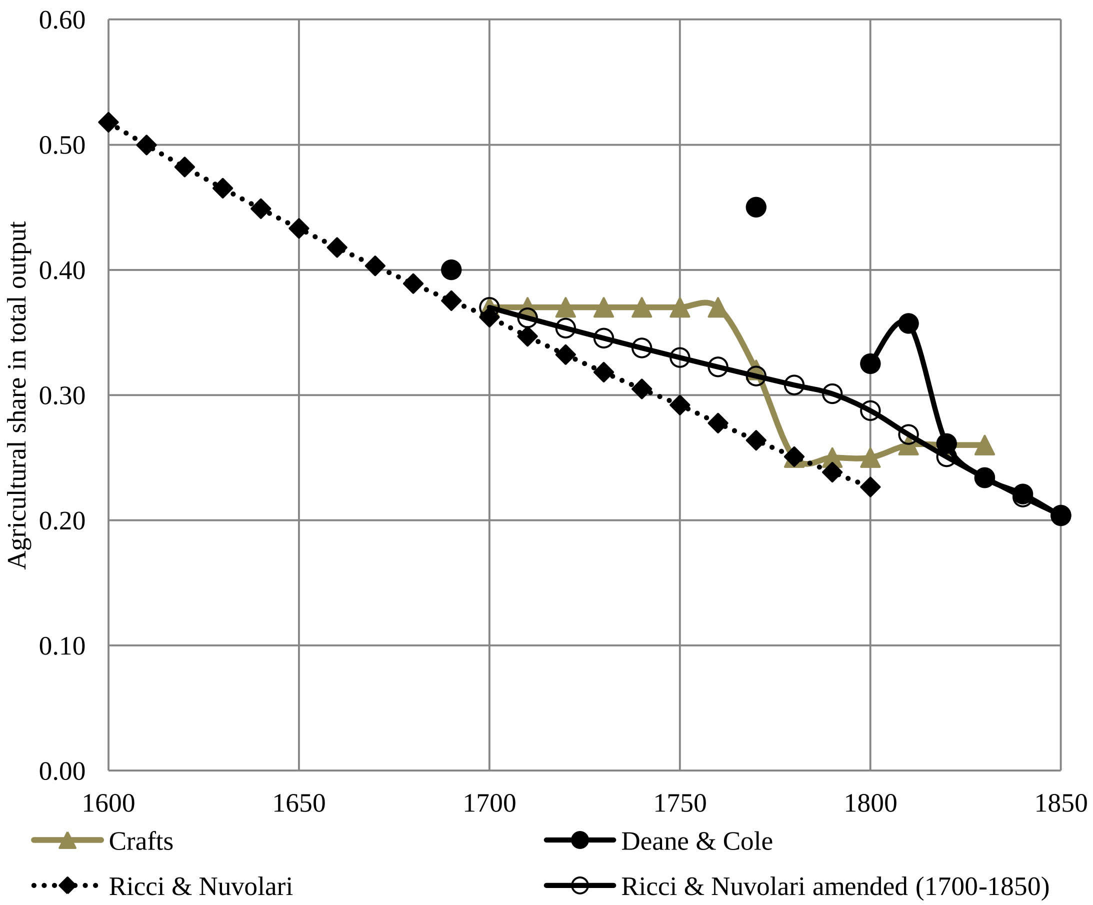

Figure 3: Agricultural output (1700=100)

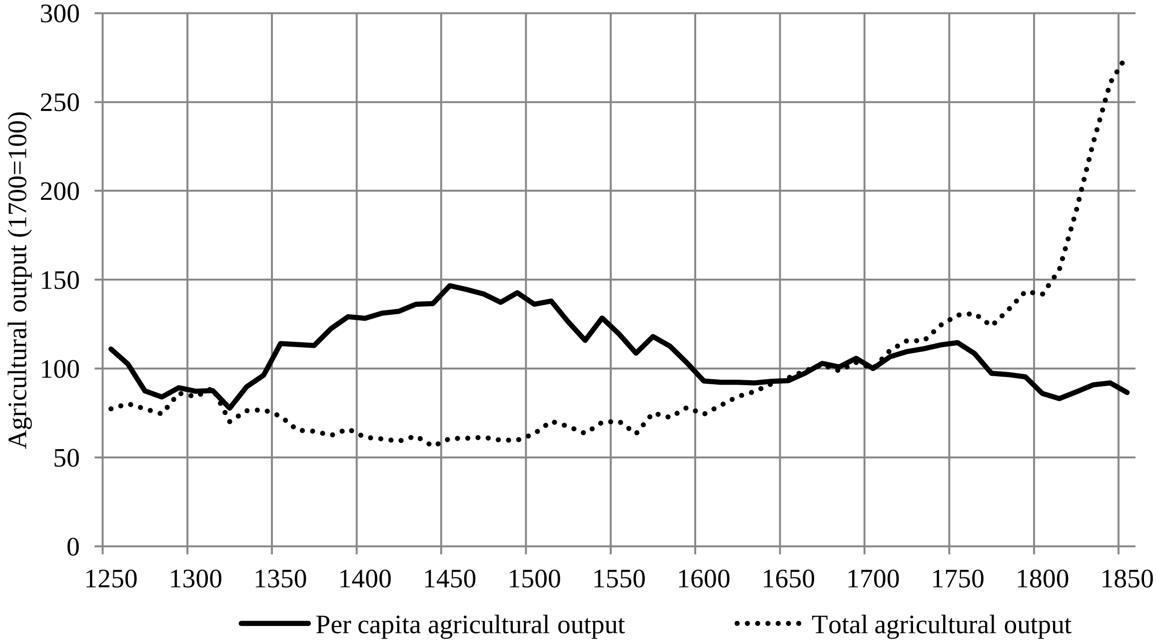

Figure 4: Comparative estimates of total agricultural output (1700 =100)

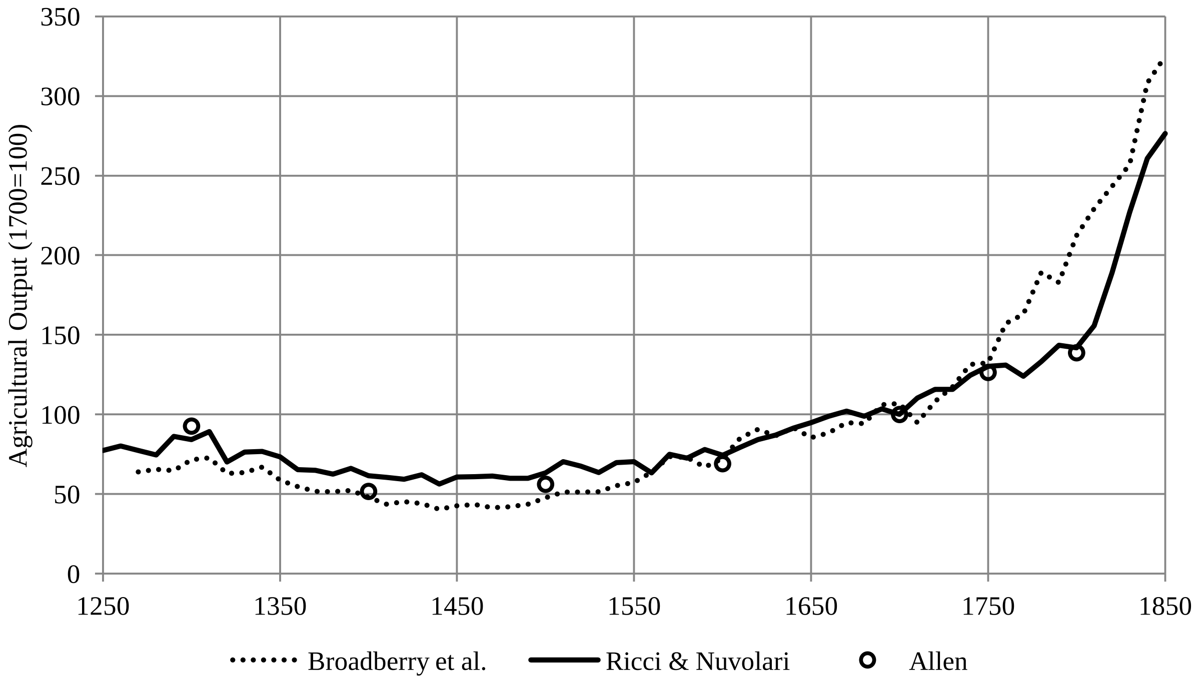

Figure 5: Comparative estimates of per capita GDP (1700=100)

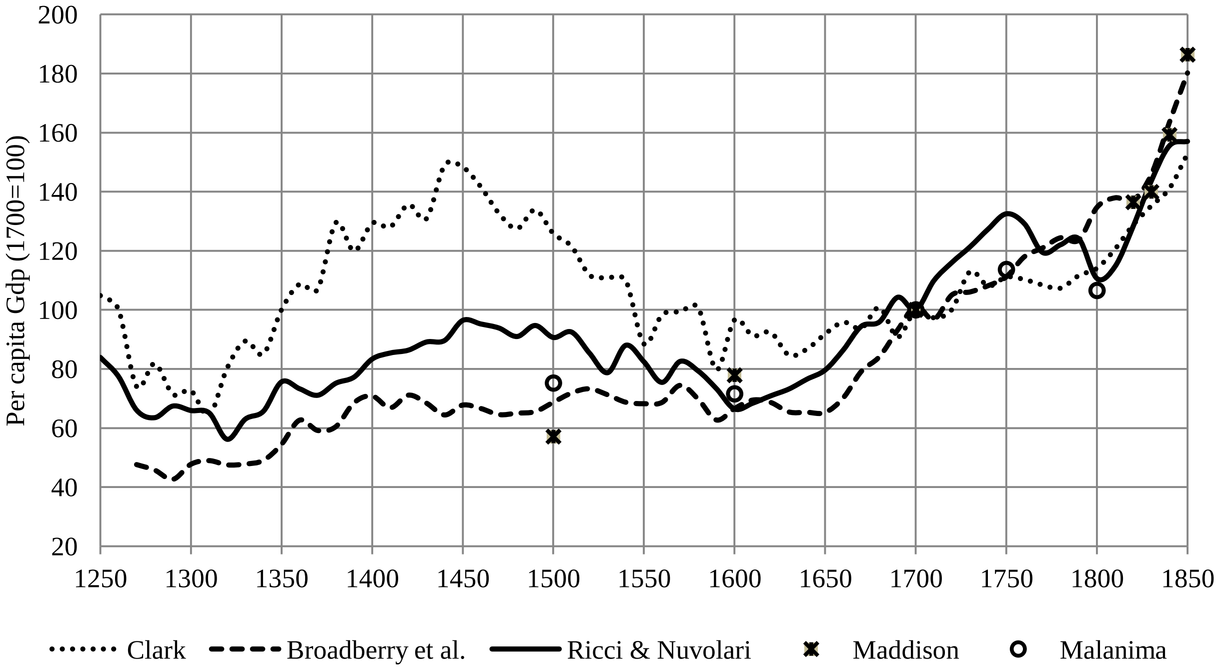

Table 1: Rates of growth of GDP per capita (annual average compound growth rates (%))

Period	Broadberry et al.	Clark	Maddison	Malanima	Crafts & Harley	Ricci & Nuvolari
1250-1580	0.12*	-0.01				-0.02
1580-1780	0.29	0.03				0.22
1780-1850	0.53	0.51				0.36
1780-1820	0.24	0.46				0.12
1500-1700	0.19	-0.11	0.28	0.14		0.05
1700-1820	0.25	0.21	0.26			0.21
1700-1800				0.06		0.10
1820-1850	0.91	0.57	1.05			0.68
1800-1870				0.79		
1700-1780	0.26	0.09			0.24	0.25
1780-1830	0.32	0.46			0.45	0.33

*: 1270-1580.

Figure 6: GDP per capita in England and in central/northern Italy (1990$), 1250-1850

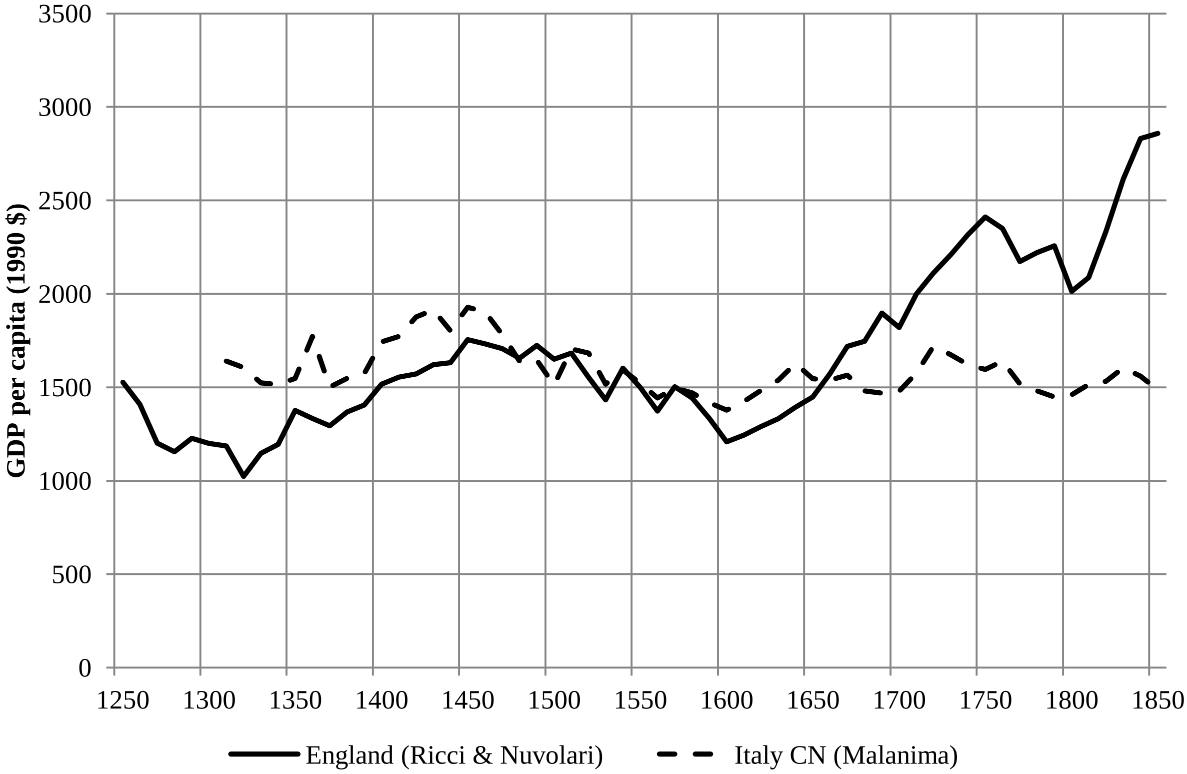

Figure 7: Number of working days implied by Ricci-Nuvolari GDP per capita estimates, 1250-1850

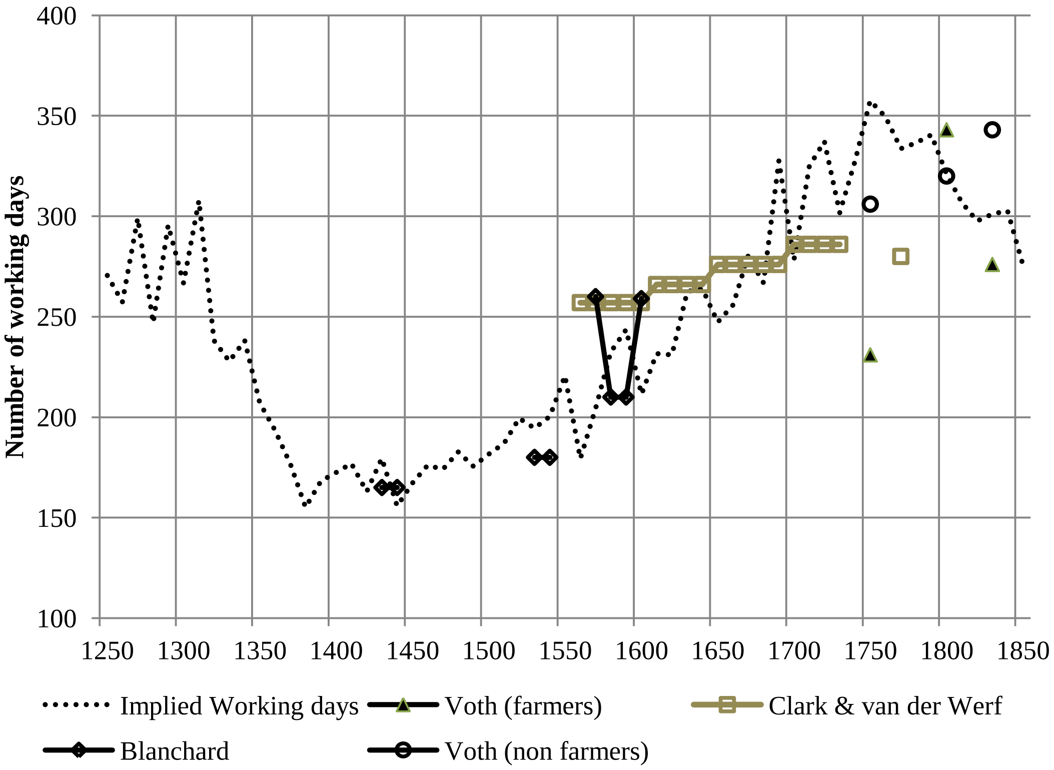

Table 2: Per capita agricultural output and per capita GDP in England, 1250-1850

Year	Per capita agricultural output (1700=100)	Per capita GDP (1700=100)
1250	111.10	83.92
1260	102.57	77.47
1270	87.47	66.07
1280	84.09	63.52
1290	89.29	67.45
1300	87.29	65.93
1310	87.56	65.15
1320	77.83	56.20
1330	89.87	63.03
1340	96.36	65.70
1350	114.06	75.65
1360	113.51	73.30
1370	113.03	71.10
1380	122.60	75.19
1390	129.12	77.25
1400	128.28	83.37
1410	131.12	85.42
1420	132.28	86.38
1430	136.18	89.14
1440	136.65	89.66
1450	146.65	96.46
1460	144.45	95.24
1470	142.03	93.87
1480	137.37	91.01
1490	142.65	94.73
1500	136.20	90.67
1510	138.01	92.52
1520	126.38	85.33
1530	115.83	78.76
1540	128.56	88.04
1550	119.54	82.44
1560	108.65	75.47
1570	118.05	82.57
1580	112.56	79.29
1590	103.37	73.33
1600	93.00	66.45
1610	92.38	68.41
1620	92.41	70.92
1630	92.04	73.21
1640	92.87	76.56
1650	93.21	79.64
1660	97.60	86.43
1670	102.95	94.48
1680	100.88	95.96
1690	105.78	104.29

1700	100.00	100
1710	106.75	109.91
1720	109.52	116.10
1730	111.22	121.39
1740	113.37	127.40
1750	114.57	132.56
1760	108.44	129.18
1770	97.40	119.47
1780	96.68	122.09
1790	95.43	124.09
1800	85.99	110.66
1810	83.23	114.72
1820	86.92	128.31
1830	90.86	143.66
1840	91.88	155.60
1850	86.61	157.09