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Why was the First Industrial Revolution English?

Roman Real Wages and the *Little Divergence* within Europe Reconsidered[1]

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Abstract

We compare early-modern Roman construction wages to Judy Stephenson's downward-adjusted construction wages for London. We find that Roman workers earned at least as much as their London counterparts in the run-up to the Industrial Revolution, challenging the *high-wage-economy* explanation for why the Industrial Revolution was English and not Italian. We argue, however, that daily construction wages present a poor testing ground for the *high-wage* hypothesis, proposing instead that wages are compared among permanent employees in sectors less prone to seasonality and economic fluctuations than construction work.

JEL: J3, J4, J8, I3, N33

Keywords: Construction Work, Convergence, Divergence, Industrial Revolution; Living Standards; Prices, Wages.

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1. Introduction

This study presents the first long-run wage series of unskilled workers in the former capital of the Roman Empire. Our wages concern construction workers hired by the Papal State to build and maintain St Peter's Basilica in Rome. We compare their wages to Judy Stephenson's downward-adjusted unskilled construction wages from St Paul's Cathedral in London. Our wage series begins in 1541, shortly after the Sack of Rome, a devastating military episode that caused Rome's population to drop by three quarters. Labour shortages allegedly pushed up Roman wages, making Rome a plausible candidate to match the high-wage economies of North-West Europe in the run-up to the first Industrial Revolution.

Our study contributes to the ongoing debates about the root causes of the Industrial Revolution. The Roman wages escape the complications inherent to earlier wage series, which are based on imprecise secondary sources and suffer from regional shifts. Imprecise secondary sources sometimes lead to confusion about how much historical workers were effectively paid. For example, wages reported in account books from early-modern London building sites habitually included a profit-margin for subcontractors, obscuring how much construction workers actually earned (Stephenson 2018a). Moreover, earlier wage series for Northern Italy include a shift in the location where the wages were recorded (Malanima 2013). In light of the large regional wage gaps observed in post-unification Italy (Federico et al 2019), it is not unlikely that previous long-run wage series for Northern Italy therefore suffer from compositional effects. Our Roman wages are drawn from the account books of the *Fabbrica of Saint Peter*, a primary source covering the same city across several centuries leading up to the classical years of the Industrial Revolution. The *Fabbrica* hired and paid its labourers directly, with no profit-margins needing to be adjusted for. Our new wage series thus improves the quality of historical construction wages used for international comparison.

Our wage comparison below between London and Rome speaks directly to the question of why the first Industrial Revolution occurred in England and not in Italy. The leading theory holds that expensive labour and cheap energy induced English producers to substitute workers for machines (Allen 2009). Earlier work has argued that Italian workers were relatively inexpensive, which meant the incentive to introduce labour-saving technology in Italy was lacking at the time (Allen 2001). Our real-wage comparison between Rome and London shows, however, that Roman construction workers in the run-up to the Industrial Revolution were paid at least as much as their London counterparts after sub-contractors' profit-margins in London are accounted for (Stephenson 2018a). Our finding thus contests the so-called *little divergence* hypothesis, which holds that early 18th-century labour was more expensive in North-West Europe than elsewhere. In turn, this conclusion challenges the *high-wage-economy* explanation for why England industrialised before Italy.

We do not, however, use our findings as a case against the *high-wage* model. Instead, we argue that construction workers' wages do not provide a suitable testing ground for the *high-wage* hypothesis. The construction sector everywhere was comparatively small, highly sensitive to economic fluctuations, and often characterised by seasonality. The demand for construction workers therefore varied greatly, from year to year and even from day to day. Lacking statistics concerning the length of the historical working year, earlier studies simply assumed that construction workers everywhere could always find 250 days of work (e.g. Allen 2001). But recent research has questioned this assumption, showing that construction workers in 18th-century London rarely secured more than 100 days per year (Stephenson 2018b) and even fewer days in early modern Malmö in Sweden (Gary 2018). In France, construction workers had to seek employment on several building sites each year and, for less specialised labour, even in agriculture in order to find some 250 days of work (Ridolfi 2016). It is no surprise, then, that early-modern construction workers were often observed as part of a traveling team that left town after the building project ended (Lucassen 1987).

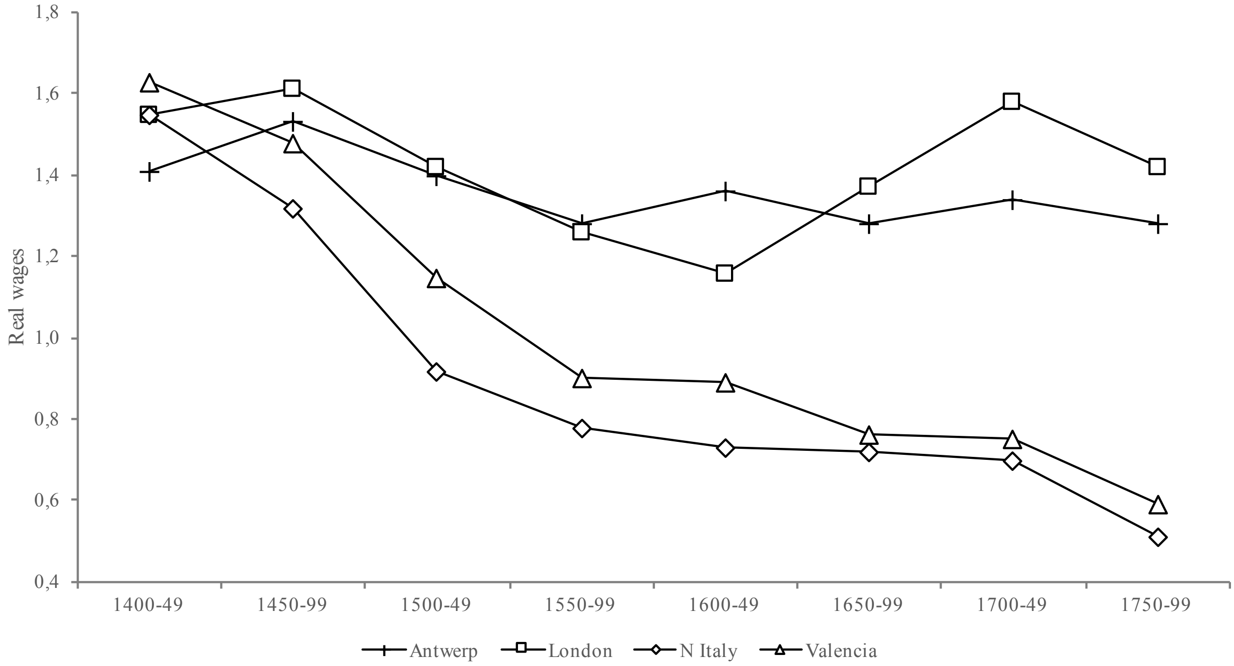
Less mobile construction workers might have struggled to find enough local work. This presents a problem if construction work paid a premium for seasonal unemployment. Inspired by evidence presented in Swenson (1991), we hypothesise that the risk of seasonal unemployment helped construction workers negotiate a wage premium that workers employed in more stable sectors of the economy could not command. The size of this premium arguably varied inversely with construction workers' low-season options, which again varied from city to city. Combined, these issues raise doubts as to whether construction workers provide a good representation of an average worker at the time, both in terms of payments and patterns of work. We advocate, therefore, that the *high-wage* hypothesis should be applied to sectors unexposed to seasonality and tested using annual pay rates rather than daily wages (Humphries and Weisdorf 2018).

We proceed as follows. Section 2 summarises the key arguments of the ongoing debate. Section 3 describes the nominal wages and prices underlying the Roman real wages. Section 4 details the comparison between the Roman and London price of labour. Section 5 addresses the central problems associated with using construction workers' wages to examine the *high-wage* hypothesis, and Section 6 concludes.

2. Background

Robert Allen's seminal comparison of construction wages across historical Europe showed that workers in late 17th- and early 18th-century London were paid considerably better, in real terms, than workers living elsewhere in Europe. Allen's data indicated that some of Europe's richest cities, e.g. Florence, Madrid, Milan, Valencia, etc., were on par with London by the mid-15th century. However, whereas these European cities gradually witnessed falling wages in the centuries leading up to the Industrial Revolution, the wages in London remained high. These contrasting wage developments – now known as the *little divergence* with Europe – are illustrated in Figure 1. Allen deftly used this pattern of the divergence to explain England's position as a frontrunner in the Industrial Revolution, arguing that the high cost of English labour made it profitable for English producers to replace workers with machines (Allen 2001, 2009). Allen's *high-wage* explanation is commonly seen as the leading hypothesis for why the first Industrial Revolution was in England.

Figure 1: Allen's cross-European real wages comparison, 1400-1800



Source: Allen (2001).

Follow-up work has pointed to a number of issues with Allen's original study. One complication concerned the consumption basket used by Allen to transform nominal wages into real wages. Jane Humphries argued that the caloric needs of women and children were not properly accounted for and suggested that the budget underlying Allen's cost-of-living deflator should contain more calories (Humphries 2013). Allen responded to Humphries' critique by adjusting the caloric consumption from 1,940 calories for an adult male (and less for women and children) to 2,100 calories per family adult (Allen 2015). This adjustment did not affect Allen's original conclusion.

Other complications concerned the nominal wages used in Allen's seminal article. Subsequent studies argued that these were either too pessimistic, as in the cases of France, Italy, and Spain, or too optimistic, as in the case of London. For example, Vincent Geloso's re-examination of Allen's wage rates for Strasbourg showed that the French payments in kind were not fully accounted for. After adjusting for these, Geloso established that France was still poor, but not as poor as in Allen's original study (Geloso 2018). Similarly, after re-examining Allen's wage rates for Northern Italy, Paolo Malanima proposed that England diverged from Italy some two centuries later than Allen's study showed, i.e. after c. 1700 (Malanima 2013). A crucial part of Malanima's conclusion came from substituting Allen's London wages for Allen's wages for Southern England. Since the latter did not include an urban wage premium, Malanima was able to narrow the English-Italian wage gap considerably. Furthermore, after revisiting the historical wages and prices for Spain, Mario García-Zúñiga and Ernesto López-Losa found that England diverged from Spain later than Allen's original study had shown, part of which came from the substitution of oats for bread in the consumption basket (García-Zúñiga and López-Losa 2018a). Likewise, a re-examination of wages and prices in Poland (Malinowski 2016) and Germany (Phister 2016) led to adjustments of the positions of the relevant cities vis-à-vis the rest of Europe.

As with Humphries' critique, the amendments proposed in the follow-up studies mentioned above ultimately did not challenge Allen's *little divergence* conclusion. But their studies emphasised a number of drawbacks connected to the wages used to substantiate Allen's work. Allen's study covered vast amounts of time and space, and hence was chiefly built upon prices and wages reported in secondary sources. A main problem with secondary sources is that they do not allow a proper examination of the underlying data. For example, Allen, for his London wage series, had relied on studies assuming that the major building institutions in London had paid their workers directly (e.g. Boulton 1996; Gilboy 1934; Schwarz 1986). Judy Stephenson's examination of the primary sources behind Allen's original study showed, however, that this was not the case after all (Stephenson 2018a). Instead, beginning in the 17th century or possibly even earlier, London construction workers were commonly appointed by sub-contractors. These contractors retained a mark-up for their services, paying workers only a portion of the salaries reported in the building institutions' account books. Once the profit-margins were deducted, it turned out that the sampled construction workers' actual earnings were significantly lower than suggested by the secondary sources underlying Allen's London wage series.

A further issue, pointed out both by Stephenson for England and García-Zúñiga and López-Losa for Spain, concerns the fact that unskilled workers usually received a premium for seniority, possibly linked to aptitude achieved via learning-by-doing (Stephenson 2016a; Garcia-Zuniga and Lopez Losa 2018b). Because secondary sources are prone to simply report the average or median payment among *all* unskilled workers employed, they neglect the fact that wages might vary over time depending on the composition of more and less senior, and hence apt, workers. After inspecting the underlying primary sources of the English data mentioned above, Stephenson concluded that the London wages of *strictly* unskilled workers during the long 17th century were effectively 20-30 per cent lower than the London wages used in Allen's original study (Stephenson 2016a, 2018a).

These complications warrant a reconsideration of Allen's *little divergence* hypothesis. In particular, Stephenson's downward-adjusted London wages combined with the Sack of Rome that reputedly elevated the Roman wages (e.g. Ait and Pineiro 2005) makes the former capital of the Roman Empire a potential candidate to challenge London's position as the most labour-expensive European city at the onset of the Industrial Revolution. Clear of any profit-margins; stripped of any regional shifts; and with the possibility to account for payments made to *semi-skilled* unskilled workers, our novel Roman salaries provide a more clear-cut historical wage series for construction workers in Italy compared to previous estimates.

3. Data

This section describes the Roman wages underlying our comparison with Stephenson's revised wages for London. We compute the Roman real wages in the traditional way, i.e. by dividing workers' nominal wages by a standardised cost-of-living index based on Roman commodity prices. In the following, we first present our nominal wages: where they come from; how we treat them; and how their levels compare with existing nominal wages for England and Northern Italy. Next, we present the prices used to calculate our Roman cost-of-living index: the sources used; the region-specific consumption baskets; and ultimately how the Roman cost-of-living index compares with those of England and Northern Italy. The resulting real wages are presented and discussed in Section 4 below.

Nominal Wages

Our nominal wages come from the archive of the *Fabbrica of Saint Peter*. The *Fabbrica* was an autonomous building institution initiated in 1506 by Pope Julius II with the aim of constructing a new cathedral in the capital city of the Papal State. The previous cathedral, today known as the *old* St Peter's Church and built in the 4th century, had long been neglected and by the 15th century had fallen into disrepair. The new St Peter's Basilica, designed by famous Italian artists including Michelangelo, is one of the world's largest churches and one of the finest works of Renaissance architecture. Suitably, Stephenson's English wages come from a comparable building site, St Paul's Cathedral in London, the construction of which began shortly after the Great Fire of London in the late 17th century. Architecturally, St Paul's Cathedral was greatly inspired by its Roman equivalent (Summerson 1983), emphasising the direct comparability of the wages used in our comparison between London and Rome below.

The *Fabbrica of St Peter* was responsible for organising and supervising the construction of the new Roman cathedral, as well as its subsequent maintenance. The wages used below come from the registers of the *Soprastante*, the managing unit of the *Fabbrica*'s employees. The records begin in 1541 and contain the daily wage rates of the workers employed, their occupational titles, the numbers of days worked per week, and occasionally the worker's names. Although the registers continue beyond 1810, after this point they do not allow us to separate skilled from unskilled workers. Hence, our wage series ends in 1810, though still leaving us sufficient time coverage to address the question of why the Industrial Revolution first emerged in England.

Not all wages found in the *Fabbrica's* registers before 1810 were used in our analysis below. First, the Roman harvest season – notably the months of June and July – largely emptied the building site and moreover inflated the wage rates of the remaining employees. Indeed, the lack of daylight and absence of competition from agriculture meant that winter wages were some 40 per cent lower than the wagas paid during the summer period (Ait and Pineiro 2005). Similar to the English wage series, which is adjusted for seasonality, our sampled wages were drawn from the months covering October to March.

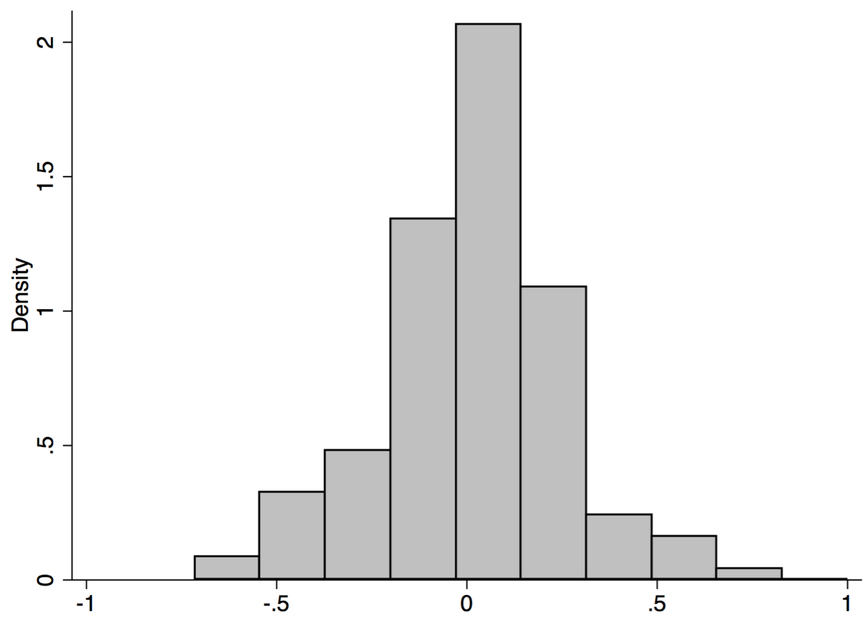
Furthermore, Stephenson's downward-adjusted wages for London concern unskilled construction work. In order to make our wage series comparable to hers, payments made to skilled workers had to be excluded. We did this in two steps. First, the registers' occupational titles helped us to sort workers by skill. The most common occupations and those most relevant for our wage series below concern *manovali* and *lavoratori* (labourers), *scopatori* (sweepers), *pulitori* (cleaners), and *portiere* (doormen). Less frequent professions, i.e. *guardiania* (guards), *brunitore* (burnisher), and a long list of generic occupational titles, were also included. Making up 79 per cent of the *Fabbrica*'s employees between 1541 and 1810, these occupational titles are traditionally considered to be unskilled work (but see the discussion about *strictly* unskilled work further below).

Other professions listed in the registers include *falegnami* (carpenters), *maestri* (masons), *scalpellini* (highly-skilled stonecutters), *stuccatore* (plasterers and decorators), and *mosaicisti* (mosaic makers). Wages linked to these occupations were all excluded on the ground that those professions required specialist training leading to a skill premium. For example, Francesco Borromini, hired as a *scalpellino* in 1619, received a wage rate almost threefold that of an ordinary unskilled labourer, and hence was dropped from the sample. We also dropped payments made to *aspiranti* (boys and very young men in training), *condannati* (criminals helping on the site), and *penitenti* (men in community service due to marital exemption). These workers were excluded on the presumption that they were employed under conditions that were out of tune with the regular labour market for construction workers. Indeed, their payments were usually some 50 per cent lower than the average day rate of a typical unskilled worker.

These truncations left us with altogether 364,884 low-season, day-wage observations spread across 269 years. Of course, as is common in long-run wage series, this number includes repeated entries for the same workers. Because not all workers are recorded by name, and since those that were frequently shared the same name, we are unable to observe to what extent repeated entry happened. Nonetheless, our more than one thousand daily wage observations per year on average makes our wage series one of the most comprehensive historical wage indices to date.

There is still one more step to take, however, before the wage series is complete. As emphasised in Stephenson (2018a), not all unskilled workers earned the same daily wage rate. Figure 2 shows the distribution of our sampled unskilled wage rates, expressed in terms of deviations from the yearly (low-season) median payment. The graph shows that the best-paid workers received roughly twice as much as the typical unskilled day rate. Conversely, the poorest-paid workers received some 70 per cent less than the norm. Despite these variations, about 90 per cent of the observed wages fell within a 40 per cent deviation of the median wage.

Figure 2: Deviations of unskilled labour wages from the yearly (low-season) median wage rate



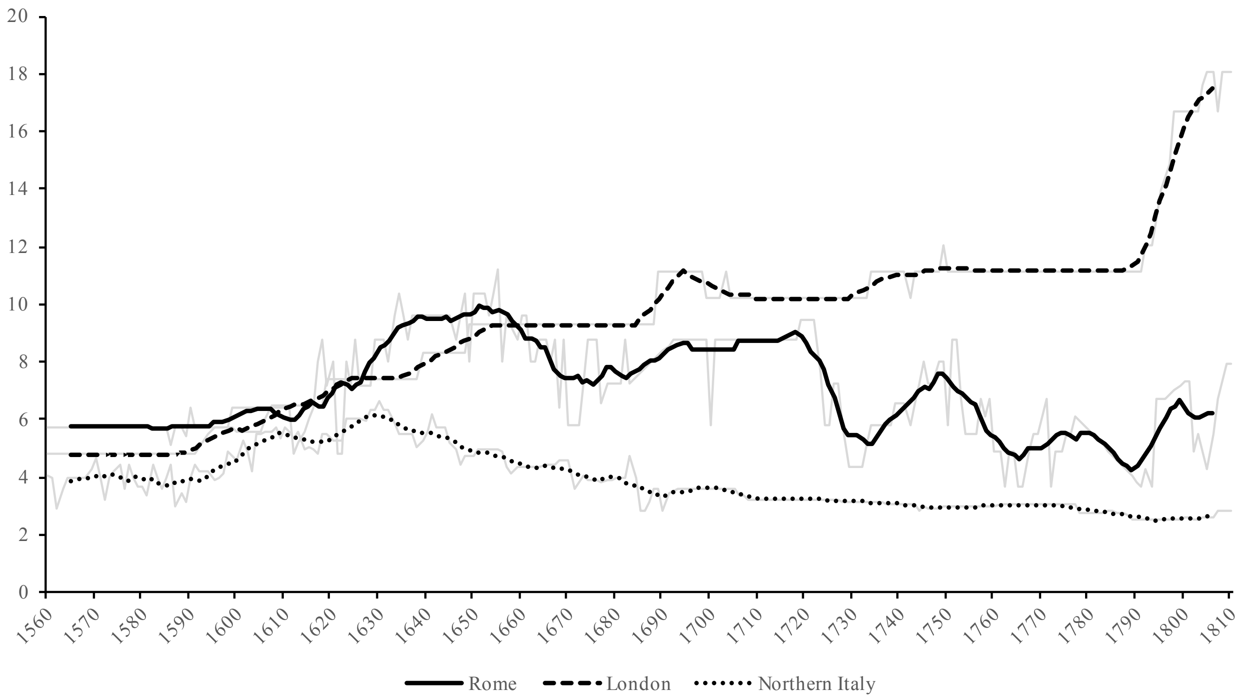
Sources: The archive of the *Fabbrica of St Peter* (see Appendix 1).

Variation in workers' day rates have implications for how we identify and exclude what Stephenson refers to as *semi-skilled* unskilled workers (Stephenson 2018a). Renata Sabene, who studied how work was organised in the *Fabbrica* during the 18th century, was occasionally able to trace workers across time by using their names. This exercise informs that the wage profiles were usually upward sloping over time (Sabene 2012, p. 161). For example, Papi Giuseppe, a *manuale*, received 20 *baiocchi* per day in 1738, which was less than the median wage rate that year, i.e. 27.5 *baiocchi*. In 1766, 28 years later, he received 35 *baiocchi* per day, which was now more than the median wage rate of 25 *baiocchi*. Similar patterns have been observed among historical construction workers in Madrid (Garcia-Zuniga and Lopez Losa 2018b). Indeed, this phenomenon was probably common across Europe. We suspect seniority and aptitude could both have accounted for such wage promotions, even if the contribution of each component cannot be isolated, since wage promotions were not justified in the *Fabbrica's* registers. Irrespective of the underlying reasons, we must therefore proceed with care when estimating the typical wage rate of a *strictly* unskilled worker.

Our second step aimed to make our wage series comparable to Stephenson's thus involves a focus on the lower-end tail of our sampled (truncated) wage distribution. We have experimented with different cut-off points, ranging from the lowest 50 per cent of the sampled wages to the lowest 10 per cent. We ultimately settled for a compromised cut-off point, which involves taking the median payment among the 25 per cent lowest (low-season) wages in each year. A lower cut-off point (e.g. the 10 per cent) would have left us with too few wage observations to create a stable wage series (cf. the thin lower-end tail in Figure 2). On the other hand, a higher cut-off point (e.g. the 50 per cent) would entail the risk of including labourers who earned a wage premium for aptitude. Figure A1 in Appendix 2 shows the difference between the median wage rate of *all* our sampled unskilled workers and the median wage rate of the lowest 25 per cent of their wage distribution. Note that the qualitative nature of our conclusions below is robust to using any cut-off point above the 25 per cent lowest wages instead. Of course, this strategy does not entirely rule out the possibility of compositional effects caused by variation in the share of strictly unskilled workers to the total. But, by removing the payments of the most well-paid unskilled workers in our sample, the strategy would still eliminate a portion of any wage premiums paid for occupational dexterities.

Figures 3 displays the resulting nominal Roman wages (solid line) between 1560 and 1810, measured in grams of silver. Our transformation of the local Roman currency (*baiocchi*) into silver wages is based on the conversion rates reported in Martini (1883) and Piola Caselli (1999). We start in 1560 rather than in 1541, because our prices discussed below usually begin in 1560. Figure 3 also shows the pre-existing nominal silver wages for London (dashed line) and Northern Italy (dotted line), both of which are taken from Allen's original study (Allen 2001). We were unable to compare with Malanima's nominal wages for Northern Italy, as these are not publicly available.

Figure 3: Nominal silver wages in Rome, London, and Northern Italy, 1560-1810



Notes: Nominal wages are in grams of sliver per day. Grey lines are yearly observations and dark lines 10-year moving averages. *Sources*: London and Northern Italy: Allen (2001). Rome: the *Fabbrica of St Peter* (see Appendix 1).

Allen's London wages were mildly higher than those in Northern Italy up until the 1630s. After that, workers in Northern Italy received increasingly less per day – and the Londoners increasingly more – until 1810. The Roman wages were generally situated between the two other wage series, changing in tandem with earnings in London until the 1650s before beginning a (bumpy) descent towards the earnings in Northern Italy. Although both the Roman and the Northern Italian wages show declining trends during the long 17th century, the wages in Rome were generally higher than those of Northern Italy, especially after the 1620s. This is consistent – although for a later period – with wage differentials observed in 1870, when Central Italian workers also received more than workers in Northern Italy (Federico et al 2019, Table 4). The less volatile wage developments observed in London and Northern Italy are probably artefacts of the low numbers of wage observations and the frequent use interpolation (Allen 2001; Malanima 2013).

The Consumption Basket

We now turn to the cost-of-living index. This is used to convert the nominal wages into real ones as explained further below. With regard to the cost-of-living index, we follow the literature, notably Allen (2001) and Malanima (2013), but with certain adaptations. Allen, in his seminal article, used the cost of a so-called *respectability* consumption basket to track workers' historical living expenses (Allen 2001). The basket specifies a set of basic commodities supposed to have been consumed by an average person in the past (Allen 2009). It includes food, clothing, housing, and heating in "respectable" amounts (see Table 1). Compared to the English basket, Malanima's cost-of-living index for Northern Italian replaced butter with oil, beer with wine, and rye with maize (Malanima 2013, Table 2). Maize was relatively uncommon in Rome, however, so we have included bread instead of maize in the Roman basket. Compared to Malanima's numbers, we have also increased the consumption of wine and oil (the most expensive items in the Roman basket) in order to match the calories of the London basket.

Turning to the question of sustenance, studies of dietary intake have contended that people living in warm climates consume fewer calories than people living in cooler climates due to the negative effect of heat on appetite (e.g. Herman 1993). Gross (1990) has estimated the caloric ingestion of two representative Roman individuals during the middle of the 18th century. He estimated that a middle-class adult consumed 2,315 calories per day on average, whereas a lower-class adult consumed somewhat less, i.e. 2,124 calories per day. Allen's original cost-of-living index included 1,940 daily calories for an adult male (Allen 2001). However, inspired by Humphries' critique discussed above, we have allowed 2,500 calories per person per day in Rome, London, and Northern Italy. This is roughly identical to the caloric consumption assumed in Malanima (2013) and more than sufficient to satisfy Humphries' caloric requirements (Humphries 2013). Of course, if Gross' caloric estimates above are correct and a negative effect of heat on appetite applies, then the

Romans would have consumed fewer calories than their counterparts in Northern Italy and, even more so, London. In turn, that would make the Roman basket cheaper than we expected.

One of the significant components of the non-food budget is heat expenditure (Allen 2017). Malanima assumed twice the amount of heating per year in England as he assumed for Northern Italy (six million BTU and three million BTU, respectively). This was slightly more than Allen's original numbers (five Million BTU in London and two million BTU in Northern Italy). We use the latter for better comparability with Allen's original study, but our conclusions are robust to using Malanima's numbers instead. Note that heat energy in England is assumed to come from coal and in Italy from firewood (Table 1). As with food calories, downward-adjusting the heat expenditures in the Roman basket in order to account for Rome's milder climate compared to Northern Italy would further reduce the Roman living expenses.

Different from Allen and Malanima's baskets, and because we were unable to construct a Roman price series for linen, this item was excluded from our cost-of-living indices for Rome, London, and Northern Italy. The five meters of linen contained in Allen's basket for London make up some four per cent of the annual consumption expenditures in London during our period of interest. We know from Friz (1980) and Gross (1990) that clothing for lower-class people in Rome accounted for some two per cent of their annual budget. Moreover, it seems reasonable to assume that more linen was needed in London than in Rome due to temperature differences (Allen 2017). Hence, we do not suspect that including linen in the index will alter our conclusions below. The items contained in each of the two baskets used below – one for England and one for Italy – are reported in Table 1.

Table 1: Allen's *respectability* consumption basket for England and Italy

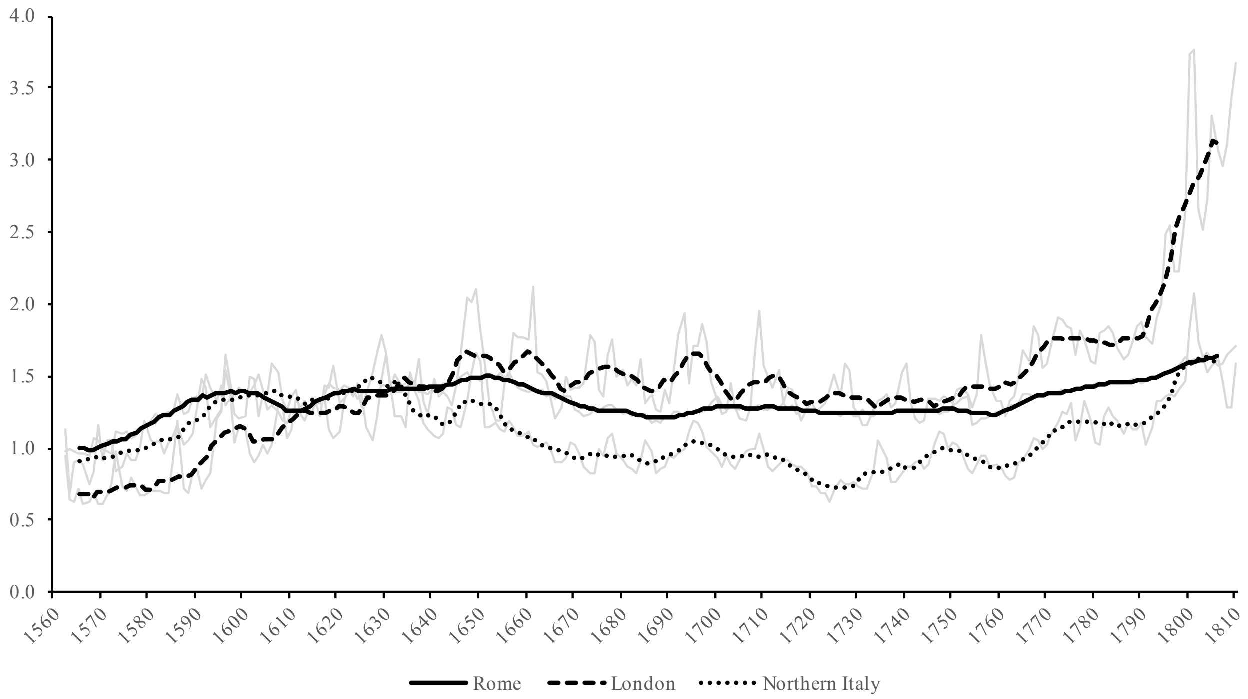
	England			Italy		
Food:	Amount	Unit	Calories/day	Amount	Unit	Calories/day
Bread	234	kg	1,571	234	kg	1,571
Meat	26	kg	178	26	kg	178
Butter	5.2	litres	104	-	-	-
Oil	-	-	-	6.2	litres	139
Beer	182	litres	212	-	-	-
Wine	-	-	-	76	litres	177
Cheese	5.2	kg	54	5,2	kg	54
Eggs	52	pieces	11	52	pieces	11
Beans	52	litres	369	52	litres	369
Total calories			2,500			2,500
Non-food:	Amount	Unit	Mill. BTU/year	Amount	Unit	Mill. BTU/year
Firewood	-	kg	-	168	kg	2
Charcoal	210	kg	5	-	kg	-

Notes: The consumptions of oil and wine in the Italian basket are adjusted so that the total daily calories in English and Italy are identical. Rent allowance is five per cent (Allen 2001). Beans in the Roman basket are replaced by bread. *Sources*: Allen (2009); Malanima (2013).

Prices and the Cost-of-Living Indices

London and Northern Italian prices were taken from Allen (2001). Similar to Allen's work, the Roman prices come from a variety of secondary sources, which are detailed in Appendix 1. The bulk of our prices were reported in the Monography on the City of Rome (1878) and in Jean Delumeau's detailed historical Roman economic indicators (Delumeau 1959). It should be noted that Allen and Malanima both predicted their prices of bread from the prices of wheat and labour using Allen's so-called "bread equation" (Allen 2001). Different to their approach, we use instead the retail market prices of bread published in Reinhardt (1990). Similar to Allen and Malanima's earlier price indices, sporadic gaps in our price series were closed using interpolation (see Appendix 1 for details).

Figure 4: Silver cost-of-living indices in Rome, London, and Northern Italy, 1560-1810



Notes: The cost-of-living indices are calculated using the baskets reported in Table 1. Grey lines are yearly observations and dark lines 10-year moving averages. *Sources*: Prices for London: Allen (2001). Prices for Northern Italy: Malanima (2013). Prices for Rome: see Appendix 1.

Figure 4 shows the cost-of-living indices between 1560 and 1810, measured in grams of silver, for Rome (solid line), London (dashed line), and Northern Italy (dotted line). The indices for Rome and Northern Italy were rather similar, both in size and trend, with Northern Italy being mildly more expensive than Rome until the 1630s, but somewhat cheaper thereafter. While the English baskets were less expensive during the early part of the period, costing some 60-70 per cent of the Italian baskets during the 1560-80s, they were nearly three times more expensive than the Italian ones after 1800. Yet, for most of the period under observation, the cost of living in all three regions was surprisingly similar, especially given how much nominal wages differed during the same period (Figure 3 above).

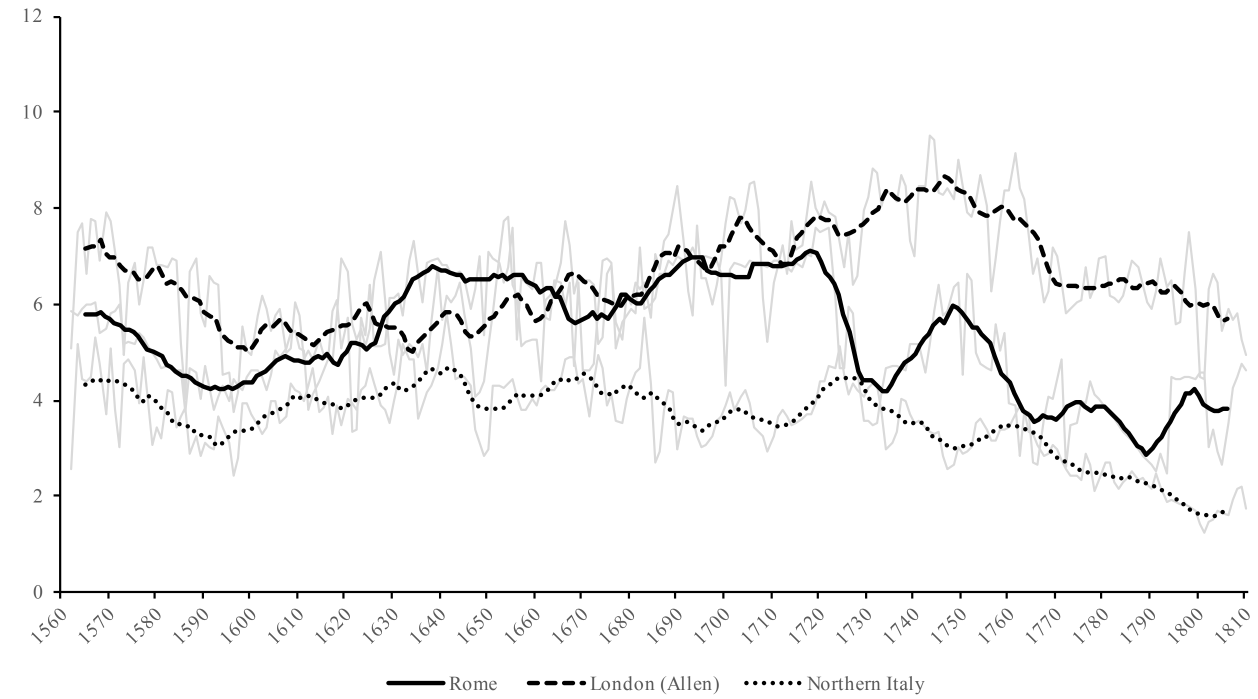
The cost-of-living index varied much less in Rome than in London and Northern Italy. Regarding the Italian indices, we suspect this was due to differences in the efficiency of the system of the *Annona*, a public-sector legacy of the Roman Empire intended to avoid political unrest by keeping food prices low and stable. It is well-known that the *Annona* effectively regulated food prices in Rome, whereas public price intervention in Milan and Florence normally only happened in cases of severe food shortage (Maffi and Mocarelli 2018; Mocarelli 2019; Strangio 1999). The London index is more volatile than both of the Italian indices, possibly reflecting the different nature of public food-price intervention in early modern England (e.g. Nielsen 1997).

4. Comparison

This section compares the real wages in Rome with those reported for London and Northern Italy. We first consider Rome against Allen's original real wages for London and Northern Italy (Allen 2001). Then, we replace Allen's London wages with the downward-adjusted London wages provided in Stephenson (2016a). The ultimate goal is to re-examine the *little divergence* hypothesis in light of Stephenson's critique and our newly-built real-wage series for Italy.

Our real wages for each of the three locations were computed by dividing the nominal daily wage rate in each year by daily cost of living. Similarly to the real wages reported in Malanima (2013), this calculation makes no assumptions about the number of days worked per year or the size of families potentially needing support. Hence, the real wages reported in the following inform how many *respectability* baskets an unskilled construction worker was able to buy on days when he was working.

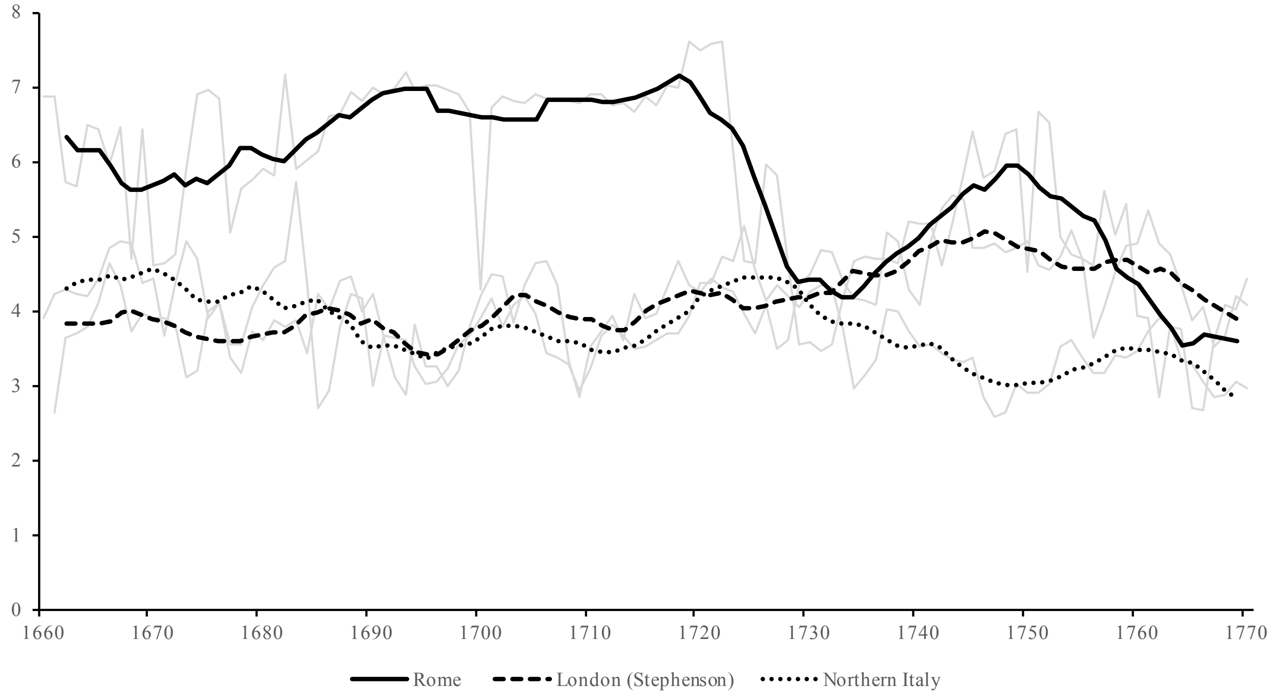
Figure 5: The real wages of labourers in London, Rome, and Northern Italy, 1560-1810



Note: Real wages are the nominal wages (Figure 3) divided by 365 multiplied by the daily cost of living (Figure 4). Grey lines are yearly observations and dark lines 10-year moving averages. *Sources*: Nominal wages and prices for Northern Italy and London: Allen (2001). Nominal wages and prices for Rome: the *Fabbrica of St Peter* (see Appendix 1).

Figure 5 shows, consistent with Allen's original findings, that the real-wage gap between London (dashed line) and Northern Italy (dotted line) was already significant by the mid-16th century. At that point, real earnings in London were more than twice as high as those in Italy. The gap tightened slightly in the early 17th century, but then grew wider again after the 1640s. By the mid-18th century, at the onset of the classical years of the Industrial Revolution, the real wages in London were some three times higher than in Northern Italy. The real wages of Rome (solid line) were generally positioned in-between the other two real-wage series. Roman earnings followed the London level rather closely up until the 1710s, after which it trended towards the level in Northern Italy instead. After the 1750s, all three series drifted downward. Overall, Figure 5 provides clear support to Allen's *little divergence* hypothesis and thus to his *high-wage-economy* explanation for why the first Industrial Revolution was English.

Figure 6: Profit-adjusted real wages of labourers in Rome, London, and Northern Italy, 1660-1770



Note: Real wages are the nominal wages (Figure 3) divided by 365 multiplied by the daily cost of living (Figure 4). Grey lines are yearly observations and dark lines 10-year moving averages. *Sources*: Nominal wages for London: Stephenson (2016a). Prices for London: Allen (2001). Nominal wages and prices for Northern Italy: Allen (2001). Nominal wages and prices for Rome: the *Fabbrica of St Peter* (see Appendix 1).

Meanwhile, Stephenson argued that London construction workers effectively received 30-35 per cent less than the wages used in Allen's original study (Stephenson 2016a). To consider the implications of this adjustment, Figure 6 repeats the real-wage comparison displayed in Figure 5, but this time with Stephenson's downward-adjusted wages for London, which cover the period 1660 to 1770 (*ibid*., Appendix). The first important point is that Stephenson's corrected wages (dashed line) still confirm Allen's hypothesis, as long as the comparison is made (as originally) between London and Northern Italy (dotted line). The pay gap is obviously smaller this time due to Stephenson's adjustments, but the gap widens after the 1730s, coinciding with the spread of steam engines in England, one of the major labour-saving technological efforts (e.g. Nuvolari et al 2012). The downward-adjusted London wages are, however, markedly lower than those in Rome (solid line) until the 1730s. At that point, the Roman real wages drop to the level in London, roughly tracking these until the end of Stephenson's period.

In conclusion, whereas the Stephenson-adjusted comparison between London and Northern Italy still confirms Allen's *little divergence* hypothesis, the comparison between London and Rome predicts a "little convergence" between England and Italy instead, with Roman workers receiving at least the same real wages as their London counterparts in the century leading up to the classical years of the Industrial Revolution.

5. Discussion

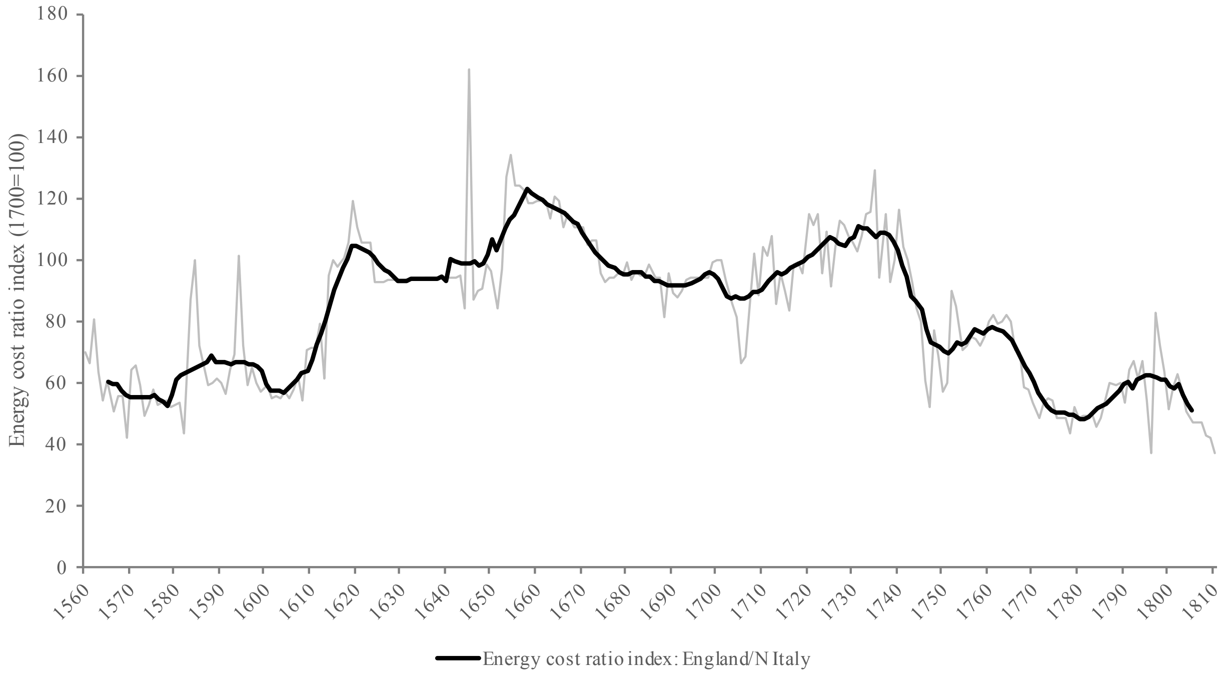
Why was the first Industrial Revolution English and not Italian? Allen argued that a combination of expensive labour and cheap energy induced English producers to substitute labour for machines. Our real-wage comparison between London and Rome showed, however, that unskilled Roman workers were either paid better or in line with their English counterparts after profit- and skill-margins were deducted from the London wages originally used in Allen's seminal study (Allen 2001). This conclusion presents a challenge to the *little divergence* hypothesis that North-West Europe pulled away from other European cities during the early-modern period. By implication, this contests the *high-wage-economy* explanation for why the Industrial Revolution was English.

Our Roman real wages have been constructed in a rather prudent manner. We assumed the same caloric intake per adult per day in London and Rome, even though research suggests that the caloric needs in Rome would have been lower because of its warmer climate. We also applied the same level of heat energy in Rome as was assumed for Northern Italy, even though the Roman weather is milder and therefore less heat-energy demanding than the northern regions of Italy. Hence, both in terms of calories and with respect to heat consumption, the actual Roman cost of living may well have been lower than we assumed above. We also believe that we have been fairly conservative when identifying the strictly unskilled workers in the *Fabbrica*'s account book, using only the 25 per cent lower-end tail of the sampled unskilled wage distribution to build our nominal Roman wage series. If anything, therefore, the real wages of unskilled Roman construction workers were probably higher than we estimated above.

We nevertheless believe there are several reasons *not* to reject Allen's *high-wage-economy* explanation for England's early industrialisation. In part, these reasons relate to the broader aspects of Allen's hypothesis, which not only includes the price of labour, but also the price of energy used to run machines. Other reasons concern Joel Mokyr's theory about the absence or presence of the scientific knowledge needed to create a steam engine (Mokyr 2002). Above all, however, we argue that the reasons not to refuse the *high-wage* explanation based on what we observed above concern the specific nature of construction work in the past. The remainder of our article is devoted to discussing these matters in detail and explaining why it would be premature, in light of these considerations, to jump to the conclusion that Allen's *high-wage* argument is wrong.

First, the flipside to Allen's *high-wage* hypothesis – cheap energy – could well have played a role independent of wages. A declining relative cost of energy in England could have been an additional factor prompting English producers to shift to labour-saving technology. Figure 7 shows the relative cost of 1 million BTUs in England compared to Italy. Between the 1560s and the 1650s, the cost of energy in England rose relative to the cost in Italy. But after the 1650s, and especially between 1730 and 1810, i.e. early into the classical years of the Industrial Revolution, English energy prices dropped by some 50 per cent compared to those in Italy. Largely equal real wages (Figure 5) and falling energy prices (Figure 7) might thus have tipped the balance for English producers in favour of introducing labour-saving inventions.

Figure 7: The relative cost of energy in England and Italy, 1560-1810



Note: The index tracks the relative costs in grams of silver of one million BTU. The grey line is yearly observations and the dark line 10-year moving averages. *Sources*: Allen (2001).

Another potential reason why the Industrial Revolution was not Italian links to Joel Mokyr's hypothesis about scientific knowledge as a key factor for industrialisation. Mokyr argued that the size of the stock of *prescriptive* knowledge was critical for technical change to catch on, including the knowledge needed to build a steam engine (Mokyr 2002). In this sense, high real wages and cheap energy transform into new technology *only* if enough prescriptive knowledge exists. This would certainly explain why the Industrial Revolution did not occur in any of Allen's European cities despite their high medieval and earlier-modern real-wage levels (see Figure 1 above). Mokyr's hypothesis would then imply that Roman producers did not lack an economic incentive to industrialise, but rather the prescriptive knowledge necessary for the steam engine to be invented.

Perhaps the paramount reason why the steam engine was not introduced in Rome, however, concerns the fact that Allen's hypothesis is tested using payments for construction work. On the one hand, there are very good reasons why construction wages have been vigorously explored in earlier studies going back to seminal work by Gilboy (1936) and Phelps Brown and Hopkins (1956). Payments to builders have the advantage of being well represented in the historical records and moreover easy to compare across time and space. On the other hand, for the reasons discussed below, the wages paid in the labour market for construction work may have been out of tune with the wages paid in other sectors of the economy.

In particular, construction work was always a comparatively small sector of the economy. Building sites frequently opened and closed, and construction activities were highly sensitive, both to economic fluctuations and to seasonality. These matters meant that the demand for construction labour was highly volatile, influencing how many days per year construction workers were able to earn the day wage reported in the sources, a problem already stressed in Phelps Brown and Hopkins (1956). As a possible starting point, Allen's seminal study assumed that construction workers everywhere managed to get 250 days of work per year. But later evidence suggests that the working year of an average European construction worker varied considerably across time and space.

For example, Leonardo Ridolfi found that geographic mobility and seasonality were distinctive features of the labour market for construction work in pre-industrial France (Ridolfi 2016). He observed that the great majority of construction workers (75 per cent) was employed for less than 20 per cent of the total duration of the building project. Only five percent of workers remained on site for more than 60 per cent of the time. In combination with the actual daily wage rates, these numbers meant it would have been difficult for an average construction worker in France to support an average family without resorting to other income-generating activities. Ridolfi concluded, by tracking specific workers across time and space, that 250 days were approximately correct, but that his sampled workers had to seek employment on several building sites and, for less specialised labour, even in agriculture in order to achieve that many days each year.

Construction work in England and Sweden point in similar directions. Judy Stephenson found that the working days of an average construction worker, even at large London construction sites such as St Paul's Cathedral, ranged between 50 and 100 days per year (Stephenson 2018b). Worse still, Kathryn Gary observed that an unskilled worker in Malmö, Sweden, would work as little as 30-85 days per year on average, even during the busiest construction years (Gary 2018). That amount of working days would not have been enough, either in London or in Malmö, to provide for an average family at the time. As in France, English and Swedish construction workers thus either had to supplement their income from other sources in order to make ends meet or they would have been part of a team of travelling men who moved from one building site to the next in order to make an adequate income (Lucassen 1987; Ridolfi 2016).

The fact that a building site would not commonly offer its workers 250 days per year is not a problem *per se*. If construction workers were able to supplement their income from other sources, and if those sources offered the same daily salary as they received on the sampled building sites, then the *high-wage* hypothesis would still be valid. The problem is that many construction workers might *not* have been able to find enough work, and that this may have led to a risk premium for seasonal unemployment. For example, Peter Swenson observed that Northern European construction workers earned systematically higher wages than comparable workers employed in industries not influenced by seasonality (Swenson 1991). Swenson argued that construction premiums were paid to compensate the Northern European construction workers for winter periods, when building work ceased due to freezing temperatures. Strikingly, whereas construction wages in Stockholm, Sweden, were twice as high as the wages paid in non-seasonal industries, Swenson did not observe a construction premium in Rome, where winter temperatures were substantially higher than in Stockholm and the working season then comparatively longer (*ibid.*, Table 1).

One of Swenson's key arguments is that construction workers were able to negotiate a wage premium linked to job uncertainty, the size of which depended on their low-season options. It is not unlikely, therefore, that construction workers' outside options, and hence their wage premium vis-à-vis other sectors of the economy, generally differed across European cities. For example, the Great Fire of London in 1669 would have increased the demand for housing and thus construction work. This would weaken construction workers' bargaining power in London, as outside opportunity were plenty. Conversely, the Sack of Rome in 1527 caused the population to decline, leaving many houses empty and thus raising the bargaining power of Roman construction workers, as work alternatives were lacking. Different low-season options would then have contributed to different construction-wage premiums across European regions. A good case can be made for the argument, therefore, that an average European construction worker was a poor representation of a typical worker at the time, both in terms of payments and patterns of work.

6. Conclusion

There are good reasons to believe that the day rate of an average unskilled construction worker was out of tune with that of an average unskilled worker employed in other more stable sectors of the economy. One of the key reasons is that construction work may have paid a wage premium for seasonal unemployment, the size of which would vary with construction workers' outside options, which likely differed from city to city. It is not implausible, therefore, that the resulting construction-wage premiums provide misleading estimates of the costs of hiring an average unskilled worker across Europe, making construction wages an unsuitable testing ground for the *high-wage-economy* hypothesis. Whether such premiums existed or not should be investigated by comparing the day rates of unskilled construction workers with those of unskilled workers in sectors not subjected to seasonality. Regardless, and based on the considerations discussed above, we advocate that the *high-*

wage explanation is better examined using payments made in large sectors of the economy that are not subject to seasonality or economic fluctuations. Moreover, in order to address the problems linked to lack of knowledge about the length of the historical working year, we propose the *high-wage* hypothesis be tested for permanent employees working for an annual salary rather than a day rate (Humphries and Weisdorf 2018).

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Appendix 1: Sources of Data

Wages

Wages were collected from the following archival sources at the archive of the St Peter's Church:

1558-1562: Giornale A terzo, ASFP, Arm. 25, B, 61

1562-1569: Giornale. B, ASFP, Arm. 25, B, 65

1570-1579: Giornale, ASFP, Arm. 25, C, 70

1579-1582: Giornale, ASFP, Arm. 25, C, 86

1582-1587: Giornale, ASFP, Arm. 25, D, 99

1585-1586: Giornale, ASFP, Arm. 25, D, 104

1587-1589: Libro delle giornate di muratori e manovali, ASFP, Arm, 25, D, 112

1589-1590: Libro delle giornate de muratori e manovali della Fabbrica, ASFP, Arm. 25, E, 126

1589-1590: Giornate di muratori e manovali de la Cupola di Santo Pietro, ASFP, Arm. 25 E, 127

1591-1593: Giornate de muratori e manovali, ASFP, Arm. 25, E, 134

1597-1602: Giornale de muratori e manovali della Cupula, ASFP, Arm. 26, A, 158

1617-1622: Stracciafogli, ASFP, Arm. 26, B, 218

1623-1633: Giornate del soprastante, ASFP, Arm. 26, C, 244

1629-1637: Giornate. Soprastante, ASFP, Arm. 26, C, 256

1648-1650: Rassegna di manuali della Fabrica di San Pietro, ASFP, Arm. 96, D, 296

1648-1653: Libro mastro del Fattore. Giornate di homini, AFSP, Arm. 96, D, 298

1653-1667: Libro mastro del Soprastante, AFSP, Arm. 26, E, 309

1653-1667: Libro mastro del Fattore, AFSP, Arm. 26, E, 310

1667-1684: Libro mastro del Fattore, AFSP, Arm. 27, A, 358

1667-1684: Libro mastro del Soprastante delle giornate, ASFP, Arm. 27, A, 359

1691-1716: Libro mastro del Soprastante delle giornate, ASFP, Arm. 27, B, 393

1712-1726: Rassegna dei manovali, ASFP, Arm. 27, C, 408

1716-1736: Libro mastro del Soprastante, spese, ASFP, Arm. 27, C, 415

1720-1725: Libro del Soprastante per il riscontro delle spese dei manovali, ASFP, Arm. 27, C, 418

1738-1755: Registro delle opere dei manuali, ASFP, Arm. 27, D, 431

1755-1769: Registro delle opere dei manovali, ASFP, Arm. 27, D, 433

1769-1777: Registro delle opere dei manovali, ASFP, Arm. 27, D, 436

1786: Liste bimestrali e giustificazioni dell'anno 1786, ASFP, Arm. 44, C, 1-2

1791-1794: Registro delle opere manovali, ASFP, Arm. 28, A, 446

1796-1798: Liste bimestrali e giustificazioni, ASFP, Arm. 44, F, 34/40

1800-1802: Liste bimestrali e giustificazioni, ASFP, Arm. 44, G, 44/50

1803-1805: Liste bimestrali e giustificazioni, ASFP, Arm. 45, A, 53/57

1809-1810: Liste bimestrali e giustificazioni, ASFP, Arm. 45, C, 66/69

Prices

Bread: 1563-1762: Reinhardt (1990). 1770-1810: Friz (1980). 1763-1769: interpolation. *Olive oil*: 1532-1648: Deluemau (1959). 1674-1810: Baccelli et al (1878). 1649-1673: interpolation. *Wine*: 1533-1630: Deluemau (1959). 1631-1810: extended using wine prices for Northern Italy from Allen (2001) and for Rome from Friz (1980). *Meat*: 1538-1629: Delumeau (1959); 1630-1810: Baccelli et al (1878). *Eggs*: 1538-1630: Deluemau (1959). 1770-1810: Friz (1980). *Beans*: Prices assumed to be equal to the prices of wheat. Wheat prices: 1563-1797: Reinhardt (1991). 1798-1810: Baccelli et al (1878). *Cheese*: 1560-1810: average prices of *ricotta fresca* from Baccelli et al (1878) and Vaquero Pinerio (2009). *Firewood*: 1552-1650: Delumeau (1959). 1651-1810: prices of firewood in North Italy from Allen (2001).

Appendix 2: Wage series details

Figure A1: The wage series when using all labourers and the lowest-paid 25 per cent, 1560-1810

Notes: Wages are reported in *Baiocci* per day. Grey lines are yearly observations and dark lines 10-year moving averages.
Source: the *Fabbrica of St Peter* (see Appendix 1).