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UNREAL WAGES? REAL INCOME AND ECONOMIC GROWTH IN ENGLAND, 1260-1850¹

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Abstract

Historical estimates of workers' earnings suffer from the fundamental problem that annual incomes are inferred from day wages without knowing the length of the working year. This uncertainty raises doubts about core growth theories that rely on existing income estimates to explain the origins of the wealth of nations. We circumvent the problem by building an income series of workers employed on annual rather than casual contracts. Our data suggests that existing annual income estimates based on day wages are badly off target, because they overestimate the medieval working year but underestimate the working year during the industrial revolution. Our revised annual income estimates indicate that modern economic growth began almost two centuries earlier than commonly thought and was driven by an 'Industrious Revolution'.

JEL classification: J3, J4, J5, J6, J7, J8, N33

Keywords: England; Industrial Revolution; Industrious Revolution; Labour Supply; Living standards; Malthusian Model; Modern Economic Growth; Real Wages

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Introduction

Historical estimates of workers' earnings are seriously out of tune with trends in GDP per capita. This inconsistency raises doubts about core theories that build on existing income estimates to answer one of the key questions in economic history: when and how did western societies grow rich? The issue is best understood in the light of two conflicting views about long-run economic development. The traditional 'Malthusian' view, articulated in Clark (2005; 2007) and Galor (2000; 2011), sees all societies worldwide as being characterised by wide swings in real earnings linked to rising and falling populations, but with no sustained income growth until the latter half of the 19th century. The competing 'Revisionist' view, expressed in De Vries (2008) and supported by recent estimates of per capita GDP presented in Broadberry et al (2015), argues it is possible to discern incremental but compounded gains in real earnings long before that time, notably in England, the cradle of the industrial revolution. The two conflicting views are illustrated by Figure 1, which shows how real incomes in England, as represented in mainstream accounts by the estimated annual earnings of day workers, rise sharply in response to the demographic disaster of the Black Death, then fall as the population recovers, and eventually stagnate during the classic years of the industrial revolution. Figure 1 also shows how per capita GDP follows a very different path, with modest economic growth in the aftermath of the Black Death gathering momentum after 1650.

The divergences between the trajectories of real incomes and per capita GDP have called for clarification. The standard response draws on two central narratives relating to changing factor payments. The first narrative, known as the 'Golden Age of Labour', refers to the period after 1350 when conventional indices of real earnings surged while per capita GDP stagnated. The Black Death, and ensuing demographic catastrophe, is thought to have caused food prices to fall and wages to rise, so benefiting workers at the expense of landowners (e.g. Postan 1966). The second narrative, known as 'Engels' Pause', refers to the period c. 1650-1830 when the standard measures of real income stagnated while per capita GDP grew. In this case, industrial technical progress supposedly skewed income in favour of profits, so this time benefiting capitalists over labourers (e.g. Allen 2009). The diverging trends shown in Figure 1 are not unique to England, but apply with equal strength to France, Germany, Holland, Italy, and Spain (e.g. Campbell 2013).

Figure 1

Indices of GDP per capita and estimated real annual income of day workers, 1260-1850



Note: Annual real income is constructed by dividing annual nominal income by 365 days multiplied by daily costs of consumption (see Table A1). Annual nominal income is inferred from day work and computed by multiplying day wages by 250 days. Real income and GDP per capita are indexed using their respective averages of the period 1260 to 1850. *Sources:* Day wages: Clark (2007, Table A2). Daily costs of consumption: Allen (Link). GDP per capita: Broadberry et al (2015).

As is made clear in the macroeconomic growth tradition, the discrepancy between trends in real incomes and per capita GDP, and hence the conflict between the Malthusian and Revisionist views, can be reconciled by variations in annual earnings caused by hypothetical changes in annual labour supply per head (e.g. Angeles 2008; Broadberry et al 2015; De Vries 2008; Hatcher 2011; Nuvolari and Ricci 2013; Palma and Reis 2016). The problem lies in giving such hypotheses empirical substance. Hitherto, annual incomes have been constructed using day rates paid to casual workers. To gross these up on an annual basis requires knowledge of the number of days worked, which is rarely provided in the surviving records. As a result, current estimates of workers' annual incomes, as shown in Figure 1, are subject to measurement error pertaining to scholarly ignorance about casual workers' annual labour input. This issue has been widely acknowledged in previous studies ever since Phelps-Brown

and Hopkins (1956) first warned against predicting workers' annual incomes from their pioneering long-run day-wage series in the absence of knowledge about the length of the working year.

In trying to side-step the issue, previous research has relied on a crude but simple conjecture. Namely that workers always worked for 250 (or sometimes 260) days per year (e.g. Allen 2001; Allen 2007; Allen and Weisdorf 2011; Allen et al 2012). This assumption underpins the standard account of the evolution of workers' incomes depicted in Figure 1. Equal to a 5-day working week plus two weeks' holiday, this conjecture is perhaps not unreasonable in today's world. But in the historical context, as Hatcher (2011) has emphasised, it involves two controversial suppositions about the days that casual workers were able, needed, or wished to work. The first supposition is that day work was always available 250 days per year, which Hatcher claims is out of touch with reality, because 250 annual working days would have made casual workers much better off than many of their land-owning counterparts. The second supposition is that casual workers always supplied 250 days of labour, which Hatcher points out involves an entirely inelastic labour supply, contradicting evidence that medieval workers set themselves goals in terms of cash and ceased to work once these were achieved (Farmer 1996; Hatcher 1998).

The historical record provides occasional indications of the length of the working year. These suggest that labour input varied widely in the past (Allen and Weisdorf 2011). For example, numbers provided by Blanchard (1978) indicate that the medieval working year was sometimes only 165 days long, while Voth's estimates suggest that the industrial-revolution working year was as long as 330 days (Voth 2000; 2001). If these numbers are even roughly correct, then existing proxies for annual income, which are based on 250 days of work, overestimate medieval incomes as much as they underestimate early industrial incomes, by some 30 per cent. The discipline's best guesses about annual income scould well be off target. This raise questions about levels and trends in existing income estimates with ramifications for core theories of long-run growth, which build on these estimations to account for the wealth of nations, including the Malthusian model (e.g. Clark 2007), Unified Growth Theory (Galor 2011), and the so-called 'little divergence' and 'great divergence' hypotheses (e.g. Allen 2001).

This paper tackles the issue by constructing an income series for English male workers employed on *annual* contracts. Our estimates are comparable to the authoritative income series of day workers reported in Allen (2007) and Clark (2004; 2007). Yet, our new

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estimates circumvent the central problem of previous studies related to estimating annual income in the absence of information about days worked.² With the exception of Clark and Van Der Werf (1998), discussed below, previous studies have ignored annual payments in the construction of long-run income series. One reason for this is that annual workers usually received board and lodging in addition to any cash payment, so complete estimates require the valuation of such perquisites to attain proper income estimates. In this paper, as explained below, we impute values for workers' board and lodging from a historical consumption basket proposed in Allen (2009). This enables the construction of a new long-run series of historical workers' annual earnings, which fits markedly better with per capita GDP compared to earnings inferred from day wages and the debatable assumption of 250 days of work.

Our new income estimates speak to a number of long-standing central debates in the field of economic history. But two key findings stand out. The first is that early modern growth began in the first half of the 17th century, nearly two centuries before the conventional date juncture. Not only do rising earnings before 1800 challenges any lingering attachment to the Malthusian model as a relevant interpretive frame for economic development in pre-industrial societies. They also suggest the escape from the so-called 'Malthusian trap' coincided with the rise in Atlantic trade, which Acemoglu et al (2005) contends was a significant stimulus to early modern economic development.

The second finding questions the common assumption used in existing studies that workers worked for 250 days per year. Clark and Van Der Werf (1998) argued that casual workers' yearly earnings varied in tandem with their annually-employed counterparts (possibly with a premium as compensation for shouldering job insecurity or a penalty for being less preferred). Clark and Van Der Werf's assumption enables us to impute the annual number of days worked by dividing our annual income estimates by the prevailing day rates. This exercise informs us that medieval workers put in 2-3 weekly days of work on average, whereas industrial-revolution workers toiled for more than six days per week. Our imputed working year fits much better with the scattered, independent estimates of working time found in the surviving records than the conventional assumption of an unchanged 250 days.

With far smaller medieval labour inputs than previously assumed, the post-Black Death 'Golden Age' of the 14-15th centuries glittered much less brightly than annual income estimates grossed up from day wages have suggested. This finding agrees with John Hatcher's

 $^{^2}$ Our annual payments also avoid the problem that existing annual income estimates are based exclusively on day wages paid during off-season work, i.e. when daily remunerations were markedly lower than those paid during the hay and harvest seasons or other times of high demand.

reference to previous estimates of day workers' annual earnings as 'unreal wages' (Hatcher 2011). The subsequent gradual rise in annual labour inputs, reaching well over 300 days per year after 1750, lends empirical support to Jan de Vries' idea of an 'Industrious Revolution' (De Vries 1994; 2004) and to Allen's allusion to Britain's industrial revolution as '1% inspiration and 99% perspiration' (Allen 2011, p. 33).

Methods and Data

Historians have argued that the frequency of annual service, combined as it often was with coresidence, declined in the early modern period as a result of rising food prices, increasing rents, and employers' growing preference for privacy (Kussmaul 1981). But census enumerators' books, farm surveys, and oral histories have shown that annual service was under-recorded in the early occupational censuses and remained important well into the 19th century (Sheppard 1961; Devine 1984; Short 1984; Howkins 1994; Caunce 1997). Thus, for much of the extended time period with which we are concerned, annual service, habitually with co-residence or board, flourished in all sectors of the economy, its neglect in the construction of historical income indices a glaring omission.

Estimates suggest that annual workers' share ranged from almost half of the work force in the mid-13th century (Campbell 2016) to some 15-20 per cent by the early 19th century (Humphries 2004). Annual contracts were particularly important in agriculture, where most of our wage data originates. The traditional service contract, which often combined commitment for a year with board and lodging in or near the place of work, made it easier for employers to align incentives; it ensured the availability of labour at key points in the agricultural cycle; and it reduced monitoring and muster costs (Woodward 2000). In return, such contracts cut the costs of travelling to and from work and insured workers against rising rents and food prices.

For most farmers, a mix of permanent and day labourers best met their needs, the ratio depending upon farm type, price variation, and the broader political and economic context (Kussmaul 1981; Foster 2002; Whittle 2015). Whereas previous long-run series of workers' earnings are solely based on payments for daily employment, the series presented here concerns payments for annually-contracted work. By weighing the payments of the two types of workers together, an exercise which we perform further below, our study offers a very first attempt to measure the annual earnings of an average workers between 1260 and 1850.

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Payments in Kind

While payments for annual service eliminate the need for ancillary assumptions about the length of the working year (because annual income can be read directly in historical account books), they introduce a practical obstacle explaining their neglect in previous accounts of historical income. Annual workers often received non-pecuniary benefits in addition to their cash payments, usually in the form of board and lodging. Even those who resided elsewhere, some *famuli* for example in the medieval period, enjoyed perquisites in the form of grain liveries or other supplements (Poos 1991; Hilton 1975; Hanawalt 1986). Ideally, such in-kind rewards should be valued on a case-by-case basis and added to any cash payments to determine overall remuneration. Where such computations are possible we use them to check our findings in the sensitivity section below, but in general the historical evidence on the value of perquisites is insufficient to support the construction of a comprehensive series based on a case-by-case basis.³

An alternative way to 'monetise' in-kinds is to assume that they covered workers' subsistence, meaning their food, drink, clothes, and housing. Allen's (2009) so-called 'respectability' consumption basket provides a practical tool for capturing historical workers' subsistence (Humphries and Weisdorf 2015). Table 1 lists the commodities included in Allen's basket and their quantities. The basket offers 2,500 calories per day considered to be a 'respectable' amount of nourishment for an adult person. In addition to food and drink, the basket also contains linen for clothes, candles and lamp oil for light, fuel for heat, and a rent allowance. Using historical prices, also provided by Allen,⁴ the basket's annual value for each specific year can then be added to a worker's cash stipend, and the resulting income estimate transformed into real earnings in the standard way, as explained below. In a later sensitivity analysis, we discuss the usefulness of the Allen's basket as a way to monetise workers' non-pecuniary benefits by checking them against those cases where the monetary values of workers' benefits can be read directly from the sources.

³ The problem of monetising payments in kind is not unique to workers employed on an annual basis. Day labourers sometimes received an allowance for the money value of food and drink and sometimes did not, making it hard to provide an exact day wages based on the existing records.

⁴ The average daily cost of the 'respectability' basket between 1260 and 1850, taken from Allen's website (Allen *Link*), is summarized in Table A1 in our Appendix by decade.

Good	Quantities per year	Calories per day
Bread	234 kg	1 571
Beans/peas	52 L	370
Meat	26 kg	178
Butter	5.2 kg	104
Cheese	5.2 kg	54
Eggs	52 each	11
Beer	182 L	212
Soap	2.6 kg	
Linen	5 m	
Candles	2.6 kg	
Lamp oil	2.6 L	
Fuel	5.0 M BTU	
Rent	5% allowance	
Total		2,500

Table 1Allen's 'respectability' consumption basket (for one adult person)

Source: Allen (2009, Table 2.1).

Workers' Earnings and Their Sources

We follow the traditional approach to searching for historical records of workers' payments. Some of our data comes from secondary sources and classic collections of printed primary material, such those of James Edwin Thorold Rogers and Lord William Beveridge. We also searched less known secondary sources as listed in the bibliography below. We have supplemented these records with new material from diverse archival and printed primary sources, including manorial accounts, estate accounts, farm accounts, settlement examinations, diaries, and memoirs. All sources used are listed in our Appendix.

The geographical coverage is comparable to that of the authoritative series for day workers provided by Clark (2007), whose sources we systematically revisited, alongside other depositories, many uncovered in our analogous work on women's wages (Humphries and Weisdorf 2015). Our male income series include 6,860 annual payments in total.⁵ Table A1 in the Appendix report their distribution across nearly six centuries of English history.

Building an income series from heterogeneous sources, as scholars engaging in comparable endeavours have previously noted, requires care and consistency. Geographically and occupationally diverse evidence must be treated with attention to avoid the introduction of misleading trends associated with compositional shifts. We have adopted three main strategies to curb such dangers. First, we endeavoured to avoid reliance on any single source or location in any specific decade. Our data (see Table 2) come mainly from the centre of England and the south, but with some northern coverage as well.⁶ Furthermore, in order to make our series comparable to those for unskilled day workers (e.g. Allen 2007; Clark 2004; 2007), we excluded observations related to workers with managerial or financial responsibilities, ignoring also workers whose job titles implied specialist training.⁷ We have categorised our occupations into three main groups (reported in Table 2): men and helpers, labourers, and servants. Examples of 'men' are coachmen, footmen, herdsmen, horsemen, and watchmen, while 'helpers' include cook's help, groom's help, hunter's help, and so on. Sometimes, although the source reported that the work was unskilled, no occupational title was provided. This gave rise to a fourth category, unknown work, which made up about one in three workers. Our regression analysis below shows, however, that workers with no occupational designation were paid in line with men and helpers.

⁵ Our 6,860 annual payments appear perhaps to be a modest number compared to the 19,417 casual payments reported in Clark (2007). However, a large share of those casual payments are not day rates, but threshing rates. Also, it is worth noting that payments for day work are much easier to find in the surviving records: a day worker can potentially be recorded 365 times each year, but as an annual worker he can be observed only once. ⁶ Regions included in the south are the South West, the South East, as well as East Anglia. The centre includes East and West Midlands. The north includes the remaining regions (the North West and North East, as well as Yorkshire). We have excluded payments from the city of London where labour was at a premium.

⁷ To illustrate: the Shuttleworth household in 1597 included 14 full-time male employees (Harland, 1856; Harland, 1857; Foster, 2002). The four highest paid workers were the butler and brewer, the cook, the miller and the steward, who all earned over £2 per annum that year and were excluded. The shepherd and gardener, with less status and skill, earned £1 13s 4d and £1 12s 0d, close to the wage of £1 6s 8d received by the two best-paid farm workers, all of whom were included. Four of the remaining farm workers, earning between £1 3s 4d and £1 0s 0d, were also included while the two poorest paid (on 16s and 12s) were shown by their wage trajectories to be not yet adults and so excluded.

<u>Occupation</u>	Frequency	Per cent	Cum.	<u>Region</u>	Frequency	Per cent	Cum.
Men/Helpers	2,771	40.6	40.6	South	2,342	34.3	34.3
Servants	871	12.8	53.3	Centre	3,537	51.8	86.0
Labourers	556	8.1	61.4	North	954	14.0	100.0
Unknown	2,635	38.6	100.0				
All	6,860	100		All	6,860	100	

Table 2Number of annual payments, by region and occupational category

Source: see the text.

Last but not least, we account for the occupational and spatial heterogeneities reported in Table 2 above by running a piecewise OLS model of the following form:

 $ln(Wage_{it}) = \alpha_i + \sum_j \gamma_j Work_j + \sum_k \eta_k Region_k + \sum_k \phi_l Decade_l + e_{it}$

where Wage_{it} is a wage payment made to individual i at year t; Work_j is a dummy for each of the four categories of work (helpers, servants, labourers, and unknown occupations) reported in Table 2 above; Region_k is a dummy for each of the three macro regions (south, centre, north) of Table 2 above; and Decade_i is a dummy capturing the decade during when the wage payment was observed.⁸ The model is run piecewise, i.e. for each of the following periods: 1260-1349; 1350-1599; 1600-1699; and 1700-1850. This periodisation is motivated by the structural breaks in previous wage series. Our national annual income series is then predicted using the regression coefficients reported in Table A2 in the Appendix.⁹

Consistent with historians' expectations, the estimated coefficients show that labourers (the reference group) were often paid mildly less than the other three groups of workers. The analysis also suggests that workers in the north of England (the reference group) were

⁸ Following Clark (2007) but using piecewise estimation to accommodate different trends by sub-period.

⁹ The predicted nominal payments come from summing up the relevant regression coefficients (the constant plus the point estimates for each occupational group and macro region plus the decade dummy). That means the nominal payment for the 1260s is e(5.560-0.0563+0.0371-0.0781+0.0167+0.0127-0.0986)=e(5.3935)=220. This avoids compositional shifts in the data, as we give equal weight to each of the occupational groups and regions.

generally poorer paid than their central and especially southern England counterparts. However, after 1700 and during the classical years of the industrial revolution (1705-1850), which began in the north of England, northern workers were significantly better paid than their southern peers. The regression coefficients reported in Table A2 can then be used to estimate a national nominal wage by decade controlling for variation in the representation of regions and broad occupational categories.

Results

The predicted nominal annual payments, i.e. the cash component and the monetised benefits based on Allen's basket, are reported in Table A1 in the Appendix, by decade. The nominal payments were then transformed into real incomes, also reported in Table A1, by dividing them by the annual cost of living estimates, which in turn were obtained by multiplying the daily consumer prices of Allen's 'respectability' basket described above by 365 days. The resulting estimated (and indexed) real annual incomes are illustrated in Figure 2, along with indices for per capital GDP as well as the conventional account of annual income obtained from day wages multiplied by 250 working days, as reported I Figure 1.¹⁰

Figure 2 captures three key findings. First, real incomes from annual work, illustrated by the bold, black line, exhibit systematic and large divergences from annual incomes estimated on the basis of day rates multiplied by 250 days of work. If we suppose for a moment (but discuss in detail below) that income from casual and annual work was roughly identical, arbitraged into convergence by the flexibility of employers and the mobility of workers between types of contract as argued in Clark and Van Der Werf (1998), then this suggests that annual incomes inferred from day work (squares) are heavily burdened by a misrepresentation of day workers' annual labour input (the 250 days assumption) and therefore misrepresent annual earning possibilities in the past.¹¹ This conclusion, consistent with conjectures expressed in Broadberry et al (2015) and Campbell (2013), is supported by a considerably better fit between annual income from day work (squares). We return to the possibility of arbitrage between annual and casual work further below, where we also discuss how this links to a varying working year.

¹⁰ Figure A1 in the Appendix shows the raw data averages against the estimated data based on the regression coefficients reported in Table A2.

¹¹ We discuss the assumption of arbitrage between casual and annual work in the sensitivity section further below.

Figure 2

Indices of GDP/capita and estimated real annual income in day and annual work, 1260-1850



Note: Annual real income is constructed by dividing annual nominal income by 365 days multiplied by daily costs of consumption (see Table A1). Annual nominal income from day work (squares) is computed by multiplying day wages by 250 days. Annual nominal income from annual work (black), which is predicted based on the regression coefficient reported in Table A2, is the sum of cash payments and monetised in-kind benefits. *Sources*: Day wages: Clark (2007, Table A2). Annual wages: see the text. Daily costs of consumption: Allen (Link). GDP per capita: Broadberry et al (2015).

The second key finding is that the post-Black Death 'Golden Age' glittered much less brightly than is suggested by annual income estimates from day rates plus the 250 days assumption. The Golden Age apogee according to Figure 2 (solid bold line) was lower and surpassed much earlier than other authors have proposed. Annual workers' 'golden' incomes were outshone by the early 18th century rather than by the late 19th century, as posited by Clark (2007). If annual income from casual work and annual work was roughly the same, a matter we return to below, then our conclusion aligns with Hatcher's (2011) intuition that day workers' annual earnings during the long 15th century were much smaller than those inferred from multiplying day rates by 250 days of work. The third and perhaps most crucial finding is that real annual incomes from annual employment rise continuously from 1650, in stark contrast to the widespread view that England did not escape its 'Malthusian trap' until after the mid-19th century (e.g. Allen 2007; Clark 2008a, 2008b). This conclusion speaks directly to the mounting dissatisfaction with the Malthusian model as a relevant scenario for the early modern period (e.g. Persson 2008; de Vries 2008; Broadberry et al 2015) by showing that the transition from so-called 'Malthusian stagnation' to modern economic growth was a gradual process rather than a sudden ('hockey-stick') event (as McCloskey (2010) has called it). Gradually rising real annual incomes also fit with the idea of an early modern 'consumer revolution' visible in the appearance of novel commodities in 17th and 18th century probate inventories (e.g. McKendrick et al 1982; Thirsk 1978; De Vries 2004).

The three findings illustrated in Figure 2 and discussed above touch on a number of long-standing debates in the field of economic history. These debates concern questions regarding the long-term evolution of labour's share; the gender pay gap and significance of the male breadwinner model; the relevance of the Malthusian model as an interpretive framework for pre-industrial economic development; the existence of an Industrious Revolution; and the presence of a so-called 'Engels' Pause'. Below, we discuss each of these matters in detail.

Engels' Pause

Rising real annual incomes after 1650, and their better correspondence with trends in per capita GDP than annual income from day rates (see Figure 2), raises doubts about the presence of an 'Engels' Pause'. Engels (1845) reconciled the huge increases in output associated with the industrial revolution with the deleterious social and economic conditions that he observed in northern England (where industrialisation first took hold) by arguing that the gains from economic development accrued overwhelmingly to capitalists. Indeed, the mounting gap after 1650 between real annual incomes from casual work and per capita GDP (see Figure 2) prompted Robert Allen to suggest that a surge in inequality was intrinsic to the growth process: technical change increased the demand for capital and thus raised the profit rate and capital's share (Allen 2009). Based on annual incomes inferred from day rates, Allen envisioned that the rise in profits sustained the industrial revolution by financing investment, but only much later (after c. 1800) led workers' pay to rise. The closer fit between the trends

in real annual income from annual work and per capita GDP as displayed in Figure 2 thus presents a challenge to the hypothesis that inequality between workers and capitalists was a driving force in the industrial revolution. Indeed, if casual and annual workers could be expected to earn roughly the same, a point which we will return to below, then Engels' observation might turn out false.

Figure 3

Labour's share using estimated real annual income in day and annual work, 1260-1850



Note: The graph shows the indexed evolution in the share of real income to GDP per capita. The year 1620, where annual income is identical for both series, is set to 0.6. *Sources*: Annual wages: see the text. Day wages: Clark (2007, Table A2). Daily costs of consumption: Allen (Link). GDP per capita: Broadberry et al (2015).

Labour's Share

The idea that industrial technical progress skewed income in favour of profits, so benefiting capitalists over labourers, links to the question of how labour's share evolved during the medieval and early modern periods. Previous evidence from 20th-century data has shown that labour's share in national income stayed relatively constant over time, fluctuating between 50 and 80 per cent of total output (Gollin 2002). Figure 3 illustrates the long run

evolution of labour's share between 1260 and 1850. Estimating labour incomes by day rates multiplied by 250 assumed days of work, makes medieval developments in labour's share look dubious, reaching more than 100 per cent during the post-Black Death period. In contrast, the factor proportion computed using annual incomes from annual work usually fluctuates between 50 and 80 per cent of total output, with a modest advantage for workers manifest in the latter half of the 15th century.

Figure 4

The gender pay gap, 1260-1850



Sources: Male wages: see the text. Female wages: Humphries and Weisdorf (2015, Table A1) multiplied by 260 days.

The Gender Pay Gap

Annual wages for female labour, provided in Humphries and Weisdorf (2015), in combination with the male wages provided in this study enable us to compute how much more men on yearly contracts earned compared to similar women over the long run. Figure 4 shows that the gender gap between male and female payments varied considerably: from virtually zero before the Black Death to more than double in some instances in the post Black-Death period. A widening gender gap appears to coincide with periods of tight labour markets, such as in the post-plague period and during the Napoleonic wars, when men in particular were in short supply, but further work is needed to confirm this hypothesis.



Figure 5

Estimated real annual incomes from day rates (grey) and annual rates (black), 1260-1850

Note: Annual real income (see Table A3) is computed by dividing nominal income by 365 days multiplied by daily costs of consumption. Annual nominal income for day work (grey) is obtained by multiplying day wages by 250 working days. Annual nominal income from annual work (black), which is predicted based on the regression coefficient reported in Table A2, is the sum of cash payments and monetised in-kind benefits. The bold lines show the 10-year moving averages. *Sources*: Casual wages: Clark (2007, Table A2). Annual wages: see the text. Daily costs of consumption: Allen (Link).

The Male Breadwinner Model

Men and women's earning possibilities in the past connect with the question of the relevance of a 'male breadwinner model' for pre-industrial societies. Figure 5 takes a closer look at real annual earnings from annual work vis-à-vis those estimated from day rates multiplied by 250 days of work. The graph reports the number of Allen's so-called 'respectability' baskets that an annual income could buy, which Allen (2009) calls 'welfare ratios'.¹² Thin lines show the size of real annual payments, which were greatly influenced by year-by-year price fluctuations. The solid lines show the 10-year moving averages. On the assumption presented in Clark and Van Der Werf (1998) that casual and annual workers earn largely the same over the course of a year, the black line in Figure 5, which is based on incomes of annual workers, confirms a dramatically different trend in real annual earnings than does the grey line inferred from day rates and the assumption of 250 working days per year. The continuous rise in real annual incomes starting in the 17th century again shows that economic growth took off nearly two centuries earlier than commonly thought, contesting the conclusion reached in Clark (2007, p. 99) that '[t]here is no sign of secular trends towards higher living standards in the pre-industrial era'.

Figure 5 also shows that, although our estimates of real annual incomes improved significantly in the aftermath of the Black Death, some ground was lost after c. 1500 and only after c. 1700 could an unskilled man's annual income purchase more than two consumption baskets. That is, support himself and a wife. Moreover, in spite of rising real income during the first half of the 17th century, it was not until the 19th century that an unskilled male's annual income was able to provide a 'respectable' living for a contemporaneously average family comprising two adults and three children, equivalent to three and a half adults when children count as half an adult, as Allen (2009) assumes. Figure 5 thus confirms that a male breadwinner model appears irrelevant before 1800. Not just during the early modern period, as earlier scholarship has already pointed out. But also during medieval times where previous estimates of male earning possibilities supported the idea of a male breadwinner society.

The Malthusian Conundrum

Perhaps one of the most contentious accounts of economic development in pre-industrial societies is the Malthusian model (e.g. Clark 2008b; Persson 2008). While an affirmative answer to the question of whether the pre-industrial world was Malthusian or not requires an advanced econometric approach, previous studies have used simple means to good effect. Going back more than a half millennium before 1800, Clark (2007) demonstrated that English day wages plotted against national population levels provide strong support for a basic tenet

¹² Allen's original welfare ratios were computed on the assumption that an average family was made up of two adults and three children (Allen 2007). Here, because the size of historical families arguably varied considerably during the period of observation, we simply compute the number of consumption basket that one male salary could afford. In order to compare our numbers with Allen's original numbers, our numbers must be divided by 3.25 (as children consumer half as much as adults).

of the Malthusian model. Figure 6 replicates Clark's graph, showing that population and real annual income inferred from day rates are either unrelated or inversely correlated until 1800, after which population growth still appears to constrain improvement in real incomes.¹³

Figure 6

Estimated real annual incomes from day work against population levels, 1260-1850



Note: Annual real income is computed by dividing annual nominal income by 365 days multiplied by daily costs of consumption (see Table A1). Annual nominal income from day work is obtained (as conventionally) by multiplying day wages by 250 working days. *Sources*: Day wages: Clark (2007, Table A2). Daily costs of consumption: Allen (Link). Population levels: Broadberry et al (2015, Table 1.06) and Wrigley and Schofield (1981, pp. 715ff).

¹³ The day rates presented by Clark (2005), although they do not rise at the same pace and to the same extent as we observe in Figure 5, do enable Clark to see 'the beginning of the escape of the Malthusian stagnation' in the 17th century, where 'the efficiency of the economy shows the first signs of significantly exceeding medieval levels in the 1640s' (*ibid*, pp. 1311-2). But Clark also observes a pause in wage growth at the eve of the classic years of the industrial revolution, captured by the negative relationship between real income and population in Figure 6.

Figure 7

Estimated real annual incomes from annual work against population levels, 1260-1850



Note: Annual real income is computed by dividing annual nominal income by 365 days multiplied by daily costs of consumption (see Table A1). Annual nominal income from annual work is the sum of cash payments and monetised in-kind benefits. *Sources*: Annual wages: see the text. Daily costs of consumption: Allen (Link). Population levels: Broadberry et al (2015, Table 1.06) and Wrigley and Schofield (1981, pp. 715ff).

Our revised incomes derived from annual contracts suggest a very different story. Figure 7 shows that the same negative relationship between population and real income is somewhat apparent in the medieval data, even if there are upward moving trends distinguishing the 16th century from earlier centuries. The initial visitation of the Black Death in 1348-9 was followed by periodic re-visitations that left the age structure of the population unbalanced, and destroyed the social fabric of many communities, impeding demographic recovery.¹⁴ As Figure 7 suggests, the exogenous drop in labour supply first drove up incomes as the dependent variable, after which slow recovery was associated with a downward drift in

¹⁴ The plague and resulting demographic stagnation were exogenous to economic development in Britain: '[T]he trigger [was] likely to have been ecological stress arising from a sudden change in weather, leading to a crossover of infection, either directly from sylvatic rodents to humans or indirectly to commensal rodents and then humans' (Campbell, 2016, p. 286).

incomes towards (though not entirely back to) pre-plague levels. The graph also shows that population growth and economic growth show an overall positive correlation after the middle of the 17th century, when the Malthusian mechanism appears to have been broken.

The Industrious Revolution

The questions of whether or not an Industrious Revolution proceeded the industrial revolution is heavily debated among economic historians and long-run growth theorists. But because annual labour supplies per head are rarely provided in the surviving records, the debate is hard to settle.

The concept of the Industrious Revolution is perhaps most famously endorsed by Jan De Vries, who proposed that the spread of new and desirable market commodities raised the utility of money and inspired a reduction in people's leisure time as they sought higher incomes (De Vries 1998; 2004). In turn, the increased demand for marketed goods and services promoted the technological progress associated with the industrial revolution. A hallmark of De Vries' Industrious Revolution is that of increased workdays. If the working year increased during the early modern period rather than staying flat, as previous accounts of worker's earning possibilities have assumed, then this might potentially bridge the gap between the Malthusian and Revisionist views of pre-industrial economic development described in the introduction.

In their seminal article from 1998, Gregory Clark and Ysband Van der Werf pointed out that day rates in combination with annual rates facilitate the computation of the working year needed in day labour in order to obtain the income that could be earned in annual work (Clark and Van der Werf 1998). Based on wage assessments and estate records, Clark and Van der Werf found that the average working week grew modestly, from five to six days between the late 16th and the late 17th centuries. Our new and more comprehensive series of annual rates, in combination with Clark's (2007) full series of day rates, enable the replication of Clark and Van der Werf's exercise using a greatly expanded dataset and covering an extended time period.

Figure 8



The implied working year and independent estimates, 1260-1850

Note: The graphs show the number of days in casual work needed to earn an annual worker's yearly income (see Table A3). The solid line shows the 10-year moving average. Triangles report independent estimates of annual days worked per person. *Sources*: Day wages: Clark (2007, Table A2). Annual wages: see the text. Daily costs of consumption: Allen (Link). Independent working days: from Blanchard (1978), Clark and van der Werf (1998), and Voth (2001) as explained in Allen and Weisdorf (2011, pp. 720-21), and from Booth (2003) in which 21 workweeks paid a full year's salary.

The evidence illustrated in Figure 8 proposes a remarkable change in annual labour input between the pre-Black Death period and the end of the classical years of the industrial revolution. While some four days of casual work per week would provide the same income as that enjoyed by an annual worker before the plague, steeply rising day rates combined with more modestly growing annual rates in the aftermath of the plague meant that as few as two to three days of casual work per week were sufficient to match an annual worker's yearly

remuneration.¹⁵ The shorter working year after c. 1350 agrees with Hatcher's (2011) supposition that the post-Black Death labour market did not gild the peasantry's world to the extent previously thought, either because day workers could not find enough work or because their labour supply curves bent backwards. The latter conclusion accords with historians' description of medieval workers' *mentalities*: 'A plausible reconstruction of workers' attitudes in the period 1349-1520 is that they set themselves goals in cash or consumption needs, and worked until they had achieved their aims. Then they ceased to work' (Dyer 1989, p. 224).

Furthermore, Figure 8 chimes with the view that the simplifying but crude assumption of 250 days of work overlooks the possibility of a 'preference switch' in workers' evaluation of the labour-leisure trade-off as described in De Vries' concept of an Industrious Revolution (De Vries' 1994, 2008). The work-year estimates of Figure 8 are also more in line with Voth's derivation of time use from 18th- and 19th-century court records, confirming his assessment that the period 1760-1830 saw 'the longest years' (Voth 2001, title). Overall, the implied working year agrees reasonably well with the trend in the scattered, independent estimates of annual days worked per person (the triangles in Figure 8) found in the literature (Allen and Weisdorf 2011; Booth 2003; Broadberry et al 2015). Perhaps more than anything, Figures 2 and 8 together support the argument that the two conflicting views about long-run economic development described in the opening paragraph of this article can be reconciled by allowing the historical working year to vary along the lines shown in Figure 8, as anticipated in Campbell (2013) and elsewhere.

Sensitivity

This section considers two major sensitivity checks. The first check concerns the possibility that Allen's 'respectability' basket is an inadequate representation of the benefits of board and lodging. Although the basket provides sufficient food, clothing, housing, and heating to establish a 'respectable' standard of living, including 2500 calories per day, the board and lodging privileges that annual workers *actually* received could have differed from the

¹⁵ While this seems like a rather short working year, payments made in 1361-62 reported in Booth (2003) reveal that full-year salaries were paid for no more than 21 weeks' work. If the working week back then was five or six days long, then this meant that Booth's labourers supplied somewhere between 105 and 126 days of work per year. Moreover, our sensitivity analysis below shows that, if annual workers accepted non-trivial wage cuts in exchange for job security, then the working year immediately after the Black Death would have been some 130-140 days long.

contents of the basket. This is perhaps especially relevant during the medieval era when workers were sometimes paid in grains that could be either consumed or sold for cash, or during the early modern period when novel commodities appeared on the market potentially within reach of working-class consumers. In either case, the possibility that the value of Allen's basket is out of tune with workers' actual privileges threatens the aptness of the methodology and thus the validity of the conclusions drawn in the previous section.

The second sensitivity check explores the possibility of a pay gap between annual and casual work (for example if casual workers received a premium for job insecurity) and what such a pay gap would imply with respect to the earnings of an *average* worker. This check also conjectures that the share of workers on annual contracts did not remain constant over time, exploring how changes in the composition of the labour force would have influenced the earning of an average worker.

The Relevance of Allen's 'Respectability' Basket

We begin by examining whether or not the value of Allen's *one-size-fits-all* consumption basket offers a good representation of annual workers' actual board and lodging benefits. Following de Vries' idea that an early modern Consumer Revolution was paid for by an Industrious Revolution (de Vries 1998, 2008), it is not implausible that novelty commodities, which emerged during the early modern period, but which Allen's basket does not include, increasingly made their way into workers' non-pecuniary payments. Moreover, earlier in time, post-plague labour scarcity might have prompted employers to increase not only workers' cash stipends, but also their payments in kind. Because Allen's basket is not designed to accommodate such non-pecuniary pay raises, the new income estimates presented above might underestimate annual workers' *actual* remunerations, both during the medieval era and the early modern period.

Fortunately, we can resort to the historical record for occasional evidence which can be used to check whether the monetary value of Allen's baskets approximates the actual value of annual workers' in-kind benefits. Starting with the medieval period, Gerald Lui's study of medieval workers' remuneration provides us with valuations for grain wages on the Pittington manorial demesne in Durham and the Lullington manorial demesne in East Sussex between 1390 and 1450 (Lui 2012). Although Durham is situated in the North-East of England, and Sussex in the South, the total wages (paid in cash or grains or both) during this period were remarkably similar in size, thus building confidence that Lui's grain wages are more widely representative. Grain liveries from other secondary or printed-primary sources have also been collected (see Table A4 in our Appendix). Where these are valued within the source, we take this estimate; otherwise, we have imputed a value based on the grain mix specified using time-specific grain prices.

Furthermore, in our search for workers' payments from the early modern period, we sometimes came across records of payment made to workers who were *boarded out*. Although these *board wages* were usually paid in cash, they conflated the cost of board and lodging with an allowance related to the servant's usual wage. Still, these cases, along with the total remunerations including grain wages from the medieval period, can be compared directly to our estimates in Figure 5 of wages plus in-kinds valued by Allen's basket.

Figure 9 plots the cases where payments were made to workers which combined their wage with a monetary subvention in place of their usual in kinds (triangles), against our original data (the solid lines), which imputes those benefits by adding the monetary value of Allen's basket to the observed cash wages. Although the values of Allen's basket appear slightly off target during the first half of the 15th century and the middle of the 16th century when our estimates overshoot the evidence of workers' actual payments, their values generally appear to be in line with annual workers' *actual* remuneration including non-pecuniary benefits. Thus, independent historical evidence suggests that the use of the Allen basket to capture the value of annual servants' perquisites might have mildly upgraded the 'Golden Age', which (judged by the triangles) looks slightly gloomier than our benchmark case (black lines). So, if anything, our baseline downgrading of the workers' post-plague Eldorado might not have gone far enough. Also, our conclusion above, that early modern growth began nearly two centuries earlier than commonly thought, survives the spot check on the validity of the Allen basket as an approximation for the value of annual workers' payments in kinds.¹⁶

¹⁶ One question that springs to mind from this is how the cash component in workers' annual earnings evolved over time. Figure A1 in the Appendix sheds light on this question. Before the Black Death, cash payments comprised less than 20 per cent of workers' total compensation. But, as Figure A1 shows, the cash component rose markedly in the aftermath of the plague reaching nearly 50 per cent during the 15th and 16th centuries. Then, as the population recovered, cash payments also returned to their pre-plague level, reaching slightly less than 25 per cent of total income just before 1600. Cash payments then once gradually again increased in importance to reach 70 per cent of workers' compensation around 1850.

Figure 9





Note: The triangles report the monetary value of grain and board wages. Annual real income is computed by dividing nominal income by 365 days multiplied by daily costs of consumption (see Table A1). The bold line is the 10-year moving averages. *Source*: Annual wages: see the text. Grain and board wages: see Table A4. Daily costs of consumption: Allen (Link).

The Earnings of an Average Worker

Our initial assumption, inspired by the supposition presented in Clark and Van Der Werf (1998) that casual and annual workers could expect to earn roughly the same per year, has taken us a long way by enabling annual incomes to proxy for the earnings of an average worker. However, if labour market regulations, or compensating differential, or still other selection effects meant that casual workers earned systematically more (or less) per annum than did annual workers, then the incomes of annual workers would systematically under- (or over-) estimate average earnings. Worse still, the size of such mis-estimation would vary with the relative shares of casual and annual workers in the economy in ways that are explicated below. Of course, this problem is not unique to our study, but applies with equal strength to existing income estimates based on casual earnings.

To address these issues, we can consider a simple model for a segmented labour market: one segment for casual work and one for annual work. The annual earnings of an average worker are then the weighted average of workers' earnings in the two sub-markets. In other words, average annual earnings can be expressed as $e=\alpha e_A+(1-\alpha)e_c$, where e_c and e_A are annual incomes in casual and annual work, respectively, and where α denotes the share of workers employed in annual work. If we suppose that earnings in the two segments of the labour market are proportional, i.e. that $e_c=\beta e_A$, then average earnings can be written as $e=(\alpha$ $+(1-\alpha)\beta)e_A$. It follows from this that if $\beta=1$ – i.e. if there are no labour market specific premium or selection effects, so that casual and annual workers earn the same over the course of a year – then $e=e_A=e_C$. In this case, the share of labour engaged in annual work (α) plays no role in determining the earnings of an average worker. This is the scenario upon which the conclusions reported in the result section build.

However, if it turned out that $\beta \neq 1$ (i.e. a premium or selection effect applied), then average annual earnings becomes $e=(\alpha+(1-\alpha)\beta)e_A$. In this case, α (the share of annual workers) and β (the casual-annual pay gap) will both influence average earnings. This means that yearly incomes from annual work, e_A , is a more or less accurate indicator of *average* earnings, e, depending on changes in the magnitudes of α and β over time. For example, in the standard interpretation, β would have exceeded unity because day workers required compensation for shouldering labour market risk and were more mobile and therefore better able than their annual counterparts to take advantage of labour scarcity and bargain more aggressively. If so, them the higher the day worker premium was, the more the payments in annual work underestimate average earnings (i.e. $d(e/e_A)/d\beta>0$). Moreover, if the share of annual workers declined over time, as is usually assumed in the literature, the more annual earnings underrate average earnings ($d^2(e/e_A)/d\betad\alpha<0$). Although the historical values of α and β are not well known for the period we observe, we can still make educated guesses about their magnitudes and trends to see if the resulting average earnings challenge the conclusions of the previous section.

The conventional view is that α declined over the course of the pre-industrial era. Here, we firm up the fragmentary evidence derived from the literature with reference to research on social structure, which has identified socio-economic groups by number and size of household. This enables us to compute rough estimates of the number of live-in servants relative to wage-earners and subsistence producers. Starting at the beginning of our time

period, the Social Table constructed by Campbell (2016, Table 3.4) for the end of the 13th century divides the population into eight social groups.¹⁷ For each group, Campbell estimates the number of households, household size, population, various measures of landholdings, and incomes. On the basis of household size, landholding, and income, it is assumed that those in group (1) had four annual male servants; those of group (3) had two annual male servants; and those in groups (2) and (4) had one annual male servant. We also assume that groups (6) to (8), characterised by small households (\leq 3.5 persons) and living below Campbell's poverty line, contained no annual servants, although it is assumed that half of group (8), which contains soldiers and sailors, were employed on annual contracts. Adding the numbers up comes to a total of 444,000 workers employed on annual contracts.¹⁸ Further, households in groups (1), (6), and (7) are assumed to have contained one male day labourer, which gives a total of 530,000 day workers. Adding together annual servants and day labourers gives a total of 974,000 wage earners. Next, adding to this the total landowners, yard-landowners, and smallholders (501,000), and the remaining 25,000 from group (8), assuming they are unwaged subsistence workers. This gives a total male labour force of 1,500,000,¹⁹ meaning that annual workers comprised 46 per cent of the waged labour force in the latter half of the 13th century.

For 1688, we used Gregory King's celebrated Social Table (King 1696, reproduced in Barnett 1936) as the basis for a similar exercise. By this date, the proportion of annual servants in the male labour force was down to 23 per cent, an estimate roughly consistent with Peter Laslett's claim (based on household listings) that 29 per cent of households in British pre-industrial communities (1564-1821) contained servants of one kind or another. Finally, for an estimate towards the end of our period, we resorted to the first population censuses.²⁰ In agriculture, where live-in service persisted longest, by 1871 16 per cent of hired workers were annual servants. A conservative but not implausible estimate is therefore

¹⁷ These are: (1) landowners (spiritual lords, aristocracy, gentry, clergy); (2) minor clergy, professionals, lawyers, merchants, tradesmen, craftsmen, builders, urban labourers; (3) substantial tenants; (4) yardlanders;
(5) smallholders; (6) cottagers and agricultural labourers; (7) rural craftsmen, non-agricultural labourers, labourers, paupers, vagrants; and finally (8) men-at-arms, miners, fishermen and sailors.

¹⁸ Our estimates of servants in the households of landowners (i.e. 84,000) fit reasonably well with Claridge and Langdon's (2016) estimate of 94,000 *famuli* employed on English demesnes in 1300.

¹⁹ If half of the population in 1290, which consisted of 4,746,000 people in total, was male, and if 65 per cent of them were in the working-age group, then this suggests a male labour force of 1,542,450, which is consistent with our 1,500,000 male work force.

²⁰ The censuses suggest considerable variation by type of community: in rural Lancashire, where traditional family farms survived, 28 per cent of households continued to harbour servants; Preston at 10 per cent; Nottingham at 12 per cent; and the potteries at 9-11 per cent were more typical.

that α gradually (we assume linearly) declined from 46 per cent in the 1260s, to some 25 per cent in the 1680s, and further around 16 per cent in the 1850s.

Turning to β , it is commonly thought that the casual-annual income premium was persistently positive, even if it varied over time. In the 13th century, some annual workers appear to have been relatively well paid compared with day labour.²¹ By contrast, in the post-Black Death period, especially shortly after the plague, it is widely held that day labourers were best able to exploit the labour scarcity and hold up landowners in order to force wage concessions, while annual remunerations remained anchored to customary levels or levels set by law and were slower to respond, as we also noted of our own data (see Figure 5 above). Differential bargaining power explains the widespread accounts of medieval workers' preference for casual employment and the coercive prominence given to yearlong contracts in the labour legislation of the 14th century (Putnam 1908; Bailey 1994; Penn and Dyer, 1990, pp. 367-9; McIntosh 1986, pp. 161). Under these circumstances, the casual-annual pay gap probably grew larger and remained inflated until labour scarcity abated.

Moreover, with population growth in the 18th century, the supply of younger workers seeking berths as servants and apprentices grew, while a growing preference for privacy on the part of employers, perhaps alongside increasing recognition of the real costs of live-in servants, continued to ensure a day-labour premium. A plausible scenario, then, is that β was 1.05 before the Black Death rising to 1.25 when the plague first hit (c. 1350), after which it gradually (again we assume linearly) fell back to 1.05 after the population had re-stabilised (c. 1700), staying at this level to the end of our period. Based on these suppositions about the magnitudes and trends in α and β , we can now compute and illustrate the earnings of an *average* worker against the estimated earnings of *annual* workers. Figure 10 above shows that despite the introduction of a significant pay gap between the two types of labour, the magnitudes and trends in yearly incomes were roughly similar for annual and average workers, even if the 'Golden Age' for an average worker would have been slightly brighter under the probable assumptions about α and β explained above.

²¹ According to Claridge and Langdon (2016), however, there were groups within the famuli that did not fare so well. David Farmer has suggested that *famuli* on medieval estates, while employed year-round, were not full-time workers, since they held farmland of their own on which they would simultaneously have worked (Farmer 1996, pp. 228-9). This originally discouraged Clark and Van Der Werf from using such workers' annual wages to impute the length of the working year. We have corrected for this matter in the data collection by paying careful attention to those instances when workers were paid by the term, often in differing cash amounts, aggregating up to the annual wage rather than simply multiplying out. Besides, even for the medieval period our estimates of days worked per year presented below do not just rely on the wages of *famuli*, but instead include many other types of workers and of domestic servants (see Table 2).

Figure 10

Estimated real annual incomes of an annual worker and an average worker, 1260-1850



Note: Annual real income is constructed by dividing annual nominal income by 365 days multiplied by daily costs of consumption (see Table A1). Annual nominal income from annual work (black) is the sum of cash payments and monetised in-kind benefits. Annual nominal income of an average worker (squares) is equal to $(\alpha+(1+\alpha)\beta)e_A$, where e_A is the annual nominal income of an annual worker (black). *Sources:* Annual wages: see the text. Daily cost of consumption: Allen (Link).

Conclusion

The leading theory of long-run developments in real incomes in Western Europe, known as the 'little divergence' hypothesis, holds that the North Sea region, notably England and the Low Countries, diverged from the rest of Europe between 1500 and 1750, in terms of real annual incomes inferred from day rates (Allen 2001). The income estimates used to sustain the 'little divergence' hypothesis also have a central role in the 'great divergence' debate, where they feature as illustrations of Western European advancement in comparison with Africa, Asia, and the Americas (e.g. Allen et al 2011, 2012; Broadberry and Gupta 2006; Frankema and van Waijenburg 2012). Furthermore, real incomes similar to those provided by Allen (2001, 2009) and Clark (2007) are the central pillars in the Malthusian model used to describe economic development in pre-industrial societies (e.g. Clark 2008), which in turn frames Unified Growth Theory (Galor 2011). If the annual earnings supporting these theories are subject to measurement error of the kind and extent suggested here, then that challenges the leading theories informing about long-run economic developments. At risk are not just core theories, such as the Malthusian model and the 'little' and 'great divergence' hypotheses, but also the findings of a large number of studies in economic, social, and demographic history, which rest on conceivably misleading accounts of the long-run evolution of annual earnings based on potentially improper estimates of the length of the working year.

Moreover, in a discipline increasingly captured by the idea that the industrial revolution was a product of scientific advancement or inventive genius, the post-1600 continuous increase in the length of the working year and the intensification of this growth in the run-up to industrialisation, provides a salutary reminder of the relevance of other factors. The evidence for a leisurely medieval Golden Age and an early modern Industrious Revolution presented here not only challenges the assumption that medieval and early modern England had an unchanging working year but carries over to oppose such a conjecture in any preindustrial context. Whether the English increase in labour input was voluntary, as workers gave up leisure for material goods, or imposed as a consequence of structural changes in employment, or the erosion of alternatives to wage labour, or shifts in bargaining power, remains to be examined.

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Appendix

Table A1Estimated payments, in pence and real terms, by decade, 1260-1850

Years		Ann	ual paymei	nts		Cas	ual payme	ents	Other v	ariables
in	Number of	Estimated	Implied	Implied	Real	Day	Implied	Real	СРІ	GDP
decades	payments	cash pay	benefits	income	income	payment	income	income	per day	per capita
1260s	101	27	193	220	1.14	1.28	321	1.66	0.53	48
1270s	179	39	197	236	1.20	1.29	323	1.64	0.54	47
1280s	126	31	197	228	1.16	1.32	330	1.67	0.54	43
1290s	245	52	197	249	1.26	1.32	331	1.68	0.54	47
1300s	631	39	223	262	1.18	1.32	331	1.48	0.61	48
1310s	148	62	241	303	1.26	1.46	364	1.51	0.66	50
1320s	105	42	248	290	1.17	1.51	376	1.52	0.68	47
1330s	157	40	201	241	1.20	1.49	372	1.85	0.55	47
1340s	235	31	212	243	1.15	1.78	446	2.11	0.58	50
1350s	338	95	241	336	1.39	2.58	645	2.68	0.66	63
1360s	38	108	259	367	1.42	2.82	705	2.72	0.71	62
1370s	56	124	237	361	1.52	3.14	784	3.31	0.65	58
1380s	79	148	230	378	1.64	3.09	772	3.36	0.63	65
1390s	48	174	234	408	1.75	3.08	771	3.3	0.64	70
1400s	76	241	226	467	2.06	3.49	873	3.86	0.62	71
1410s	72	239	245	484	1.98	3.46	864	3.53	0.67	68
1420s	28	276	241	517	2.15	3.58	895	3.72	0.66	69
1430s	27	266	256	521	2.04	3.7	924	3.62	0.70	67
1440s	33	246	241	487	2.02	3.73	933	3.87	0.66	68
1450s	97	290	237	527	2.22	3.77	943	3.97	0.65	66
1460s	76	291	241	532	2.21	3.57	892	3.70	0.66	67
1470s	82	272	237	509	2.15	3.6	901	3.80	0.65	65
1480s	108	288	256	543	2.13	3.46	866	3.39	0.70	65
1490s	57	306	234	540	2.31	3.86	965	4.13	0.64	67
1500s	58	294	245	539	2.20	3.38	844	3.45	0.67	70
1510s	90	256	266	522	1.96	3.41	854	3.20	0.73	72
1520s	65	321	281	602	2.14	3.46	864	3.07	0.77	72
1530s	67	303	285	588	2.07	3.56	890	3.13	0.78	70
1540s	19	375	369	744	2.02	4.24	1060	2.88	1.01	70
1550s	102	601	526	1127	2.14	5.4	1350	2.57	1.44	70
1560s	73	571	533	1104	2.07	6.36	1589	2.98	1.46	73
1570s	57	401	602	1003	1.67	6.67	1668	2.77	1.65	72
1580s	63	392	646	1038	1.61	6.77	1693	2.62	1.77	62
	1								1	

		Annu	ual paymer	nts		Cas	ual payme	nts	Other w	variables
Table A1	Number of	Estimated	Implied	Implied	Real	Day	Implied	Real	CPI	GDP
cont'd	payments	cash pay	benefits	income	income	payment	income	income	per day	per capita
1590s	65	497	872	1369	1.57	7.27	1817	2.08	2.39	62
1600s	146	538	799	1337	1.67	7.66	1916	2.4	2.19	70
1610s	135	584	960	1544	1.61	7.82	1956	2.04	2.63	69
1620s	249	575	1033	1608	1.56	8.32	2079	2.01	2.83	68
1630s	221	541	1121	1662	1.48	8.97	2242	2.00	3.07	63
1640s	112	624	1278	1901	1.49	9.4	2350	1.84	3.50	62
1650s	155	851	1161	2012	1.73	9.86	2466	2.12	3.18	70
1660s	105	836	1164	2000	1.72	10.55	2638	2.27	3.19	76
1670s	178	1139	1197	2336	1.95	9.84	2459	2.05	3.28	82
1680s	27	948	1084	2032	1.87	9.74	2436	2.25	2.97	87
1690s	29	1127	1292	2419	1.87	9.62	2404	1.86	3.54	100
1700s	25	1527	1146	2673	2.33	9.75	2437	2.13	3.14	105
1710s	35	1619	1080	2699	2.50	10.04	2510	2.32	2.96	105
1720s	320	1670	1132	2801	2.48	9.94	2486	2.20	3.10	105
1730s	301	1732	1106	2838	2.57	10.66	2665	2.41	3.03	109
1740s	214	1713	1080	2793	2.59	10.61	2652	2.45	2.96	109
1750s	60	2079	1150	3229	2.81	10.96	2741	2.38	3.15	114
1760s	141	2226	1303	3529	2.71	11.55	2888	2.22	3.57	121
1770s	139	2748	1427	4175	2.93	12.36	3090	2.16	3.91	122
1780s	109	3148	1402	4550	3.25	13.29	3323	2.37	3.84	123
1790s	92	3502	1737	5239	3.02	15.58	3896	2.24	4.76	131
1800s	31	4956	2237	7193	3.21	20.02	5005	2.24	6.13	138
1810s	72	5260	2467	7727	3.13	22.77	5694	2.31	6.76	135
1820s	73	5145	1905	7050	3.70	20.12	5031	2.64	5.22	142
1830s	42	5411	1818	7229	3.98	20.43	5108	2.81	4.98	155
1840s	21	6322	1902	8224	4.32	20.65	5161	2.71	5.21	172

Note: Implied annual incomes are estimated using the regression coefficients reported in Table A2. Implied benefits are computed as 365 days multiplied by the daily costs of consumption. Implied nominal income in annual work is the sum of cash payments and the implied benefits. Implied nominal income in day work is 250 days multiplied by the daily cash payment. Real annual income computed as the nominal annual income divided by 365 days multiplied by the daily costs of consumption. *Sources*: Annual wages: see the text. Day wages: Clark (2007). Daily costs of consumption (CPI per day): Allen(2007)/Allen (*Link*). GDP per capita index (1700=100): Broadberry et al (2015).

	Nominal annual payment	Nominal annual payment	Nominal annual payment	Nominal annual payment
Variables	1260-1349	1350-1599	1600-1699	1700-1850
Helper	-0.0563***	0.0230**	0.0882***	0.0990***
Servant	(0.00443) 0.0371 (0.0935)	(0.0113) 0.0173 (0.0163)	(0.0320) 0.00536 (0.0330)	(0.0169) -0.000166 (0.0236)
Occ. unknown	-0.0781***	0.106***	0.0876***	0.107***
Labourer (ref)	-	-	-	-
South	0.0167**	0.0538***	0.0835***	-0.0814***
Centre	0.0127*** (0.00291)	-0.00614 (0.0117)	0.0940*** (0.0171)	0.0454** (0.0180)
North (ref)	-	-	-	-
1260s	-0.0986***			
1270s	-0.0281***			
1280s	(0.00846) -0.0628*** (0.00885)			
1290s	0.0268***			
1300s	0.0750*** (0.00815)			
1310s	0.223***			
1320s	0.177*** (0.00921)			
1330s	-0.00603			
1340s (ref)	-			
1350s		-1.406*** (0.0194)		
1360s		-1.316*** (0.0224)		
1370s		-1.334*** (0.0220)		
1380s		-1.288***		
1390s		-1.211*** (0.0257)		
1400s		-1.075***		
1410s		(0.0211) -1.041*** (0.0312)		
1420s		-0.974***		
1430s		-0.966***		
1440s		-1.034***		
1450s		-0.955*** (0.0228)		

Table A2Estimated coefficients of the OLS regression

Table A2 cont'd	Nominal annual payment	Nominal annual payment	Nominal annual payment	Nominal annual payment
	1260-1349	1350-1599	1600-1699	1700-1850
1470s 1480s 1490s		-0.989^{***} (0.0260) -0.925^{***} (0.0259) -0.931^{***} (0.0374)		
1500s		-0.933***		
1510s		(0.0314) -0.965*** (0.0264)		
1520s		-0.822***		
1530s		-0.845***		
1540s		(0.0248) -0.610*** (0.0443)		
1550s		-0.196***		
1560s		(0.0245) -0.216*** (0.0267)		
1570s		-0.312***		
1580s		-0.277*** (0.0275)		
1590s (ref)		-		
1600s			-0.593***	
1610s			-0.449*** (0.0367)	
1620s			-0.408*** (0.0341)	
1630s			-0.375*** (0.0363)	
1640s			-0.241*** (0.0367)	
1650s			-0.184*** (0.0366)	
1660s			-0.190*** (0.0376)	
1670s			-0.0348	
1680s			-0.174*** (0.0388)	
1690s (ref)			-	
1700s				-1.124*** (0.0565)
1710s				-1.115***
1720s				-1.077***
1730s				(0.0387) -1.063*** (0.0385)
1740s				-1.080***
1750s				-0.935***
1760s				(0.0438) -0.846*** (0.0423)

Table A2 cont'd	Nominal annual payment 1260-1349	Nominal annual payment	Nominal annual payment	Nominal annual payment
	1200-1349	1330-1399	1000-1099	1700-1030
1770s				-0.678***
				(0.0412)
1790s				-0.451***
				(0.0431)
1800s				-0.134***
				(0.0430)
1810s				-0.0622
1020-				(0.0452)
18205				-0.154^{***}
19206				0.120***
10303				(0.129)
1840s (ref)				-
Constant	F F (0***	7 0 2 0 * * *	7 (0/***	0.044***
Constant	5.560***	7.029***	7.696***	8.844***
	(0.00988)	(0.0195)	(0.0562)	(0.0458)
Observations	1.927	1.873	1.357	1.675
R-squared	0.714	0.882	0.560	0.745
1				

Note: Nominal annual payment is the sum of cash payments and the implied benefits. Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). *Sources*: annual wages, see the text.

Table A3The real income of unskilled annual male workers, 1260-1850

10/1	4.00	1000	4.04	400	4.00	40.00	4.9.4	4.40	
1265	1.22	1300	1.31	1335	1.08	1370	1.24	1405	2.30
1266	1.22	1301	1.34	1336	1.14	1371	1.43	1406	2.14
1267	1.25	1302	1.31	1337	1.28	1372	1.41	1407	2.07
1268	1.09	1303	1.37	1338	1.43	1373	1.50	1408	1.79
1269	1.14	1304	1.27	1339	1.19	1374	1.39	1409	1.74
1270	1.14	1305	1.27	1340	1.38	1375	1.41	1410	2.14
1271	1.12	1306	1.34	1341	1.38	1376	1.57	1411	2.22
1272	1.18	1307	1.27	1342	1.41	1377	1.71	1412	2.04
1273	1.18	1308	1.10	1343	1.24	1378	1.71	1413	2.04
1274	1.10	1309	0.99	1344	1.35	1379	1.52	1414	2.04
1275	1.26	1310	1.24	1345	1.32	1380	1.57	1415	1.91
1276	1.16	1311	1.46	1346	1.09	1381	1.59	1416	1.80
1277	1.18	1312	1.39	1347	1.13	1382	1.62	1417	2.04
1278	1.26	1313	1.34	1348	1.27	1383	1.62	1418	1.97
1279	1.18	1314	1.16	1349	1.17	1384	1.59	1419	2.14
1280	1.17	1315	0.82	1350	1.37	1385	1.62	1420	2.21
1281	1.10	1316	0.82	1351	1.17	1386	1.76	1421	2.25
1282	1.08	1317	1.11	1352	1.29	1387	1.83	1422	2.29
1283	1.06	1318	1.34	1353	1.57	1388	1.86	1423	2.33
1284	1.19	1319	1.39	1354	1.49	1389	1.64	1424	2.14
1285	1.21	1320	1.20	1355	1.46	1390	1.57	1425	2.33
1286	1.21	1321	0.96	1356	1.37	1391	1.77	1426	2.41
1287	1.45	1322	1.02	1357	1.39	1392	1.97	1427	2.37
1288	1.38	1323	1.15	1358	1.49	1393	1.87	1428	1.82
1289	1.29	1324	1.16	1359	1.37	1394	2.01	1429	1.85
1290	1.16	1325	1.30	1360	1.47	1395	1.87	1430	2.06
1291	1.25	1326	1.48	1361	1.43	1396	1.72	1431	2.16
1292	1.27	1327	1.51	1362	1.37	1397	1.77	1432	1.94
1293	1.10	1328	1.26	1363	1.37	1398	1.77	1433	2.06
1294	1.03	1329	1.24	1364	1.41	1399	1.84	1434	2.12
1295	1.18	1330	0.92	1365	1.57	1400	1.87	1435	2.16
1296	1.35	1331	0.98	1366	1.45	1401	1.90	1436	2.12
1297	1.25	1332	1.19	1367	1.35	1402	1.97	1437	1.81
1298	1.27	1333	1.19	1368	1.41	1403	2.18	1438	1.49
1299	1.20	1334	1.19	1369	1.13	1404	2.18	1439	1.86

Table 42									
Table A3									
cont a									
1440	2.12	1475	2.18	1510	2.35	1545	1.92	1580	1.77
1441	2.08	1476	2.21	1511	2.13	1546	2.16	1581	1 79
1442	2.05	1477	2.04	1512	1.87	1547	2 34	1582	1 79
1443	2.08	1478	1.98	1513	2.06	1548	2.07	1583	1.82
1444	2.19	1479	2.08	1514	2.10	1549	1.60	1584	1.81
1445	1.87	1480	2.15	1515	2.00	1550	2.28	1585	1.43
1446	2.02	1481	1.91	1516	2.03	1551	2.54	1586	1.18
1447	2.02	1482	1.77	1517	1.97	1552	2.56	1587	1.77
1448	2.02	1483	2.05	1518	2.00	1553	2.54	1588	1.82
1449	2.08	1484	2.29	1519	1.84	1554	2.24	1589	1.57
1450	2.05	1485	2.36	1520	2.04	1555	1.76	1590	1.92
1451	2.12	1486	2.25	1521	2.21	1556	1.84	1591	2.28
1452	2.22	1487	2.25	1522	2.38	1557	2.51	1592	2.19
1453	2.22	1488	2.25	1523	2.45	1558	2.51	1593	2.11
1454	2.37	1489	2.21	1524	2.38	1559	2.19	1594	1.49
1455	2.25	1490	2.24	1525	2.38	1560	1.93	1595	1.45
1456	2.25	1491	2.20	1526	2.21	1561	2.07	1596	1.19
1457	2.18	1492	2.43	1527	1.73	1562	1.57	1597	1.31
1458	2.22	1493	2.47	1528	2.07	1563	2.09	1598	1.67
1459	2.25	1494	2.39	1529	2.09	1564	2.10	1599	1.58
1460	2.07	1495	2.39	1530	2.07	1565	1.91	1600	1.52
1461	2.04	1496	2.27	1531	1.97	1566	2.12	1601	1.67
1462	2.44	1497	2.35	1532	2.07	1567	2.13	1602	1.84
1463	2.44	1498	2.24	1533	2.10	1568	1.97	1603	1.79
1464	2.31	1499	2.35	1534	2.22	1569	2.15	1604	1.65
1465	2.24	1500	2.13	1535	1.87	1570	1.94	1605	1.70
1466	2.20	1501	1.95	1536	1.85	1571	1.83	1606	1.65
1467	2.20	1502	1.98	1537	2.16	1572	1.72	1607	1.37
1468	2.20	1503	2.13	1538	2.07	1573	1.33	1608	1.34
1469	2.14	1504	2.23	1539	2.19	1574	1.69	1609	1.54
1470	2.04	1505	2.31	1540	2.81	1575	1.76	1610	1.75
1471	2.04	1506	2.27	1541	2.37	1576	1.56	1611	1.51
1472	2.29	1507	2.27	1542	2.37	1577	1.65	1612	1.53
1473	2.29	1508	2.31	1543	2.28	1578	1.79	1613	1.49
1474	2.21	1509	2.47	1544	2.26	1579	1.79	1614	1.57

Table A3									
cont'd									
					Γ	I			
1615	1.50	1650	1.49	1685	1.92	1720	2.57	1755	2.82
1616	1.53	1651	1.66	1686	1.86	1721	2.65	1756	2.34
1617	1.50	1652	1.91	1687	1.96	1722	2.60	1757	2.52
1618	1.72	1653	2.09	1688	2.00	1723	2.57	1758	2.71
1619	1.79	1654	2.13	1689	1.84	1724	2.45	1759	2.86
1620	1.84	1655	1.84	1690	2.29	1725	2.33	1760	3.13
1621	1.58	1656	1.76	1691	2.05	1726	2.49	1761	3.32
1622	1.47	1657	1.52	1692	1.82	1727	2.24	1762	3.15
1623	1.53	1658	1.51	1693	1.70	1728	2.28	1763	3.09
1624	1.47	1659	1.54	1694	2.09	1729	2.59	1764	2.90
1625	1.52	1660	1.54	1695	1.86	1730	2.71	1765	2.66
1626	1.76	1661	1.31	1696	1.86	1731	2.85	1766	2.72
1627	1.91	1662	1.70	1697	1.74	1732	2.83	1767	2.46
1628	1.69	1663	1.72	1698	1.84	1733	2.68	1768	2.53
1629	1.42	1664	1.76	1699	2.08	1734	2.60	1769	2.79
1630	1.32	1665	1.86	1700	2.47	1735	2.58	1770	3.24
1631	1.51	1666	2.02	1701	2.52	1736	2.55	1771	3.03
1632	1.46	1667	1.95	1702	2.56	1737	2.66	1772	2.77
1633	1.49	1668	1.76	1703	2.32	1738	2.59	1773	2.77
1634	1.49	1669	1.83	1704	2.54	1739	2.31	1774	2.83
1635	1.46	1670	2.11	1705	2.63	1740	2.19	1775	2.84
1636	1.49	1671	2.11	1706	2.66	1741	2.50	1776	3.05
1637	1.32	1672	2.07	1707	2.55	1742	2.67	1777	2.84
1638	1.58	1673	1.77	1708	2.09	1743	2.72	1778	2.93
1639	1.71	1674	1.80	1709	1.85	1744	2.71	1779	3.11
1640	1.69	1675	2.12	1710	2.16	1745	2.50	1780	3.44
1641	1.80	1676	2.15	1711	2.26	1746	2.50	1781	3.17
1642	1.80	1677	1.87	1712	2.36	1747	2.52	1782	3.19
1643	1.84	1678	1.79	1713	2.25	1748	2.50	1783	3.22
1644	1.86	1679	2.02	1714	2.48	1749	2.51	1784	3.30
1645	1.72	1680	1.72	1715	2.35	1750	2.98	1785	3.40
1646	1.55	1681	1.81	1716	2.37	1751	2.84	1786	3.47
1647	1.26	1682	1.78	1717	2.52	1752	2.80	1787	3.39
1648	1.27	1683	1.81	1718	2.65	1753	2.85	1788	3.28
1649	1.22	1684	1.65	1719	2.51	1754	2.99	1789	3.23

Table A3									
cont'd									
contra									
1790	3.56	1803	3.74	1816	3.31	1829	3.62	1842	4.34
1791	3.66	1804	3.50	1817	3.15	1830	3.83	1843	4.76
1792	3.72	1805	3.04	1818	3.37	1831	3.79	1844	4.59
1793	3.51	1806	3.24	1819	3.52	1832	3.95	1845	4.65
1794	3.38	1807	3.39	1820	3.36	1833	4.09	1846	4.10
1795	2.90	1808	3.20	1821	3.60	1834	4.18	1847	3.67
1796	2.76	1809	2.84	1822	3.88	1835	4.42	1848	4.37
1797	3.11	1810	2.96	1823	3.81	1836	4.11	1849	4.55
1798	3.09	1811	2.93	1824	3.64	1837	3.88	1850	4.55
1799	2.72	1812	2.62	1825	3.46	1838	3.79		
1800	2.84	1813	2.67	1826	3.71	1839	3.53		
1801	2.73	1814	3.09	1827	3.78	1840	4.06]	
1802	3.62	1815	3.73	1828	3.79	1841	4.17		

Note: Real annual income is computed as the annual income by decade (see Table A1) divided 365 multiplied by the daily costs of consumption. *Sources*: Annual wages: see the text. Daily costs of consumption: Allen (2007)/Allen (*Link*).

Table A4

Years decades	Cash equivalent	CPI per day	Real income	Source used
1260-70 1280-90 1290-1300 1300-10 1330-40 1340-50 1350-60 1360-70 1390-1400 1400-10 1410-20 1420-30 1430-40 1440-50	242 249 288 260 269 281 396 384 452 384 452 384 481 434 401 516	0.53 0.54 0.54 0.61 0.55 0.58 0.66 0.71 0.64 0.62 0.67 0.66 0.70 0.66	1.25 1.26 1.46 1.17 1.34 1.33 1.64 1.48 1.94 1.70 1.97 1.80 1.57 2.14	Rogers (1866) Wells-Furby (2012) Raban (2011) Britnell (2014); Raban (2011) Wells-Furby (2012) Salzman (1955); Wells-Furby (2012) Salzman (1955) Booth (2003) Lui (2002) Lui (2002) Lui (2002) Lui (2002) Lui (2002) Lui (2002) Lui (2002)
1450-60	551	0.65	2.32	Lui (2002)
1530-40 1550-60 1560-70 1660-70 1690-1700 1700-10 1790-1800	640 640 2280 2702 2696 5340	0.78 1.44 1.46 3.19 3.54 3.14 4.76	2.25 1.22 1.20 1.96 2.09 2.35 3.07	Bailey (2007) Adams (1995) Adams (1995) Bettey (2005) Bettey (2005) Bettey (2005) Orde (2006)

The real income of unskilled annual male workers from board and grain wages, 1260-1850

Note: Annual real income is the annual cash payment divided by 365 times the daily costs of consumption. *Sources*: Annual wages: as listed. Daily consumption costs: Allen (Link).

Figure A1

Raw data averages and estimates based on regression coefficients, by decade, 1260-1850



Note: Annual real income is constructed by dividing annual nominal income by 365 days multiplied by daily costs of consumption (see Table A1). Annual nominal income is the sum of cash payments and monetised in-kind benefits. Annual nominal income estimates are predicted based on the regression coefficient reported in Table A2. *Sources*: Annual wages: see the text. Daily cost of consumption: Allen (Link).

Share of cash in total payment Share of payments received in cash

Figure A2 The share of cash in annual workers' total remuneration, 1260-1850

Sources: Annual wages: see the text. Daily consumption costs: Allen (Link).

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