GDP per capita or Real Wages? Making sense of conflicting views on pre-industrial Europe.

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Abstract

This paper studies the apparent inconsistency between the evolution of GDP per capita and real wages in pre-industrial Europe. We show that these two measures will diverge when any of the three following factors are present: changes in income distribution, changes in labour supply per capita and changes in relative prices. We propose a methodology for measuring the effects of these three factors and apply it to the case of 18th century England. For this particular episode the gap between the growth of GDP per capita and real wages can be successfully explained and the main explanatory factor is changes in labour supply per capita. Some further conclusions are drawn from the experience of England during the 19th century and Europe during the early modern period.

1 Introduction

How are we to regard the evolution of economic well-being over the pre-industrial period? Were pre-industrial economies stuck in a long term equilibrium characterized by a level of economic well-being that showed no trend over several

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centuries? Or did pre-industrial economies experience sustained growth which, despite much slower rates than the ones we are currently used to, cumulates over the course of the centuries in large and significant gains in living standards?

These difficult questions have occupied social scientists at least since the work of Adam Smith and Thomas Malthus. Unfortunately, notwithstanding a large and insightful literature, we seem to be as far from a consensus today as two centuries ago. An important reason for this is the fact that different measures of economic well-being seem to tell surprisingly different stories about pre-industrial economies. Thus, what one believes will be inevitably conditioned by what measure one is ready to trust.

The measures of economic well-being for which we have long time series extending well before the 19th century are essentially two: the real wage and GDP per capita[1]. Each one of them can claim a long history of scholarly effort and important improvements in their methodologies over time, and surprisingly, each one of them shows a very different trend over the pre-industrial period.

Real wage estimates show a consistent picture of no positive trend over the centuries going from the late middle ages to the industrial revolution. Authors have computed real wage series for several European countries and cities and, more recently, for some non-European societies[2]. The most common outcome of these estimates is actually a net *fall* in real wages between the Renaissance and the Industrial Revolution. Only the most successful European economies, namely England and the Netherlands, are able to maintain their real wages over this period. No persistent positive trend is to be detected over the six

[1] There are other, less direct, indicators of well-being for which we have more sparse data; for example data on people's height and probate inventories.

[2] The seminal reference is Phelps Brown and Hopkins (1981). More recent contributions that we will be using are Allen (2001), Clark (2005, 2006) and van Zanden (1999). For recent estimates of real wages in pre-industrial Asia see Allen (2005) and Allen et al. (2005).

centuries preceding the Industrial Revolution in any European country. This description is remarkably consistent across the estimates of different authors, allowing for relatively modest quantitative differences. Thus, the picture that emerges from the real wage literature is clearly one of a stagnant or even falling level of economic well-being over the pre-industrial period.

Estimates of GDP and GDP per capita over the pre-industrial period have been done for fewer countries and extend over a shorter time interval[3]. These estimates have a somewhat larger degree of uncertainty than the ones of real wages, as less work has been done on them and authors might disagree about their values. There have been at least two attempts at summarizing the overall picture for Europe: the work of Maddison (2001, 2003) and van Zanden (2001).

Maddison (2001) is the most optimistic of the two and has been highly influencial. He uses available evidence augmented with some educated guesses to conjecture that Europe's GDP per capita was on a persistent positive trend over as much as eight centuries. Even with modest growth rates this would have implied a level of GDP per capita in 1800 Western Europe that more than doubles its level in the late middle ages. The estimates of van Zanden (2001) are more sobering, showing that GDP per capita growth was the exception rather than the rule in pre-industrial Europe.

Despite these differences, both Maddison (2001) and van Zanden (2001) seem to contradict the evidence from the real wage literature and paint a more positive view of the evolution of economic well-being during this period.

The aim of this paper is to address this apparent inconsistency between real wages and GDP per capita in pre-industrial Europe. We show that these two

[3] Estimates of the growth of GDP (or of some of its components) in the pre-industrial period exist for Belgium (Blomme, Buist and Van der Wee 1994), the Netherlands (van Zanden 1993, de Vries and van der Woude 1997), Spain (Yun 1994), Italy (Malanima 1994) and, particularly, England (see the next section for references).

measures can show persistent differences in growth rates in the presence of any of the three following factors: (i) Changes in the share of national income allocated to labour, (ii) Changes in the labour supply per capita, and (iii) Changes in relative prices.

We contribute to the literature by linking the methodology used to calculate growth rates of GDP per capita with the one used in the real wages literature. We derive algebraically the effects of the three factors mentioned above and apply our methodology to a particular case: England during the 18th century. We show that changes in income distribution and in labour supply per capita are able to explain a divergence between GDP per capita and real wages of the same magnitude as the one observed in the data. After analyzing the case of 18th century England in detail we check that our framework is also consistent with the English experience during the 19th century. We finalize by discussing the case of continental Europe and set a research agenda for the future.

2 GDP per capita and real wages over time

In order to explain why our measures of GDP per capita and real wages differ over time we ought to start by understanding how they are calculated.

The objective behind a calculation of GDP per capita is to quantify the average amount of goods and services available to each person in an economy. As we cannot sum up different goods we proceed by creating an index of aggregate production using the monetary value of the different goods. Since good prices change over time we must compromise in some way, for example by fixing prices at their value at some point in time.

In this literature the most commonly adopted solution consists in fixing all

prices at the level they take in some initial period called the base year. In other words, authors use a Laspeyres index to calculate the growth of real GDP.

Let us consider an economy with n sectors, each sector characterized by a level of production $Y_{i,t}$ and a price $P_{i,t}$, $i = 1..n$. The growth of real GDP between periods 0 and 1 will be given by[4]:

$$\frac{Y_1}{Y_0} = \frac{\sum_{i=1}^{n} P_{i,0} Y_{i,1}}{\sum_{j=1}^{n} P_{j,0} Y_{j,0}}$$

As is well known, this formula can be rewritten as a weighted arithmetic average of the growth rates of each individual sector; the weights being the shares of each sector in GDP at the base year:

$$\frac{Y_1}{Y_0} = \sum_{i=1}^{n} \phi_{i,0} \frac{Y_{i,1}}{Y_{i,0}} \tag{1}$$

where:

$$\phi_{i,0} = \frac{P_{i,0} Y_{i,0}}{\sum_{j=1}^{n} P_{j,0} Y_{j,0}} \tag{2}$$

Equation (1) is the formula that authors use in practice since it accords with the nature of the data at their disposition.

As GDP per capita is just GDP divided by population, its growth rate will be given by:

$$\frac{y_1}{y_0} = \left[\sum_{i} \phi_{i,0} \frac{Y_{i,1}}{Y_{i,0}} \right] \left(\frac{N_1}{N_0} \right)^{-1} \tag{3}$$

where N_t is population at time t.

While estimates of the evolution of GDP and GDP per capita are numerous

[4] The ratio $\frac{Y_1}{Y_0}$ is of course *one plus the growth rate* of Y_t between periods 0 and 1; but we will refer to it simply as the growth rate to alighten the presentation.

from the 19th century onwards, data concerning the pre-industrial period is much more scarce. The country that has been the object of most academic efforts is certainly England. Economic historians have made several attempts to measure English GDP growth during the 18th century. Their aim was to find evidence of an acceleration in growth rates that would give empirical support to the formerly accepted view of an industrial revolution starting in England in the 1760s[5].

As an illustration, Table 1 reports the growth of GDP per capita in England over the period 1500-1800 from Maddison (2001) and van Zanden (2001). As we mentioned earlier, these two authors differ considerably in their estimates for other European countries but their figures for England are reasonably close. For the 18th century these authors apply equation (3) and arrive to very similar figures since they use very similar sources[6]. For the 16th and 17th centuries the authors could not rely upon direct measures of GDP growth and used different assumptions that led to different figures[7]. The estimates for these two centuries are to be regarded as much more speculative than the ones for the 18th century.

Taking the figures of Maddison (2001) at face value would lead us to reject the existence of a Malthusian period in English history since the late middle ages. Maddison (2005) goes even farther than this and claims that the belief in a Malthusian period is false not just for England but for the whole of Europe. Our view is that we are not in a position to make these claims based on our

[5] Early estimates seemed to confirm this prior (Deane and Cole 1962), but subsequent revisions showed a much more progressive transition (Harley 1982, Crafts 1983).

[6] Both authors use Wrigley et al. (1997) for the data on population growth and the work of N. F. R. Crafts (Crafts and Harley 1992 for Maddison, Crafts 1985 for van Zanden) for the data on sectorial production and shares.

[7] Maddison (2001) finds that it is "reasonable to assume that the Crafts-Harley rate of growth of per capita income for 1700-1801 was also valid for 1500-1700" (p. 246). Van Zanden (2001) proceeds by using the estimates of Overton and Campbell (1997) for the productivity per capita in English agriculture. By assuming that labour productivity in the rest of the economy was growing at a rate either equal (scenario one) or double (scenario two) of the growth rate in agriculture he is able to construct estimates of GDP per capita that differ considerably from the ones of Maddison (2001).

current (lack of) knowledge of GDP per capita before 1700. For the 18th century, on the other hand, the picture seems convincing and a stagnant level of GDP per capita can be safely rejected.

Real wages express the value of nominal wages in terms of a basket of goods and services. If we have a time series for nominal wages, a time series for real wages can be constructed as:

$$rw_t = \frac{w_t}{P_t} \tag{4}$$

where rw_t is the real wage, w_t the nominal wage and P_t a price index. Authors will use as a price index a geometric or an arithmetic weighted average of individual prices where the weights are the shares of each good in the consumption basket of a typical worker. The scope of goods included in the consumption basket is determined largely by data availability. Some studies have limited themselves to just a single good (bread; or its main ingredient, wheat) but more recent ones have included quite a comprehensive range of goods.

The literature on the evolution of real wages over time is voluminous and can be traced back to the nineteen century. An advantage of this literature is that it can tap into direct observations of wages and prices going back as far as the 13th century. Research in the area is very active with new and exciting work from Allen (2001), Clark (2005, 2006), van Zanden (1999) and the longtime influential work of Phelps Brown and Hopkins (1981).

To illustrate the overall message of this literature, Figure 1 plots three of the most recent estimates for the evolution of the real wage in England: Allen (2001), Clark (2005) and Clark (2006)[8]. These series can be regarded as the

[8] Allen (2001) and Clark (2006) calculate yearly estimates of the real wage, and we add a 25 years centered moving average to smooth out short term fluctuations. Clark (2005) presents his results in decadal averages. To ensure comparability, we calculate a 20 years moving average every ten years (for example, for 1720 we calculate the average of the decades 1710-1719 and 1720-1729).

latest update on this type of work. While the magnitude of some of the cycles that can be observed differs with respect to earlier series, the general picture has remained remarkably consistent. Allen (2001) calculates the real wages for building labourers and craftsmen, Clark (2005) also focuses on building helpers and craftsmen while Clark (2006) studies farm workers.

As can be seen, real wages experience important upturns and downturns over the six centuries preceding the industrial revolution but no definite trend can be detected. The general outline of this -and previous- series is as follows: real wages are low at the beginning of the 14th century and experience a very large increase with the advent of the Black Death in the mid 14th century. This change is naturally explained by the scarcity of labour in England after as much as 60% of the population was wiped out by the plague (Benedictow 2004). The high level is maintained for about a century and starts falling as population recovers. A new low point is found around the year 1600, roughly at a similar level as in the pre-plague years. Real wages start to increase again from that point. By the end of the 18th century they are somewhat higher but still below the maximum levels reached during the 15th -16th centuries. It is only well into the 19th century that wages finally depart from this long term trap and decidedly trend upwards.

The evolution of real wages and GDP per capita during the pre-industrial period seem to contradict each other. Quite naturally, Figure 1 speaks for the existence of a "Malthusian trap" in England up to the 19th century. Clark and Hamilton (2006) present evidence supporting the existence of Malthusian mechanisms in pre-industrial England and Clark (2005) shows that an inverse relationship between population and real wages was very apparent until the mid 17th century.

These different interpretations stemming from the real wages and the GDP per capita literatures seem hard to reconcile. Criticism has been at times severe between these camps. De Vries (1994) warned that "The real wage indexes that give such a sombre and static portrayal of modern purchasing power require caution and scepticism", while Maddison (2001) states that "The tradition in real wage measurement is quite simplistic compared with that in demography or national accounts"[9].

The approach we will follow is not to disprove one of the two estimates but to reconcile them. As we discussed before, GDP per capita figures for the pre-1700 period are not reliable enough. We will therefore concentrate on a case where both GDP per capita and real wage estimates are on solid ground: England during the 18th century. For this period the literature has reached what can be called a consensus about the growth of GDP around the estimates of Crafts and Harley (1983, 1992). These authors' estimates are based on production data for a large number of industries, and their numbers have been subject to scrutiny by other researchers[10]. Coupled with the very reliable data on English population from Wrigley et al. (1997), they lead to an increase of GDP per capita of 37%

[9] Both de Vries (1994) and Maddison (2003) have sustained their criticism of the real wages approach by pointing out several potential shortcomings in their construction: the representativeness of a particular type of wage earners for the whole labour force, the limited number of items included in the price index and the large weight given to agricultural products in it.

Without going into details, we believe that recent efforts in the real wage literature have dealt with these criticisms quite successfully. Representativeness, for instance, has been an issue since real wage studies typically used wage quotations for a particular type of workers, like construction workers, for availability reasons. Clark (2006), however, constructs a real wage series for workers employed in Agriculture -the largest sector of pre-industrial economies- and finds a very similar pattern.

The number of goods included in the price index has been considerably extended to include several types of foods and beverages, together with non-food items such as fuel, housing, clothing and other manufactures. Allen (2001) uses 12 items to construct its price index, while Gregory Clark expands the range to 36 items in Clark (2006) and up to 49 items in Clark (2005).

The weight of Agricultural goods in the price index is in line with numerous studies of workers' expenditures for the 18th and early 19th century (see Clark 2006 and Hoffman et al. 2002).

[10] See Crafts and Harley (1992) for a discussion of the criticisms on their work and how they revise their estimates in consequence.

over the 18th century. How does this compares with the evolution of real wages during the same epoch?

Figure 2 shows the evolution of the 5 series of real wages presented before during the 18th century. We also show the evolution of GDP per capita for comparison[11]. The levels of all series have been normalized to 100 in 1700.

The 5 series of real wages follow a similar pattern over the century. The first half of the century is characterized by increasing real wages; the level around 1750 being between 10% and 20% higher than initially. The second half of the century experiences an opposite movement, with real wages falling almost all the way back to the level they took at the beginning of the century. Four out of five series estimate a real wage in 1800 just about 5% higher that in 1700 while the fifth one estimates that the real wage in 1800 is considerably lower than in 1700. These numbers are very much in line with earlier work: van Zanden (1999) estimates that the real wage in England is the same in 1800 as in 1700 while Phelps Brown and Hopkins (1981) calculate an increase of 12.7% over this period.

At first sight, there is considerable divergence with respect to GDP per capita, which in 1800 is 37% higher than in 1700. But Figure 2 reveals some similarities as well as differences. During the first half of the century GDP per capita and real wages do not diverge, or at any rate not by much. Both measures are increasing and their growth rates are not very different. It is only during the second half of the century that a large gap opens between them. A closer look allows us to speculate that there are similarities during this phase as well. The

[11] While Maddison (2001) and van Zanden (2001) only calculate the overall growth rate of GDP per capita over the whole 18th century, the data from Crafts and Harley (1983, 1992) contains enough information to calculate growth rates for three subperiods: 1700-1760, 1760-1780 and 1780-1800. We show the results of these calculations in Figure 2, more details will be given in the next section.

GDP per capita series is stagnant over the period 1760-1780 and resumes growth during 1780-1800. At the same time, real wages are falling quickly during 1760-1780 and look rather stagnant during 1780-1800. This is a surprising degree of uniformity for series that, let's not forget, have been obtained from completely different data sources and variables.

Having well framed the empirical problem that we will search to explain, we turn now to a general analysis of the factors driving GDP per capita and real wages apart from each other.

3 Explaining the differences

3.1 Comparing the construction of GDP per capita and real wages

If the data and calculations behind the series of GDP per capita and real wages are both correct, and for 18th century England there are firm reasons to believe that they are, then we are left with a puzzle. An increase of GDP per capita of about a third, fast by pre-industrial standards, should not be accompanied by a similar increases in real wages? And what are we to conclude about living standards during this period; raising or stagnant?

We analyze the construction of these two measures and identify three factors that can account for the observed difference. Ours is an accounting approach, therefore the whole difference between GDP per capita and real wages would be explained by these three factors by definition. It must be borne in mind, however, that additional factors could be uncovered if the framework was modified or some hypothesis were changed.

As mentioned earlier, the calculations of GDP per capita and real wages

are based on different sets of data: the first one uses data on production and population, the second one on nominal wages and prices. But while information on these variables can be collected independently, their values are linked since total wage payments are a fraction of the total value of production. In what follows we build up on this observation and make explicit the relationships between these two measures of well-being.

Consider again an economy with n sectors, each sector producing a different type of good. We note sector's i level of production at time t as $Y_{i,t}$, the price of its product as $P_{i,t}$, the quantity of labour employed in the sector as $L_{i,t}$ and the nominal wage rate as $w_{i,t}$, with $i = 1..n$. Total wage payments across all sectors in the economy will equal some fraction α_t of the total value of production in the economy:

$$\sum_{i=1}^{n} w_{i,t} L_{i,t} = \alpha_t \sum_{i=1}^{n} P_{i,t} Y_{i,t} \tag{5}$$

The sum $\sum_{i=1}^{n} P_{i,t} Y_{i,t}$ is of course nothing else than nominal Gross Domestic Production.

The only assumption that we will make is that labour is freely mobile across sectors and as a consequence the wage rates of all sectors are equalized. i.e. $w_{i,t} = w_t \; \forall \; i$. This allows us to solve equation (5) for the wage rate:

$$w_t = \alpha_t \frac{\sum_{i=1}^{n} P_{i,t} Y_{i,t}}{L_t} \tag{6}$$

where $L_t = \sum_{i=1}^{n} L_{i,t}$ is the total labour supply in the economy.

Real wages are defined as the ratio of nominal wages and an index of the cost of living, as equation (4) stated:

$$rw_t = \frac{w_t}{P_t}$$

the price index that is used is irrelevant here, we will only require it to be a homogeneous function of degree one in all individual prices: $P_t(\lambda P_{1t}, ..., \lambda P_{nt}) = \lambda P_t(P_{1t}, ..., P_{nt})$.

Substituting (6) in (4) we have:

$$rw_t = \alpha_t \frac{\sum_{i=1}^{n} P_{i,t} Y_{i,t}}{L_t} \frac{1}{P_t}$$

This formula can now be used to calculate the growth rate of the real wage between periods 0 and 1 :

$$\frac{rw_1}{rw_0} = \frac{\alpha_1}{\alpha_0} \left[\frac{\sum_{i=1}^{n} P_{i,1} Y_{i,1}}{\sum_{j=1}^{n} P_{j,0} Y_{j,0}} \right] \left(\frac{P_1}{P_0} \right)^{-1} \left(\frac{L_1}{L_0} \right)^{-1} \tag{7}$$

We will rewrite this last expression by dividing and multiplying each term of the sum in the numerator by $P_{i,0} Y_{i,0}$:

$$\frac{rw_1}{rw_0} = \frac{\alpha_1}{\alpha_0} \left[\frac{\sum_{i=1}^{n} P_{i,0} Y_{i,0} \frac{P_{i,1} Y_{i,1}}{P_{i,0} Y_{i,0}}}{\sum_{j=1}^{n} P_{j,0} Y_{j,0}} \right] \left(\frac{P_1}{P_0} \right)^{-1} \left(\frac{L_1}{L_0} \right)^{-1}$$

which, using the definition for $\phi_{i,0}$ given in (2) is equal to:

$$\frac{rw_1}{rw_0} = \frac{\alpha_1}{\alpha_0} \left[\sum_{i=1}^{n} \phi_{i,0} \frac{P_{i,1}}{P_{i,0}} \frac{Y_{i,1}}{Y_{i,0}} \right] \left(\frac{P_1}{P_0} \right)^{-1} \left(\frac{L_1}{L_0} \right)^{-1}$$

Finally, let us define $p_{i,t} = \frac{P_{i,t}}{P_t}$ as the relative price of good i with respect to the representative basket of goods. Our final expression for the growth rate of real wages can then be written as:

$$\frac{rw_1}{rw_0} = \frac{\alpha_1}{\alpha_0} \left[\sum_{i=1}^{n} \phi_{i,0} \frac{p_{i,1}}{p_{i,0}} \frac{Y_{i,1}}{Y_{i,0}} \right] \left(\frac{L_1}{L_0} \right)^{-1} \tag{8}$$

This last expression is to be compared with the growth rate of GDP per

capita as given by equation (3), which we reproduce below:

$$\frac{y_1}{y_0} = \left[\sum_i \phi_{i,0} \frac{Y_{i,1}}{Y_{i,0}}\right] \left(\frac{N_1}{N_0}\right)^{-1}$$

Equations (3) and (8) are very similar as they both include a weighted average of the growth rates in each sector of the economy. Here, however, we are mostly interested in what differentiates them. Given (3), the growth rate of real wages as expressed in equation (8) can be written as:

$$\frac{rw_1}{rw_0} = \frac{y_1}{y_0} \left(\frac{\alpha_1}{\alpha_0}\right) \left(\frac{L_1/N_1}{L_0/N_0}\right)^{-1} \frac{\sum_{i=1}^{n} \phi_{i,0} \frac{p_{i,1}}{p_{i,0}} \frac{Y_{i,1}}{Y_{i,0}}}{\sum_i \phi_{i,0} \frac{Y_{i,1}}{Y_{i,0}}} \tag{9}$$

This last expression has the merit of highlighting the three possible causes of divergence between real wages and GDP per capita, given by the three fractions multiplying $\frac{y_1}{y_0}$ on the right hand side. The growth rates of these two measures can thus differ for any of the following causes:

(i) Changes in the share of total income allocated to labour, i.e. $\alpha_1 \neq \alpha_0$. Ceteris paribus, an increase in this share ($\alpha_1 > \alpha_0$) implies a growth rate of real wages larger than the growth rate of GDP per capita.

(ii) Changes in the supply of labour per capita, i.e. $\frac{L_1}{N_1} \neq \frac{L_0}{N_0}$. Ceteris paribus, an increase in labour supply per capita $\left(\frac{L_1}{N_1} > \frac{L_0}{N_0}\right)$ implies a growth rate of real wages smaller than the growth rate of GDP per capita.

(iii) Changes in relative prices, i.e. $\exists i : p_{i,1} \neq p_{i,0}$. The direction of this effect is ambiguous, as we must have relative price appreciations in some sectors and relative price depreciations in others. If the sectors experiencing relative price appreciations tend to be large or are growing fast (i.e. large values of $\phi_{i,0}$ or $\frac{Y_{i,1}}{Y_{i,0}}$) then real wages will grow faster than GDP per capita. The opposite is

true if relative price appreciations take place mostly in small sectors or sectors growing slowly.

The first factor stresses changes in the distribution of income between labour and all other factors of production. It should come as no surprise that increases in the share of total income allocated to labour would tend to raise real wages and viceversa.

The second factor highlighted is a change in the supply of labour per capita. For a given share of labour in national income, an increase in the amount of labour supplied would reduce the remuneration of each unit of labour; i.e. the real wage. Notice that what is needed for the real wage and GDP per capita to diverge is not just an increase in labour supply but in labour supply per capita. If labour supply increased merely because of population growth (with a fixed labour supply per capita) then both the real wage and GDP per capita would fall by the same proportion (taking aggregate production as given). It is only when the increase in labour supply is greater than the increase in population that the two measures diverge.

This effect is closely related to Jan de Vries' (1993,1994) concept of an "industrious revolution". According to this thesis, during the 17th and 18th century England experienced an increase in the per-capita labour supply of peasants and workers. De Vries cites in favor of this view an increase in the labour effort of women and children, a reduction in leisure time and a shift in effort from domestic non-marketable goods to marketable goods and proto-industrial production. The reason behind this would be a change of workers' preferences away from leisure and towards the consumption of marketable goods. We will have the occasion to come back to this issue later.

Notice that if this second explanation is important then the real wage and

the workers' (real) labour income are not following parallel trajectories. Indeed, workers' labour income would be growing faster than the real wage if the amount of hours they supply trends upwards. In this paper we are focusing on the evolution of real wages, but a good question would be if real labour income would not be a more appropriate measure of economic well-being. We will not deviate much into this matter, but let us note that while labour income measures the amount of goods and services that a worker would be able to buy, it does not take into account the disutility incurred in acquiring it. The real wage has the advantage that it gives us the possibilities available to the worker by trading his endowment of time against income. What the worker then does, how many hours he works, is left for him to decide.

The third factor is changes in relative prices. If we imagine that workers are "entitled" to some fraction of the value of production then changes in nominal prices will translate into proportional changes in nominal wages. If all prices were to increase by the same proportion λ (i.e. no relative price change) then nominal wages would also increase by λ and the price index (provided that it satisfies the fundamental property of proportionality in current prices) will increase by λ as well. The real wage will thus be unaffected. But consider what happens in the more realistic case where the prices of different goods increase in different proportions. In that case general equilibrium mechanisms will shift labour from sector to sector to equalize nominal wages, and the final increase in nominal wages would be somewhere in the middle of the range of price increases. Will the real wage then be higher or lower? The answer depends on what particular goods are more important in the price index. If the goods whose price has seen the largest increases are the most important ones in the price index chances are that the increase in nominal wages will not match the increase of the index; real wages will fall. The opposite can also take place and

lead to a rise in real wages.

It must be born in mind that our three factors are not assumed to be neither exogenous nor independent from each other. As in any accounting framework, they are compatible with many different underlying models of the economy. Under a certain model these factors might be jointly determined, while a different model could consider each factor to be exogenous and independent. Discussing the most appropriate model for pre-industrial economies is beyond the scope of this paper, but we should keep this issue on the back of our minds.

In what follows we put our framework to work and test its capacity to explain the intriguing divergence between GDP per capita and real wages in 18th century England.

3.2 Application to 18th century England: the data

To explain the difference between GDP per capita and real wages in 18th century England we start from the estimates of GDP per capita growth as calculated by Maddison (2001) and, by taking into account the effects of income distribution, labour supply per capita and relative prices, hope to arrive at estimates of real wage growth in line with those of the real wage literature. If this is achieved then our framework would prove to be able to account for the difference between the two measures in an actual historical case.

England is almost certainly the pre-industrial economy for which we have the richest set of information. Even for England, however, the data requirements for a complete account of the three effects presented above are difficult to comply with. We do have good estimates on production growth per sector and on the evolution of the English population, so GDP per capita can be calculated. To evaluate the first two of our three factors we will present estimates for changes

in the share of labour in total income and for the amount of labour supply per capita. It is the evaluation of our third factor that poses most trouble since it would require data on prices for all sectors of the economy and the information we have concerns only two of them: Agriculture and Industry.

Two approaches are thus proposed. The first one takes all sectors of the economy into account to calculate GDP growth and then considers the effects of changes in income distribution and labour supply only. The effect of relative price changes is left unexplored. The second approach is to take into account all three effects mentioned before but to limit the construction of our measure of GDP to the sectors of Agriculture and Industry.

The data we use is described in Table 2. Crafts (1983) and Crafts and Harley (1992) are our sources for the growth rates of the different sectors in the economy and their share in GDP. As we mentioned earlier, these authors provide estimates for three different subperiods of the 18th century: 1700-1760, 1760-1780 and 1780-1800. We will exploit this characteristic of the data and calculate the growth rate of GDP per capita for the whole of the 18th century and for each of the three subperiods. This will allow for richer comparisons with the detailed time series of real wages, as shown in Figure 2. We will therefore try our best to match the data from other sources with the three-period segmentation of Crafts.

The least problematic piece of information is the one concerning the population of England. The remarkable work of Wrigley et al. (1997) provides with estimates of English population every five years for the period 1541-1871. We have then no problem in choosing four points in time that correspond to the limits of Crafts and Harley's three subperiods (part b of Table 2).

The next piece of information we use pertains to the distribution of income.

A very good source in this area is the work of Lindert and Williamson (1982, 1983). These authors use the information of the "social tables" constructed by Gregory King for the year 1688, Joseph Massie for 1759 and Patrick Colquhoun for 1801-1803. By adjusting some of the original estimates, most notably in what concerns the number of poor households, they are able to provide a surprisingly detailed description of the distribution of income in England at these points in time. Lindert and Williamson (1983) do not provide us with estimates of the distribution of income between labour and non-labour, so we must resort to some additional assumption. We will consider that the income to the top 10% of the population is a good measure for non-labour income. This assumption calls for some further development.

We do know that the richer part of the English population during this period received most of their income as revenues from land or capital, not from their labour, so taking the upper part of the income distribution seems a sensible thing to do. The question would be where to draw the line, what percentage of the population received the income of land and capital. The data in Lindert and Williamson (1983) gives us just two choices: the top 5% or the top 10% of the population. Of these two we believe than 10% is the most appropriate threshold since the share of income accruing to this part of the population is slightly above 40%, which is in line with estimates of the part of non-labour factors of production in total income over the last two centuries in several European economies (see Prados de la Escosura and Roses 2003).

Part (c) in Table 2 gives the share of income of the top 10% of the population in the years 1688, 1759 and 1801. In our calculation we will assign these values to the years 1700, 1760 and 1800 respectively. To provide an estimate for the year 1780 we assume that the share of labour is falling at a constant rate between 1760 and 1800. Income inequality increases considerably during the last part of

the 18th century whereas the previous decades show less variation.

Let us consider now the evolution of the supply of labour per capita. The best data we have on this area is the work of Voth (2000, 2001) on the pattern of time use in England over the period 1760-1830. Voth estimates that the number of hours worked per year increased steeply between 1760 and 1800 before stabilizing at a high level during 1800-1830. His approach is a very original one: he uses witnesses' accounts from court proceedings in London and the North of England in a similar way as contemporaneous time-budget studies use interviews enquiring about the respondent's activity at some random time in the past. He estimates that working hours passed from 2,576 per year in 1760 to 3,328 in 1800 and that most of this change was due to an increase in the number of days worked; the hours worked per day being relatively unchanged. Voth (2001) also estimates the total change in labour supply taking into account not only the increase in the number of hours worked per person but also changes in labour-force participation and in unemployment. While these additional effects are an order of magnitude smaller than the effect of increased hours per year we take them into account to increase the accuracy of our calculations. In part (d) of Table 2 we report both the number of hours worked per year and the change in total labour supply including changes in labour-force participation and unemployment[12].

In our calculations we will assume that the labour supply per capita grew at a constant rate over the period 1760-1800, which provides us with an estimate for the year 1780. We still need a figure for the year 1700. A good case can be made against important increases in the number of working hours per year

[12] The increase of working hours per year from 2576 to 3328 represents a rise of 29.19%. Coupled with a growth in population of 37.41% over the perid 1760-1800 this gives an increase in total labour supply of 77.53%. The two additional effects we mention reduce this number to 72.3%.

prior to 1760 given the relatively low level of 2,576 working hours estimated by Voth for this year. Here we cite two pieces of evidence pointing in this direction. First, Scholliers (1983) estimates the number of hours worked per year in Belgium during the 16th century at 2,800. It would be difficult to accept that Englishmen were working much less than their Belgian counterparts. Second, Voth (2000) cites anthropological evidence on time use in "advanced sedentary agriculture" societies and the average number of working hours stands at 10.9 per day. Assuming a 5-day week for preindustrial societies (with Sunday and Monday free) we would arrive at 260 working days per year and therefore 2,834 hours. The number of working days is not necessarily overestimated by the absence of religious holidays in our back-of-the-envelope calculation since the tradition of "St. Monday" was less than universal.

It seems to us then that 2,576 hours per year is in any case not high for pre-industrial societies and we will assume a constant labour supply per capita over the period 1700-1760.

The last part of Table 2 presents the data on prices of agricultural and industrial goods that we will use to evaluate the third factor of our framework. Our preferred source is Clark (2005), who provides the prices for 7 categories of agricultural products and 5 categories of industrial products by decadal averages[13].

3.3 Application to 18th century England: results

The data presented in Table 2 is put to use in Tables 3 and 4. Table 3 summarizes the results from our first approach. We start by calculating the growth over each subperiod for the five sectors of the economy identified by Crafts and Harley

[13] We use 20 years centered moving averages. Thus, for example, for the year 1740 we compute the average of the decades 1730-1739 and 1740-1749.

(1992). We then aggregate these five sectors using the weights from Table 2 and obtain the figures for GDP given in line 6. English GDP increased by 129% over the whole 18th century.

The next line shows the evolution of England's population, which was 66% larger in 1800 than in 1700. The sixth and seventh lines allow us to calculate the eighth one, the growth of GDP per capita. As can be noted, we reproduce the result of Maddison with an increase of GDP per capita of 37% over the 18th century. As we mentioned earlier, the trajectory was not an even one. GDP per capita increased by 27.7% over the first 60 years of the century, stagnated over the following 20 years and finally increased by a further 8% in the last 2 decades.

The next two lines contain the information on the evolution of income distribution and labour supply. Line 9 gives the change in parameter α, the share of labour in national income. The data from Table 1 implies that this share is falling over the 18th century. Line 10 gives us the change in the labour supply per capita, found by dividing the values for the total labour supply from Voth (2001) by the population data from Wrigley et al. (1997). We recall that labour supply per capita does not change in the period 1700-1760 by assumption. The increase over the last 40 years of the century is, however, quite dramatic. According to Voth, the average person was putting 25% more working hours per year at the end of this relatively short period.

Lines 8 to 10 allow us to apply equation (8) in order to obtain the growth of real wages (relative prices are assumed to be constant at this point).

The resulting evolution of real wages can be followed on line 11. Our calculations show an increase of 26.8% over the first subperiod, followed by a rapid fall of 13.7% during 1760-1780 and a more measured decrease of 6.7% during the

last twenty years of the century. Overall, the figure we obtain for the increase in real wages over the 18th century is just 2.1%. The result is noteworthy, as this last figure is very similar to the actual estimates for the evolution of real wages obtained by a completely independent literature. Moreover, the pattern we obtain along the 18th century follows quite closely the one described in Figure 2; with real wages rising in line with GDP per capita over the first half of the century and falling almost all the way back to their 1700 level over the second half.

To appreciate the relative importance of changes in income distribution and changes in labour supply we have also calculated the growth of real wages if only one of these two factors were present. With changes in income distribution only, real wages would grow by 28% over the century; or 9% less than GDP per capita. With changes in labour supply per capita only, real wages would grow by almost 10% over the century; a growth rate that is 27% below GDP per capita. We conclude that changes in labour supply per capita are the most important factor, accounting for three quarters of the difference between the two measures.

So far, by taking into account two of our three factors we have been able to explain a difference in the growth rates of our two measures of 35%, roughly in line with the empirical estimates. This would lead us to think that our third factor, changes in relative prices, had a net effect that was close to zero. We turn to this question now, but treat it only partially by limiting the analysis to the sectors of Agriculture and Industry.

The first two lines of Table 4 reproduce the growth rates of Agriculture and Industry over each subperiod, they are the same as the first two lines of Table 3. We then aggregate these two sectors by using as weights the share of each

sector in the sum of the two sectors. The resulting growth rates, which are given in line 3, would correspond to the growth rate of the economy if the omitted sectors were growing on average as fast as the sum of Agriculture and Industry. In Crafts and Harley's dataset this is not the case, though the difference is not very large (GDP growth over the century is 113 % in Table 4, against 129 % in Table 3)[14].

With the above caveat in mind, we proceed by taking into account population growth and calculating GDP per capita. This evolves in a similar way to that depicted in Table 3, the growth rate during the first subperiod being smaller now. Total growth over the 18th century is 28 % (Table 4, line 5).

Lines six and seven reproduce the values we used before for the changes in the share of labour (α) and labour supply per capita (L/N). The novelty comes in lines eight and nine, which show the evolution of the relative prices of agricultural and industrial goods. The procedure for constructing these relative prices from the data in Clark (2005) is as follows. First, we construct an index for Agricultural prices and another one for Industrial prices as a geometric average of individual prices using the weights in Clark (2005). The overall price index is a geometric average of these two indices, where the share of agricultural goods equals 0.694, also in line with Clark (2005). Finally, we divide the sectorial price indices by the overall price index to obtain relative prices. It is the change in these relative prices that we report in Table 4. These calculations show that agricultural goods become slightly cheaper with respect to industrial goods over

[14] Most of the difference comes from the first subperiod, 1700-1760, and in particular from the very fast growth rate assigned to the Government sector during these years. As Crafts and Harley (1992, p. 715) readily admit, "estimates of growth for sectors other than industry are distinctly less reliable.", so the whole difference could be due to a measurement error. This suspicion is made more probable by the fact that the growth rate of the Government sector is not compatible with the constant share in GDP that Crafts and Harley assign to it. As Table 3 shows, during the period 1700-1760 the government would have grown by 211 % while the whole economy grows by just 54 %. This would imply that the share of Government in GDP doubles, but Crafts and Harley keep this share constant at 7 %.

the first half of the century, but the tendency is strongly reverted over the second half. Overall, by the end of the 18th century agricultural goods had become dearer than industrial goods in relative terms. We cannot fail to notice that the relative depreciation of industrial goods comes at the same time of the classical dating of the Industrial Revolution. Such a fall in relative prices would be exactly what we would expect in a situation of increasing supply due to an improved productive capacity. These changes in relative prices are detrimental to the worker's real wages, as their expenditures on agricultural products are much larger than those on industrial ones.

We apply equation (8) to obtain changes in real wages and report the results in line 10 of Table 4. The growth rates that we obtain here are lower than those from Table 3 mainly because the starting point for our calculations is a slower growth rate of GDP per capita. The pattern of real wage growth is the same as before, with gains during the first period and large losses during the last two ones. The negative growth rate of real wages for the whole century is not of much concern: it is caused by the exclusion of 3 sectors of the economy (Commerce, Rent and Services, Government) with an average growth rate above the one for Agriculture and Industry. The question that this exercise is designed to answer is: how large was the role of changes in relative prices as compared with the other two factors? The answer seems to be: not very large. By evaluating each factor on its own we find that the growth rate of GDP per capita is reduced by 3% over the century when only relative prices are taken into account, while performing the same exercise using changes in income distribution or in labour supply lead to reductions of 9% and 27% respectively. Thus, we speculate that changes in relative prices played only a minor role in driving the divergence between GDP per capita and real wages during this particular episode.

Overall, the conclusions we can draw from our empirical application are the

following:

i) The observed differences between the growth rates of GDP per capita and real wages during the 18th century in England can be rationalized by taking into account the effects of changes in the distribution of income between labour and other factors of production and changes in the supply of labour per capita.

ii) Of these two factors, changes in labour supply per capita are responsible for about three quarters of the difference.

iii) Lack of data renders the evaluation of the importance of relative price changes difficult, but judging from an exercise where only Agriculture and Industry are taken into account the effect appears to be small.

Thus, the existence of an "industrious revolution" during the second half of the 18th century would be the main cause of the divergence between GDP per capita and real wages. The two phenomena coincide in timing and the magnitude of the change in working hours corresponds well to the observed difference in growth rates, as our calculations have shown. The greater availability of labour that this change brought would have made each labour unit cheaper, an aggregate effect that could not be predicted by individual workers. This interpretation is plausible and has empirical sustain, but one should also acknowledge that the whole concept of an industrious revolution is not without critics (Clark and van der Werf 1998).

A certain number of robustness checks have been performed on the above results. These include: changing the weight of Agricultural goods in the price index[15], using the price data from Clark (2006) instead of Clark (2005) and

[15] The weight used in Table 4 is at the lowest end of the estimates given by Hoffman et al. (2002, Table 1) for the expenditure share of "All Food and Drink" among workers and the poor before 1840. We experiment with the highest end of these estimates, 0.80, and found very small differences in the outcomes.

excluding housing prices from our calculations. Only minor quantitative changes were observed in all these cases and we do not report the results. We also experimented with an alternative hypothesis concerning the labour supply per capita over the period 1700-1760. Instead of assuming it constant over this period we hypothesized a growth rate of 0.2835% per year, half the yearly growth rate of the period 1760-1800. This would imply that the number of hours worked per year was just 2,173 in 1700, a figure that seems too low for us. Using this alternative hypothesis results in a much slower growth of real wages during 1700-1760 (7% instead of 26.8% under our preferred hypothesis) and therefore a net change over the whole century of -3.9%. While this last result is not too far away from actual estimates, we find our preferred hypothesis of no change in hours worked prior to 1760 to be more persuasive.

3.4 Further tests with 19th century data

We have shown that the three factors identified in section 3.1 reinforce each other in order to explain the divergence between GDP per capita and real wages in 18th century England. If our approach is correct then we would also expect the three factors to roughly cancel each other in periods where GDP per capita and real wages evolve similarly. It is to such a mode of assessment that we turn our attention next, by using England during the 19th century as a case in point.

The comparative performance of GDP per capita and real wages during the 19th century in England has raised less eyebrows than the 18th century case. During the 19th century these two measures experienced marked accelerations with respect to historical standards, and their estimated growth rates are roughly in line with each other. Table 5 presents estimates for the evolution of real wages and GDP per capita during the 19th century. The real wage estimates are the ones we have used before augmented with the ones from Feinstein

(1998)[16]. The source for GDP per capita is Maddison (2003), where we have used his estimates for the UK since separate information for England was not given for the 19th century. We have divided the 19th century in 3 subperiods: 1800-1830, 1830-1880 and 1880-1900, reflecting the availability of our different real wage series. We concentrate on the first two subperiods, where the number of real wage series available is respectively six and five while the last subperiod has only two real wage series.

As can be seen, there is a lower degree of uniformity among the real wage estimates during the 19th century than during the 18th century. For the period 1800-1830 the total growth rate of real wages ranges from 10.6% to 34.7%. The estimate of GDP per capita growth from Maddison is at the lower end of this range: 10.7%. During the second period, 1830-1880, the tendency is inverted. Real wage growth is estimated in the range from 45% to 93.5% while GDP per capita growth stands at 98.8%. Accordingly, when we consider the period 1800-1880 we find that the growth rate of GDP per capita (120.2%) is well within the range of estimates for real wage growth (70.8% to 154.5%). For the last period of the 19th century, 1880-1900, the two real wage estimates from Clark (2005) grow by almost the same amount as the GDP per capita estimate: between 29% and 30%.

We conclude that there is no divergence between GDP per capita and real wages during the 19th century in England and that, if anything, the major differences are between estimates of the real wage. Turning back to our framework, we would expect that the different forces we identified in the preceding section roughly cancel each other. We will assess this prediction by estimating the effects of changes in income distribution and in labour supply per capita.

[16] Feinstein's (1998) estimates are five years centered averages, while we are presenting the estimates of Allen (2001) and Clark (2006) as 25 years centered averages and those of Clark (2005) as 20 years centered averages.

We will leave the third explanatory factor, changes in relative prices, outside of the equation. While we cannot be sure that their role will be as small as during the 18th century their inclusion would require price information that we do not have.

Table 6 presents our estimates for the two effects mentioned above. For changes in income distribution we take the same approach as before and assume that the share of income to the top 10% of the population is a good index for the share of non-labour income. Lindert and Williamson (1983) provide figures for two time points in the 19th century, 1867 and 1880[17]. As these two authors describe, the 19th century witnessed important increases in income inequality. We calculate the divergence between GDP per capita and real wages that these changes would create. As Table 6 shows, the effect of changes in income distribution would be to *lower* the growth rate of real wages with respect to GDP per capita by 10.4% if we use the 1867 figure and by 12.1% is we use the 1880 figure.

What about the evolution of labour supply per capita during the 19th century? As Voth (2000) documents, the period 1800-1830 probably represents the peak in terms of working hours during all of English history. Somewhere during the 19th century the English working year started to shorten in a secular change that came to an end only in the last quarter of the 20th century. Voth (2000, p.268) gives us the figure of 2,807 worked hours per year for 1890, which represents a large fall with respect to his estimate for 1800. In Table 6 we calculate the effect that this decrease in labour supply per capita would have on the difference between real wages and GDP per capita (unemployment

[17] The figure for 1867 is from the calculations "with paupers" and is therefore comparable with the one for 1801. The figure for 1880, on the other hand, is only available in the calculations "without paupers" and for the UK instead of England and Wales. This figure can thus be considered as slightly underestimated.

and labour force participation are assumed to be constant). By itself, this effect would imply a growth rate of real wages 18.6% *higher* than the one of GDP per capita.

If we put these two effects together, using the figure for 1880 from Lindert and Williamson (1983), we arrive at a difference of just 4.2% in favor of real wages. The two effects are of similar magnitude and opposite direction, and they almost cancel each other. While these calculations are not to be taken as the last word on the subject, they do reassure us on the validity of our approach. The prediction that the different effects should be close to cancelling each other is borne out by the facts; real wages during the 19th century were slowed down by the raising income inequality but this was countered by the relative scarcity of labour that a shorter working year brought up.

4 Continental Europe and future research agenda

The evolution of living standards and economic well-being over the pre-industrial period is a huge research area where our questions easily outnumber our answers. This paper addresses one of such questions: why are estimates of GDP per capita and real wages over the pre-industrial period seemingly contradicting each other? We hope to have contributed to the literature on two different levels. On a theoretical level, we have offered an accounting framework that duly decomposes the difference between GDP per capita and real wages into three components: changes in income distribution, labour supply per capita and relative prices. We believe that this framework can help to put more order in our way to approach this question and make us appreciate that GDP per capita and real wages will perform differently if the economy experiences these types of changes. The attention of the researcher can then be focused on looking for

evidence of these changes.

On an empirical level, we have used our framework to account for the divergence between GDP per capita and real wages in 18th century England. The result was successful, the measured changes in income distribution and, specially, labour supply per capita are of the right order of magnitude to account for the observed divergence. Thus, different evolutions of GDP per capita and real wages over the pre-industrial period do not have to be contradictory; they might be the logical consequence of changes in the economy.

Our appraisal of the evolution of economic well-being during the 18th century in England should reflect the findings of this paper. While "stagnant" would certainly be inappropriate for an economy whose GDP per capita grows by a third, our assessment must be tempered by the modest performance of real wages. The growth in production was more beneficial to the owners of land and capital than to the suppliers of labour. While these last ones did see their overall income increase, this was achieved essentially through longer work.

The experience of England during the 19th century also corroborates our methodology. During this century income distribution changes would have depressed real wages with respect to GDP per capita. At the same time, changes in labour supply per capita would have caused the opposite effect. The net result, as it turns out from our calculations, would be a very similar growth rate for both measures; which is well what estimates in the literature tell us.

The next step on the empirical side would be to try to reconcile the evolution of GDP per capita and real wages in the rest of Europe. This is a tall challenge, as the figures in Table 7 reveal. Here we compare GDP per capita growth estimates from van Zanden (2001) with real wage growth estimates from Allen (2001) for six European countries for the period 1500-1820 (real wage estimates

refer to a major city within each country). The general picture is clear: real wages grew much slower (or decreased much faster) than GDP per capita in all countries. This pan-European real wage underperformance during the early modern period is puzzling and an explanation for it should be high on the researchers' agenda.

Would it be possible that a common force was sweeping all over Europe during this period and causing the systematic pattern we see in Table 7? An interesting possibility would be the existence of an "industrious revolution" taking place not just in England but in several parts of the continent, though in different degrees. This factor was the dominant one in our analysis of 18th century England, and we might speculate that the English experience had some points in common with other European countries. If the working year was progressively lengthening all over Europe between 1500 and 1820, we would expect the phenomenon to be most pronounced in North-Western Europe and this for at least two reasons. First, the lengthening of the working year was achieved mostly by increasing the number of days worked through the progressive elimination of religious holidays and "St. Monday". This was more likely to take place in protestant countries, as exposed by Max Weber's famous thesis on the protestant ethic (Weber 1930). Second, the period between the Renaissance and the Industrial Revolution saw a shift in the balance of economic power towards North-Western Europe and markets became a more pervasive feature of the economic landscape there. Our reading of Jan de Vries' work is that one of the main driving forces behind the "industrious revolution" in England was the increased presence of the market as a buyer of labour and a seller of consumption goods. The argument would then be that the more developed markets of North-Western Europe would have operated a larger effect on workers there; "pushing" them to supply more labour and consume more goods.

If, as we suggest, the increase in labour supply per capita was more marked in North-Western Europe our framework would predict *ceteris paribus* a larger wedge between the growth rates of GDP per capita and real wages in those countries. It is certainly too soon to make hard claims in this area, but one cannot help to remark that this is precisely the case in the data presented in Table 7. The difference between growth rates is largest in north-western European countries (108% in the UK, 74% in the Netherlands and 52% in Belgium) and falls as we move towards the European "periphery" (38% in Italy, 39% in Spain, 15% in Poland). It is as if the "work ethic" of protestant countries was cruelly rewarded with a larger deficit of real wages with respect to GDP per capita.

The above discussion is to be regarded as highly speculative, we have left prudence aside for a moment and squeezed out of the data as many patterns as possible. There is considerable uncertainty surrounding the estimates of GDP per capita for this period, and the first task of future research should be to extend the work in this area. We need to consolidate the estimates for the countries that are present in Table 7 and construct estimates for those that aren't. France and Germany, in particular, are two important missing countries whose GDP per capita estimates could be readily compared with real wage estimates for French and German cities calculated by Allen (2001). Concerning real wages, estimates for countries other than England are relatively rare and one would like to see Allen's calculations confirmed by other researchers. Once we feel more secure of the patterns of these two measures over the pre-industrial period we can look for explanations of their eventual divergence. Changes in income distribution and changes in labour supply per capita offer the most research bang for the buck since their effects can be applied without the need of detailed sectorial information. If the pattern we identified in Table 7 is confirmed by

future research then an explanation based on increased working efforts throughout Europe -but specially in North-Western Europe- could gain acceptance and improve our understanding of this challenging episode of economic history.

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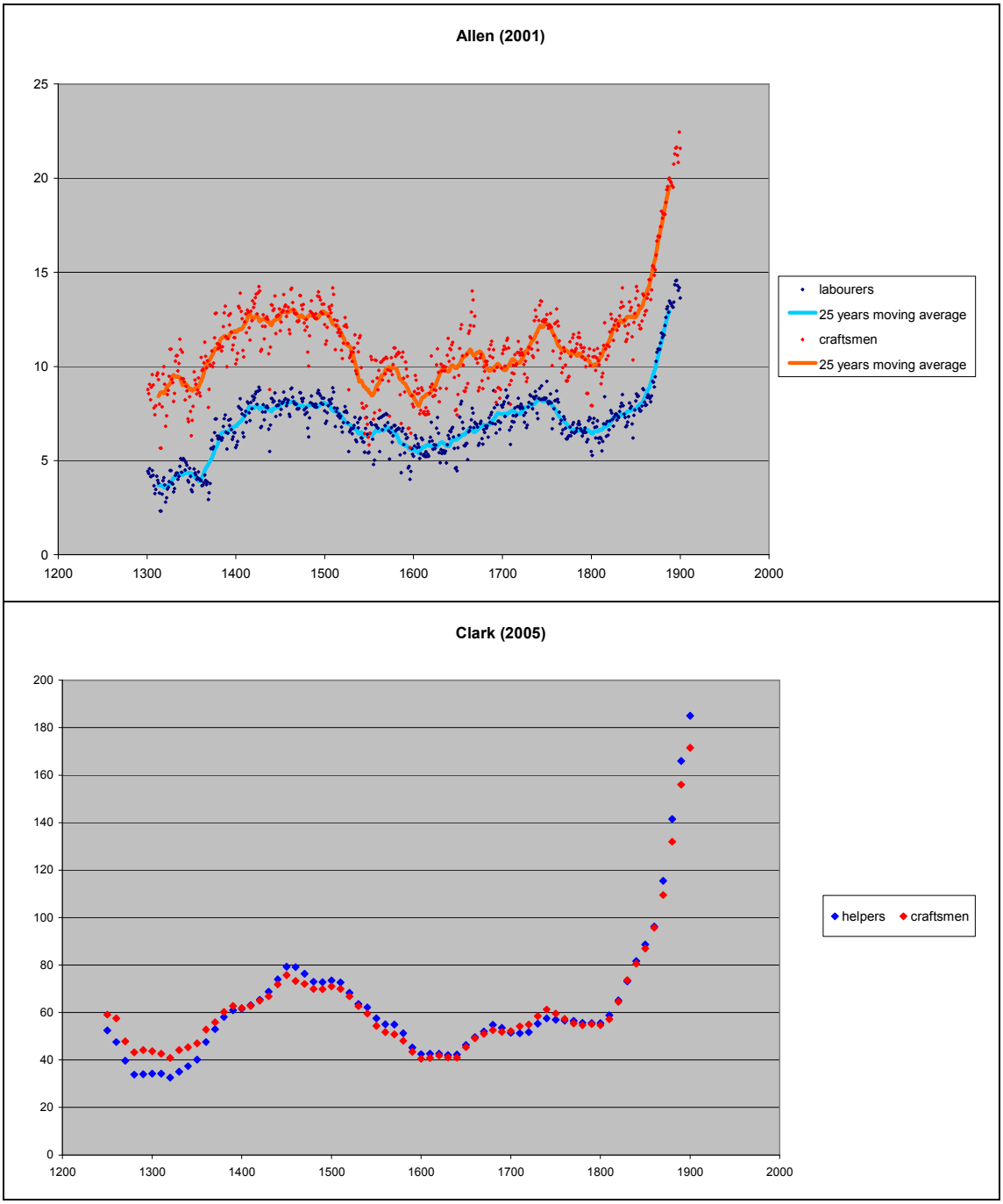
Table 1
The evolution of GDP per capita in pre-industrial England

	Maddison (2001)		van Zanden (2001)	
Year	Level (1800 = 100)	Growth over the century	Level (1800 = 100)	Growth over the century
1500	39.5		52*	
1600	53.8	36.2%	48	-7.7%
1700	72.9	35.4%	76	58.3%
1800	100	37.1%	100	31.6%
Total growth 1500-1800	153%		92%	

*Figure is the average of the two values given for 1520.

Figure 1
The evolution of Real Wages in pre-industrial England



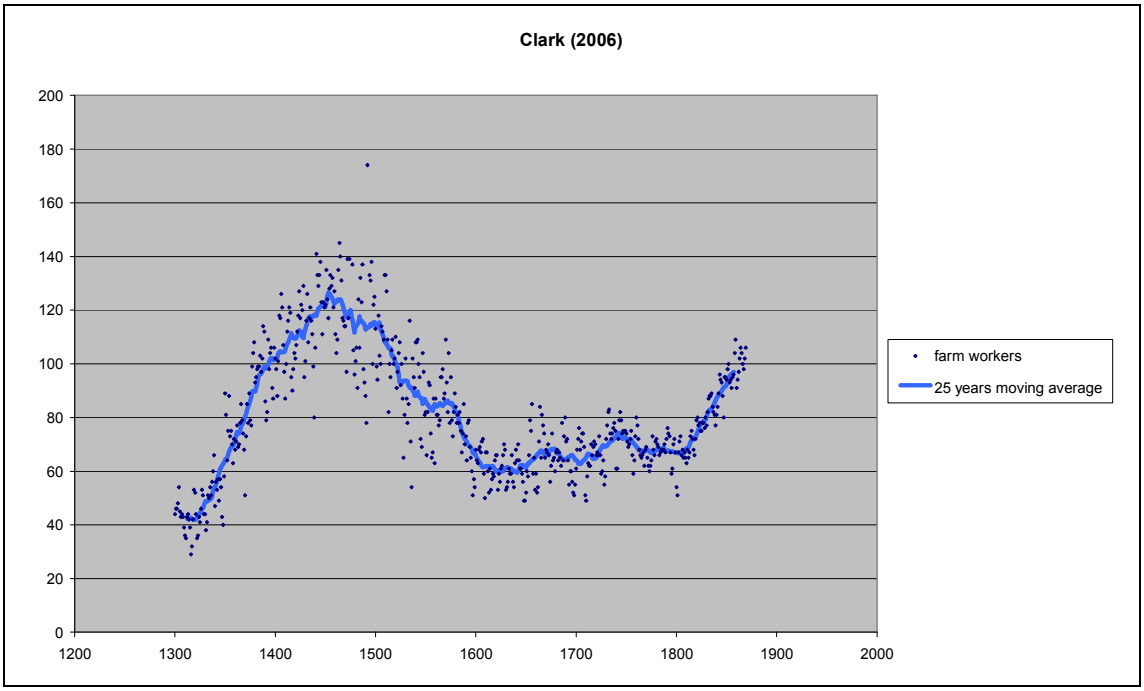

Clark (2006)
200
180
160
140
120
100
80
60
40
20
0
1200
1300
1400
1500
1600
1700
1800
1900
2000
farm workers
25 years moving average

Figure 2
Real wages in England during the 18th century

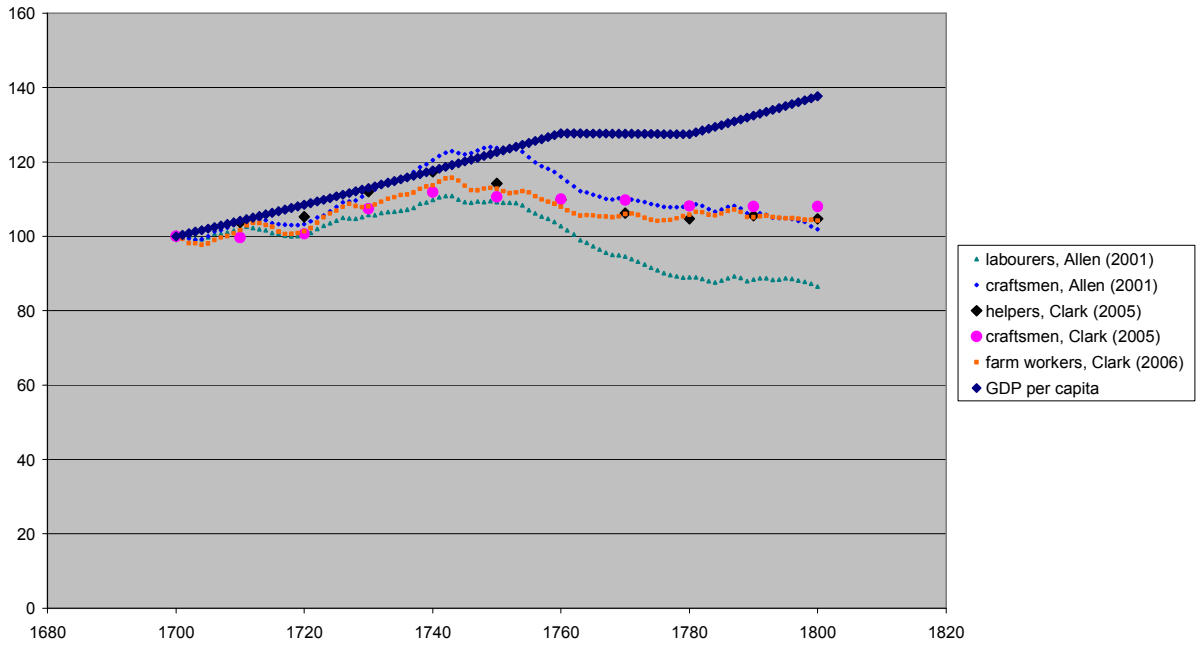


Table 2
Data Sources

(a) Crafts (1983) and Crafts and Harley (1992)

Annual growth rate of output per sector, in percentage

	1700-1760	1760-1780	1780-1800
Agriculture	0.6	0.13	0.75
Industry	0.71	1.29	1.96
Commerce	0.69	0.64	1.38
Rent and Services	0.38	0.69	0.97
Government	1.91	1.29	2.11

Share of sector in GDP

	1700-1760	1760-1780	1780-1800
Agriculture	0.37	0.37	0.32
Industry	0.20	0.20	0.25
Commerce	0.16	0.16	0.16
Rent and Services	0.20	0.20	0.20
Government	0.07	0.07	0.07

(b) Wrigley et al (1997)

Population of England, in thousands

	1701	1761	1781	1801
Population	5,210	6,310	7,206	8,671

(c) Lindert and Williamson (1983)

Share of income to the top 10% of the population (calculations with paupers)

	1688	1759	1801
Share of top 10%	44.0	44.4	47.9

(d) Voth (2001)

	1760	1800
Working hours per year	2,576	3,328
Total labour supply	100	172.3

(e) Clark (2005) and Clark (2006)

Prices for 7 categories of agricultural goods and 5 categories of industrial goods, available for each decade of the 18th century.

Table 3
Explaining the divergence between GDP per capita and Real Wages: changes in income distribution and labour supply per capita

line	variable	Percentage change over the period			
		1700-1760	1760-1780	1780-1800	1700-1800
1	*Agriculture*	43.2 %	2.6 %	16.1 %	70.6 %
2	*Industry*	52.9 %	29.2 %	47.4 %	191.3 %
3	*Commerce*	51.1 %	13.6 %	31.5 %	125.7 %
4	*Rent and Services*	25.5 %	14.7 %	21.3 %	74.7 %
5	*Government*	211.2 %	29.2 %	51.8 %	510.5 %
6	*GDP*	54.6 %	14.0 %	29.9 %	129.0 %
7	*Population*	21.1 %	14.2 %	20.3 %	66.4 %
8	*GDP per capita*	27.7 %	- 0.2 %	8.0 %	37.6 %
9	*Share of labour* (α)	- 0.7 %	- 3.2 %	- 3.2 %	- 7.0 %
10	*Labour supply per capita (L/N)*	0 %	12.0 %	12.0 %	25.4 %
11	*Real Wage*	26.8 %	- 13.7 %	- 6.7 %	2.1 %

Table 4
Explaining the divergence between GDP per capita and Real Wages: changes in income distribution, labour supply per capita and relative prices.

line	**variable**	Percentage change over the period			
		1700-1760	1760-1780	1780-1800	1700-1800
1	*Agriculture*	43.2 %	2.6 %	16.1 %	70.6 %
2	*Industry*	52.9 %	29.2 %	47.4 %	191.3 %
3	*GDP*	46.6 %	11.9 %	29.8 %	113.1 %
4	*Population*	21.1 %	14.2 %	20.3 %	66.4 %
5	*GDP per capita*	21.0 %	- 2.0 %	7.9 %	28.0 %
6	*Share of labour* (α)	- 0.7 %	- 3.2 %	- 3.2 %	- 7.0 %
7	*Labour supply per capita (L/N)*	0 %	12.0 %	12.0 %	25.4 %
8	*Relative price of agriculture* (p_a)	- 2.8 %	3.2 %	4.3 %	4.6 %
9	*Relative price of industry* (p_{ind})	6.7 %	- 6.9%	-9.0 %	- 9.6 %
10	*Real Wage*	21.0 %	-16.0 %	- 9.7 %	- 7.2 %

Table 5
Real wages and GDP per capita during the 19th century in England.

Source	series	Percentage change over the period			
		1800-1830	1830-1880	1800-1880	1880-1900
Real wage estimates					
Allen (2001)	Labourers	13.4%	56.8%	77.8%	
	Craftsmen	20.9%	45.1%	75.4%	
Clark (2005)	Helpers	31.5%	93.6%	154.5%	30.7%
	Craftsmen	34.8%	79.2%	141.5%	29.9%
Clark (2006)	Farm labourers	19.9%			
Feinstein (1998)	Manual (blue-collar)	10.7%	54.4%	70.9%	
GDP per capita estimate					
Maddison (2003)		10.8%	98.8%	120.2%	29.2%

Table 6
Changes in income distribution and in labour supply per capita, 19th century England.

Changes in income distribution			
	1801	1967	1880
Share of total income to top 10% of the population	47.9%	53.4%	54.2%(1)
	1801-1867	1801-1880	
Implied difference in growth rates(2)	-10.4%	-12.1%	
Changes in labour supply per capita			
	1800	1890	
Hours worked per year	3328	2807	
	1800-1890		
Implied difference in growth rates(2)	18.6%		
	1800-1880/1890		
Net effect on growth rates	4.2%		

(1):This figure corresponds to the UK.
(2):Positive values denote that GDP per capita would grow faster, negative values denote that real wages would grow faster.

Table 7
Real wages and GDP per capita in Europe, 1500-1820.

Country	*Total change, 1500-1820*	
	GDP per capita (van Zanden 2001)	*Real wages (Allen 2001)*
UK	113%	5%
Netherlands	48%	-26%
Belgium	35%	-17%
Italy	-18%	-56%
Spain	5%	-34%
Poland	-17%	-32%

Notes: GDP per capita growth between 1500 and 1820, from Table 4.3 in van Zanden (2001). For Spain the growth is for the period 1570-1820.
Real wage growth is from Table 5 in Allen (2001). We calculate the growth between the average for 1500-1549 and the average for 1800-1849. The real wages correspond to the following cities: London (UK), Amsterdam (Netherlands), Antwerp (Belgium), Florence/Milan (Italy), Valencia/Madrid (Spain), Krakow (Poland). For Spain we calculate the growth rate for Valencia between 1500-1549 and 1750-1799 and then increase it by the growth rate for Madrid between 1750-1799 and 1800-1849.