Kelly, Morgan; Ó Gráda, Cormac

Working Paper

Ready for revolution? The English economy before 1800

UCD Centre for Economic Research Working Paper Series, No. WP14/18

Provided in Cooperation with:
UCD School of Economics, University College Dublin (UCD)

Suggested Citation: Kelly, Morgan; Ó Gráda, Cormac (2014) : Ready for revolution? The English economy before 1800, UCD Centre for Economic Research Working Paper Series, No. WP14/18, University College Dublin, UCD School of Economics, Dublin

This Version is available at:
https://hdl.handle.net/10419/109716

UCD CENTRE FOR ECONOMIC RESEARCH

WORKING PAPER SERIES

2014

Ready for Revolution?
The English Economy before 1800

Morgan Kelly and Cormac Ó Gráda, University College Dublin

WP14/18

November 2014

UCD SCHOOL OF ECONOMICS
UNIVERSITY COLLEGE DUBLIN
BELFIELD DUBLIN 4

Ready for Revolution?

The English Economy before 1800[1]

Morgan Kelly

[email: morgan.kelly@ucd.ie]

and

Cormac Ó Gráda

[email: cormac.ograda@ucd.ie]

[1] Revised version of the paper presented at the conference commemorating the 50th anniversary of the founding of the Cambridge Group for the History of Population and Social Structure, 16-18 September 2014. Thanks to Jeremy Boulton, Stephen Broadberry, Nick Crafts, Neil Cummins, Romola Davenport, Morgan Kelly, David Mitch, Joel Mokyr, Karl-Gunnar Persson, Peter Razzell, Alex Shepard, Richard Smith, Peter Solar, and David Stead for help on various points. The standard disclaimer applies.

ABSTRACT:

Sustained economic growth in England can be traced back to the early seventeenth century. That earlier growth, albeit modest, both generated and was sustained by a demographic regime that entailed relatively high wages, and by an increasing endowment of human capital in the form of a relatively adaptable and skilled labour force. Healthier and savvier English workers were better equipped to profit from the technological possibilities available to them, and to build on them. Technological change and economic growth stemmed from such human capital rather than Boserupian forces. They were the product of England's resource endowment and its institutions.

Keywords: economic history, industrial revolution

JEL classifications: N, N3, N5, N6

Ready for Revolution?

Metaphors such as '*histoire immobile*' and 'Malthusian roller coaster' capture an economy before the Industrial Revolution that was stationary in the statistical sense. But in a context where some margin above subsistence was a precondition for economic growth even small changes were historically very important. By today's standards every European economy was poor; literacy rates and life expectancy are much higher in today's Nepal or Nigeria than in, say, *ancien régime* France. By the same token, differences in consumption levels that would seem trivial nowadays might mean the difference between stagnation and growth in the eighteenth century. This paper argues that such differences were a feature of the British economy before the late eighteenth century.

1. Growth:

Although economic growth before the mid-nineteenth century was very slow by later standards, the latest attempts at estimating British output and productivity in the more distant past reveal an upward trend in GDP that began long before the ages of cotton and steam (Broadberry *et al*., forthcoming; Nuvolari and Ricci 2013). Figure 1 describes the movements in GDP and GDP per head (both measured in logs) in 20-year blocks between 1390-1409 and 1850-69 implied by Broadberry *et al*.[1] Over this period, GDP grew about ten times as fast as GDP per head. Note that from the early seventeenth century on, GDP per head was higher in each period than in the previous period: growth henceforth was somehow built-in. Note too the implication that the growth rate of GDP per head fell during the eighteenth century before accelerating

again early in the nineteenth.

Figure 1. GDP and GDP per capita in England 1400-1870

There are other signs of progress in this pre-Industrial Revolution era. One is the remarkable increase in literacy (on which more below): between 1600 and 1750 England moved from being essentially a pre-literate society to one where more than half of all adults could at least sign their names. And although literacy (as measured thus) did not increase much for some decades thereafter, its quality did. This is reflected in the increasing number of books published and read and in the rising circulation of newspapers, from less than a million in 1690 to 7.3 million in 1750 and 16 million in 1800, despite hefty increases in stamp duty paid (Aspinall 1946, 1948; Black 1991; Mokyr 2009: 43; Gardner 2013). Books were mostly the province of the middle classes; but while the high cost of newspapers and books constrained their purchase to the elite and the middle ranks, their readership reached wider: 'ask a landlord why he takes the newspaper: he'll tell you that it attracts people to his house' (Feather 1985: 43; Erickson 1990; William Cobbett, *Political Register,* 26 September 1807, as cited in Aspinall 1946: 37).

Another indicator is the increasing urbanization and openness of the economy. The proportion of the population living in towns or cities of ten thousand or more rose from 5.8 per cent in 1600 to 13.3 per cent in 1700 and 20.3 per cent in 1800 (de Vries 1984: Table 1.7). With increasing commercialization came increases in the variety of goods consumed (McCants 2007; Hersh and Voth 2008), and McCants (2007: 461) notes that consumption of the new 'exotic' products from the Americas and Asia was not confined to the rich.

A further gain was the significant rise in adult life expectancy, evident in the case of the elite from the seventeenth on (Edwards 2008; Johansson 2010; Cummins 2014). Although Wrigley and Schofield's (1981: 230) original back-projection estimates detected little evidence of an increase in life expectancy at birth during those centuries, Wrigley *et al.*'s family reconstitution volume (1997: 295) found an increase during the eighteenth century. This tallies with Landers' (1993: 168-74) finding that the life span of the 'general population' of London rose from the 1730s on. These outcomes are summarized in Figure 2.[2]

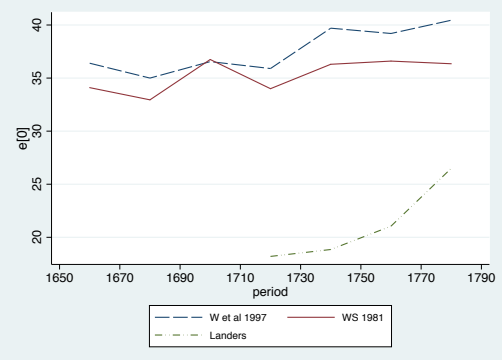


Figure 2. Life expectancy in England, 1650-1800

Note: estimates of e_0 in Wrigley and Schofield (1981); Wrigley *et al.* (1997); and Landers (1993: 171).

The significant downward drift in the coefficients of variation of cereal prices across nine English regions between the 1640s and 1740s implies significant market integration, presumably the product of improved communications, before the mid-eighteenth century (Figure 3).[3] The gradual decline in the share of the labour force employed in agriculture also implies economic progress, although estimates of the extent of that decline differ (see Figure 4a). The disparities underline the tentative character of much of the data invoked in this essay.[4] Shaw-Taylor and Wrigley's estimates inform their case for the high productivity of pre-industrial English agriculture, while Clark's estimates underpin his bleak assessment of agricultural progress on the eve of and during the Industrial Revolution, as described in Figure 4b; we return to this issue later.

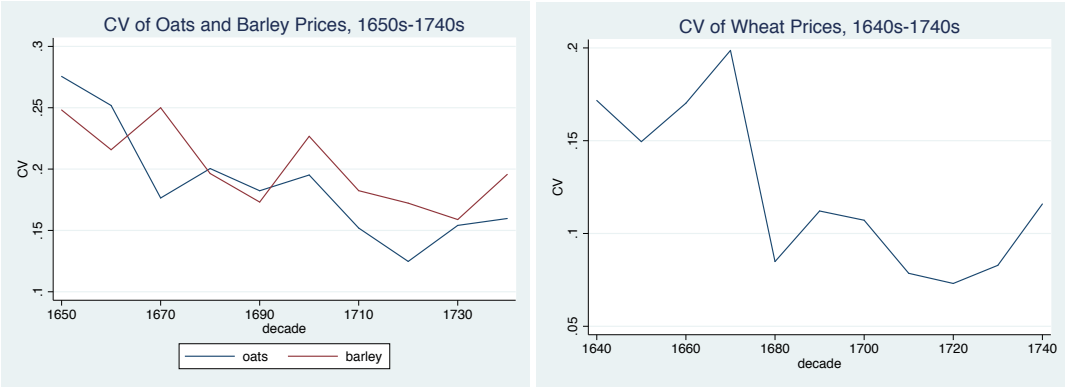


Figure 3. Coefficients of Variation of Cereal Prices (9 Regions), 1640s-1740s

Figure 4. Estimates of (a) Agriculture's Occupational Share and (b) Labour Productivity Change in Agriculture c. 1525-1850

As discussed later, productivity improvement may be identified in certain other sectors before the Industrial Revolution. In sum, the slow but self-sustaining advance of the British economy antedates the Industrial Revolution by a century or more.

2. *Industrializing on an Empty Stomach?*

This sort of slow growth is not entirely consistent with recent historical estimates of English calorie supplies, which imply significant levels of malnutrition at the lower end of the socio-economic spectrum well into the nineteenth century. Fogel (2004: 9) put per capita supplies in England at 2,168 kcals in 1750 and 2,237 kcals in 1800, while Broadberry *et al.* (2011) propose 2,248 and 2,165 kcals, respectively, for the same dates. Bearing in mind that one of the United Nations' current preconditions for declaring a famine is one-fifth or more of the population subsisting on fewer than 2,100 kcals of food per diem, such averages are consistent with extreme deprivation as a steady state on the eve of the Industrial Revolution.

Note, moreover, that those estimates refer to a representative year: year-to-year fluctuations in output before c. 1800 can only have exacerbated a malnutrition problem initially highlighted by Fogel (1994). If, as indicated by Broadberry *et al*. (2011), agricultural output declined by one fifth or more on a dozen occasions between 1550 and 1800, with cumulative shortfalls of two-fifths or more in 1594-97, 1629-31, and 1709-10, then at the non-crisis rates proposed, massive mortality among the poor would surely have been unavoidable in crisis years. Yet only in the 1590s did England suffer a nation-wide famine, and excess mortality then accounted for no more than one per cent of the population (Ó Gráda 2014a).[5]

Not surprisingly, these bleak estimates of calorie availability on the eve of the Industrial Revolution have provoked a response (Kelly and Ó Gráda 2013; Meredith and Oxley 2014; Harris 2014). While it is tempting to compare in detail, what needs emphasizing most is that all estimates are subject to considerable margins of error. While broader interpretations of economic trends and consumption levels must not rest on such data alone, the estimates in Table 1 imply consumption levels comfortably above barebones subsistence on the eve of the Industrial Revolution. These more generous estimates of calorie availability[6] are easier to reconcile with evidence that while the positive check, in the sense of the short-run response of mortality to price and real wage shocks, was powerful in the Middle Ages, it had virtually disappeared by the late eighteenth century (Kelly and Ó Gráda 2014a).

These revisions also avoid the uncomfortable implication that on the eve of the Industrial Revolution per capita calorie consumption in France matched that of England. That would be difficult to square with the latter's considerable advantage at this point in terms of mean adult height, real wages, life expectancy, and labour

productivity in agriculture.[7] Kelly and Ó Gráda (2013) and Kelly *et al*. (2014a) link the advantage English workers had over French in terms of calorie supplies to their higher stature and higher productivity.

Table 1. Calories per head and per consuming unit in E&W (1750-1800) and France (in 1705 and 1800)		
Year	*kcals per capita*	*kcals per consuming unit*
England		
1750/70	2,900/2,950	3,600/3,650
1800	2,750/2,950	3,450/3,650
France		
1705	1,657	2,209
1800	2,000	2,667
Sources: Toutain 1995; Fogel 2004: 9; Kelly and Ó Gráda 2013		

3. Literacy and Numeracy

Today both theoretical and empirical research highlights the link between educational achievement as a measure of human capital and cause of economic growth. There is even some evidence that educational human capital matters more in less developed economies than in more developed economies (e.g. Hanushek and Woessman 2012). Whether this evidence has a bearing on Britain on the eve of the Industrial Revolution remains moot. As noted earlier, literacy rates grew impressively in pre-industrial England, which between c. 1500 and c. 1750 shifted from being mainly a society of illiterates to one where half of all brides and grooms could at least sign a marriage register (Stephens 1990: 555). On the other hand, England's failure to lead in

the literacy stakes (again as measured by the ability to sign a marriage register) has led a widespread belief that literacy cannot have mattered much for industrialization (Mokyr 2009: 239-40; Mitch 1992: 14-15, 213-14; Mitch 1993; Reis 2005: 206; Allen 2009: 226fn8).[8] In this regard England was behind the Netherlands, and its lead over France was attenuating in the eighteenth century (Table 2).[9]

Schooling's role is complicated by its dual consumption and human capital aspects and by its dual affective and cognitive functions (Reis 2005). Some of the consumption demand for literacy was, presumably, driven by religion; in the seventeenth and eighteenth centuries the parish clergy everywhere played a key role in running the schools and controlling the curriculum. But the religious content of what people read fell over time. In 1670 items devoted to narrowly religious topics (i.e. prayer books, sectarian disputes, ecclesiastical history, etc.) accounted for about one publication in four; in 1680-81, when popish plots were much in the air, for 30 per cent.[10] The proportion of published books devoted to religious and philosophical subjects, more broadly defined, fell from nearly two-fifths of the total in the 1700s to about one-fifth in the 1790s (Mokyr 2009: 47).

Table 2. Literacy in England and France, 1750-1789 (%)

	France		*England*	
Decade	M	F	M	F
1750-9	39	19	61	37
1760-9	44	20	62	37
1770-9	45	23	62	38
1780-9	46	23	62	39

Source: Houdaille 1977: 68; Schofield 1981: 207

As elsewhere in Europe, in England the ability to read and write had strong social class, urban-rural, and gender dimensions (Houston 1988: 52-53; 130-33). Prescot in southwestern Lancashire, epicenter of England's watchmaking industry since the early eighteenth century (Bailey and Barker 1969), is a case in point. Prescot's parish registers contain data on the professions of grooms and their (in)ability to sign the marriage register from the 1770s. Several points stand out. First, the overall literacy rate was low—52 per cent of grooms and 78 per cent of brides failed to sign—and showed little sign of any increase before the mid-nineteenth century. This would seem to support the claim that industrialization did not require widespread literacy. Second, however, there was considerable variation in literacy across occupations. Colliers were nearly all illiterate throughout the period, as were shoemakers and laborers. Farmers were much less likely to be illiterate—and Thirsk (1985: 571-4) has highlighted the role of print in hastening the diffusion of agricultural techniques—but less so than their wives. White-collar workers, invariably literate, married literate women. And, more significantly, watchmakers and allied tradesmen/artisans were much less likely to be illiterate than the average but—and this suggests that for them literacy was more an investment rather than sheer consumption—their wives were usually illiterate. It was likewise with shoemakers, wheelwrights, and weavers.[11]

The pattern in the neighbouring parish of Warrington St. Elphin's, where data are available for 1754-1776, was rather similar, although literacy rates there were higher. Warrington, like Prescot, was a locus of craft industry before the Industrial Revolution. For Warrington shoemakers the ratios for not signing was 25/81 and it was 64/81 for their brides; for yeomen and their wives, the ratios were 3/39 and 21/39.

And while all of Warrington's fourteen watchmakers signed, only half of their wives did. In Warrington too, nearly all wheelwrights and millwrights were likely to be literate, but their brides were unlikely to sign. Again nearly all the wives of the relatively affluent could sign. In both parishes all cabinetmakers could sign. The rather complex pattern found in Prescot and Warrington reflects the dual investment/consumption aspect highlighted by Reis (2005).

Data on numeracy, arguably more important for economic development than literacy, are harder to come by. In a classic paper Keith Thomas (1987: 104, 128) made the case for an increase in the early modern period, but conceded that 'the change cannot be quantified'. His observation that innumeracy prompted people 'to use some numbers rather than others' (1987: 125-7) anticipated the use of estimates of age heaping as a proxy for numeracy and, more broadly, human capital (A'hearn *et al*. 2009). However, age heaping is only one, rather narrow, aspect of numeracy. Clearly an economy in which prices and weights and measures played a role could not function without a modicum of rudimentary numeracy, widely diffused across the population.[12]

Data on age heaping have so far not yielded much evidence on England before the nineteenth century. Figure 5 describes trends in age heaping, as measured by Whipple's Index in four different sources. The first refers to over thirteen thousand witnesses appearing before English church courts between 1550 and 1728. A very high level of age heaping is indicated, although there are interesting signs of a decline in the seventeenth century.[13] The others refer to three London populations: (a) men and women admitted to St Martins in the Fields workhouse between the 1740s and the 1820s; (b) men and women buried at St Martins in the Fields; and (c) defendants tried

at the Old Bailey, 1750-1900. One surprising aspect of (a) and (b) is the apparent tendency for males to age-heap more than females: less surprising is the higher values for the poor burials. All series trend downwards over time, however. In the case of the Old Bailey, data are thin before 1800, so we grouped defendants for the 1750-99 period together; we divided the nineteenth century into five twenty-year periods. Except in the final period (1880-99) the trend in Whipple Index values is consistently downwards.[14] A database of offenders awaiting trial at the Old Bailey between 1791 and 1805 returns a similar result: 1.31 for males (n=5,546) and 1.37 for females (n=2,088).[15]

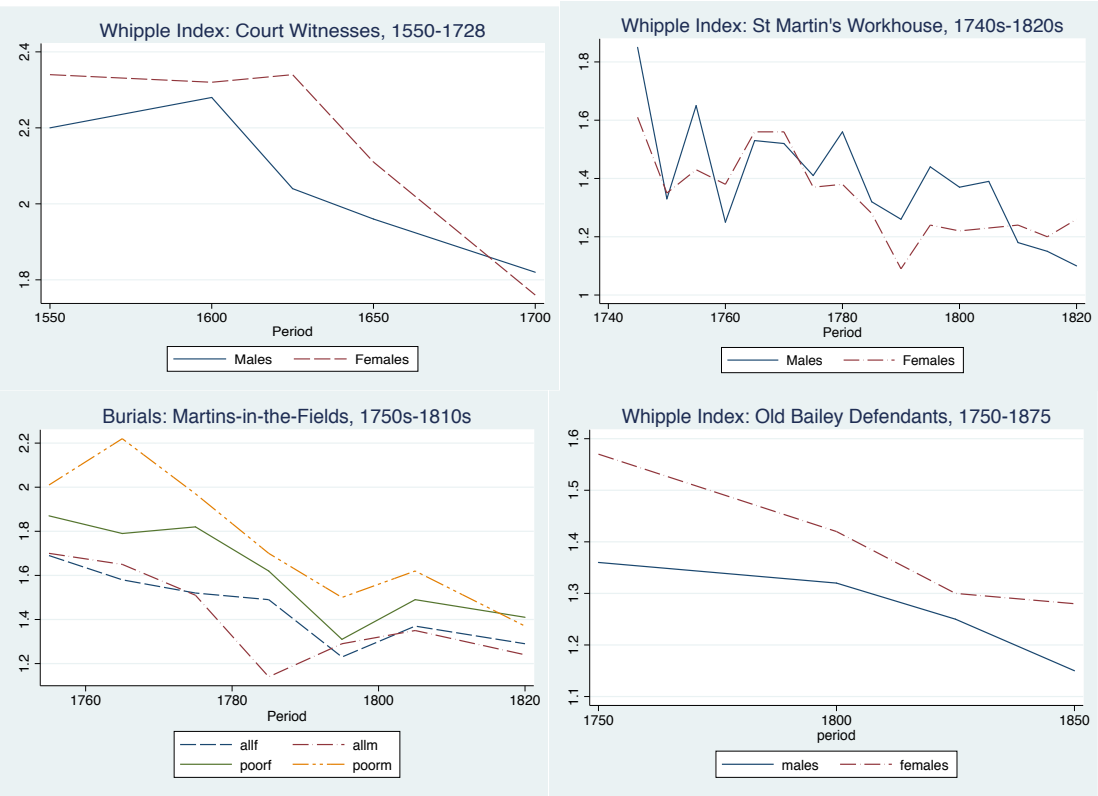


Figure 5. Some evidence on trends in age-heaping c. 1550-1850

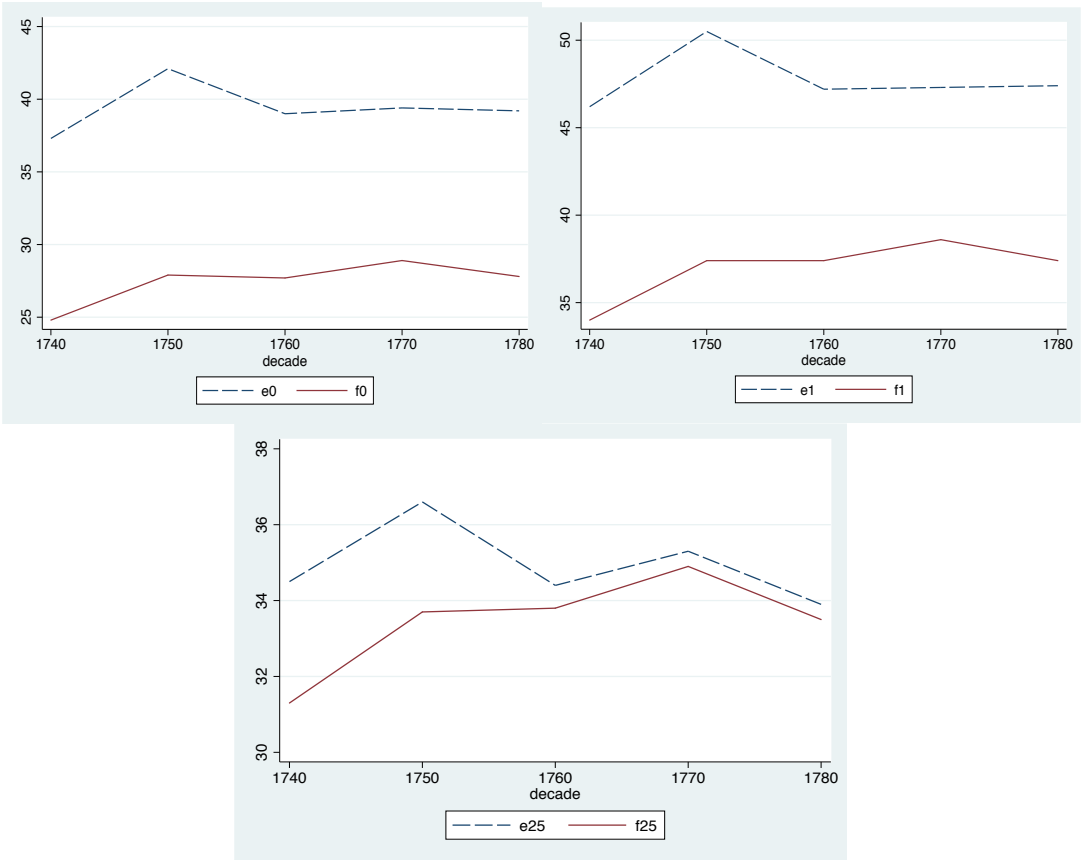
The focus on literacy and numeracy discounts the skills of agricultural

labourers and factory workers in the past. The earnings-by-age profiles constructed by Boot (1995) and Burnette (2006) for early nineteenth-century factory and farm workers, respectively, show sharp increases up to ages 30 or 35, indicating increases in skill due to on-the-job experience. Burnette's and Boot's focus is on acquired skills; Bessen's analysis of the skills of textile workers in Massachusetts in the 1830s and 1840s adds that prior schooling eased the acquisition of on-the-job skills, which may point to an unsuspected link between literacy and earnings, even in occupations where such a link might not have been expected (Bessen 2000, 2012). An alternative interpretation of Bessen's finding is that the link that mattered most in the textile factories was that between schooling and affective skills rather than that between schooling and literacy (Bowles and Gintis 2011). The link between schooling, literacy, human capital, and industrialization may be more complicated and indirect than we realize. But our main point here is that there were improvements in both literacy and numeracy before the Industrial Revolution.

4. Demographic Regime

Wrigley and Schofield's *Population History* (1981) continues to prompt several analyses of the short run response of births, marriages, and deaths to harvest shocks. Applying a multilevel regression approach to the Cambridge Group's 404 parishes, Kelly and Ó Gráda (2014a) found that the strength of the positive check diminished considerably between 1540 and 1700, only to rise again during the first half of the eighteenth century, a period that suffered two sharp mortality crises, in the late 1720s and early 1740s. During the second half of the eighteenth century, the positive check again disappeared across most English parishes. Applying the same multilevel

regression approach to marriages and births, Kelly and Ó Gráda (2012) found evidence for a significant preventive check at work, which peaked in the early eighteenth century.



Source : Wrigley *et al.* 1997 : 224, 256, 291, 295; Blayo, 'Mortalité', 138-42; Tables 1a-1b

Figure 6. e_0, e_1, and e_{25} in England and France, 1740s-1780s

Comparing Cambridge Group and INED family reconstitution studies suggests that on the eve of the Industrial Revolution life expectancy at birth in England was considerably higher than in France (Figure 5). The comparison implies that in the second half of the eighteenth century the former's edge over the latter was a striking 10-12 years.[16] True, the gap was largely due to lower infant and child mortality, but this still means that survivors of childhood in England were less likely to be scarred by

disease than their French counterparts, with attendant advantages in adult height and health. Recent research on the impact of adverse shocks (e.g. being conceived or born during a famine) or pro-active interventions in utero and during early childhood (e.g. better medical care and nutrition) points to significant long-term implications for adult physical and mental health and, indeed, also cognitive penalties (e.g. Maluccio *et al.* 2009; Hatton 2011; Barham *et al.* 2013; Currie and Vogl 2014). Surely it is not implausible to extend that link to the past?

Family reconstitution data also imply that total fertility rates (TFRs) in England on the eve of the Industrial Revolution were substantially lower than in France (Table 4). The gap—about one child for women who married at 25-29 years—may have been linked to England's lower infant and child mortality rates but, as just noted, that also had broader implications for human capital formation and child quality. So would evidence that definitive celibacy was more common in England than in France: but such evidence is more elusive.[17]

Table 3. TFRs by Female Age at Marriage			
Region	*AAM 15-19*	*AAM 20-24*	*AAM 25-29*
France			
NW	7.54	6.03	4.29
NE	8.79	6.90	4.94
SE	7.25	6.33	4.55
SW	6.49	5.75	4.20
Average	7.52	6.25	4.50
England	6.19	5.02	3.56
Source: Wrigley and Schofield (1983: 173). Note the English data refer to 1600-1799, the French to 1670-1769. French average is the unweighted mean of the four regions.			

The data are consistent with birth and death rate schedules like those described in Figure 7. The two equilibria represent 'England' (*E*) and 'France' (*F*). The death rates (*dr*) and birth rates (*br*) are negative and positive functions, respectively, of the real wage (*w*). The slopes reflect the apparent relative power of the checks in England and France, with the virtual flatness of the English *dr* schedule reflecting the disappearance of the short-run positive check. Both English schedules are below the French schedules, but such as to produce a higher zero-population-growth (*br*=*dr*) wage in England. The finding, going back to Weir (1982), that England's demographic regime was softer than France's broadly corroborates. Since the other part of the Malthusian model did not apply—because the equilibrating mechanism driving population growth to zero was trumped by productivity growth (compare Persson 1988, 2008; Møller and Sharp 2014)—the equilibria in Figure 5 are 'virtual', i.e. they were not observed.

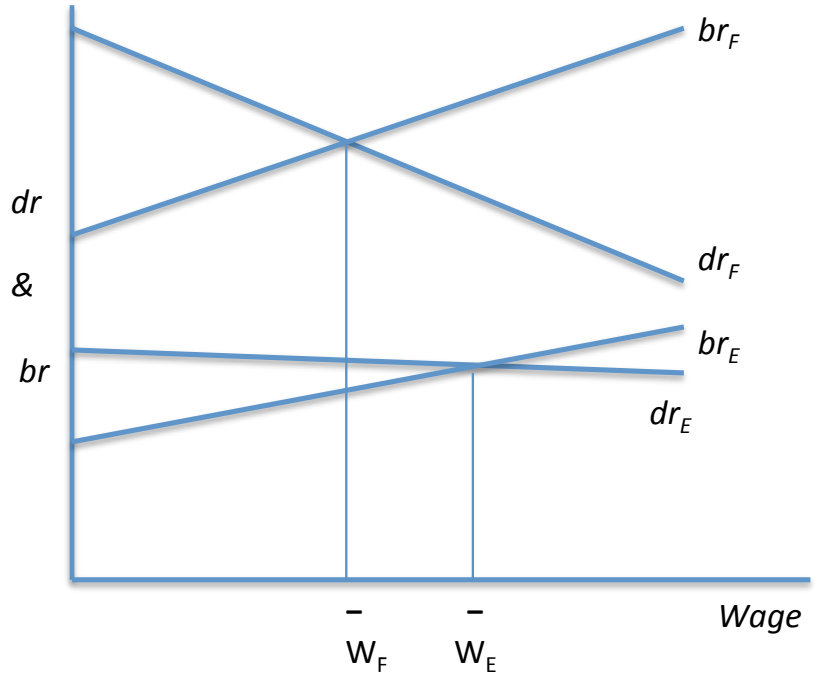


Figure 7. Demographic 'Equilibria' in England and France

Another possibility suggested by this Anglo-French comparison is that English couples were better positioned to trade off child quantity for quality. Did they invest more in children's health and education? The jury is still out on this. Klemp and Weisdorf (2012a), using Cambridge Group data, claim to have found evidence for a trade-off in England in the eighteenth century—'a decrease in the chances of finding literacy among all family offspring for each additional surviving child of eight percentage points'—but Clark and Cummins (2013), using probate data, failed to find any evidence for such a trade-off before the mid-nineteenth century.[18]

5. North and South

The Industrial Revolution turned the economic geography of England on its head (Foster and Jones 2011; 2013: 3-36). Between 1750 and 1850 the population share

of England's northern 'industrial' counties rose from 17.7 to 29.2 per cent, while that of its midland and southern 'agricultural' counties fell from 46 to 33 per cent (Shaw-Taylor and Wrigley 2014). Figure 8 describes wages, nutrition, and heights on the eve of the Industrial Revolution, and subsequent industrial growth. The wages of unskilled workers in the north were relatively low at the outset; their switch to being relatively high magnifies the contribution of the northern counties (Hunt 1986). In addition, the higher quality of food in the north is reflected in anthropometric data, so that prospective employers in the north were at a double advantage: not only was the wage cost of northern labour in mid-century at the outset lower, but the quality of the labour in terms of height and health was higher (Hunt 1986; Horrell and Oxley 2012a, 2012b).[19] Growth rates are proxied by the growth of aggregate money income between 1766 and 1833.

The combined effect of wage and population growth during the Industrial Revolution is captured in the cartograms in Figure 9, where counties are re-scaled in proportion to their aggregate labour income (wageXpopulation) in the 1760s and 1830s. The shades reflect the wage rates of agricultural labourers in each period (Hunt 1986). Figure 9 also highlights the disproportionate importance throughout of London and its hinterland to the English economy (Wrigley 1967).

Preliminary cross-county regressions analysis not reported here (see Kelly, Mokyr, and Ó Gráda 2014) finds that the two most important predictors of industrialization (as crudely measured in Figure 8) were small farms[20] (which were associated with a high biological standard of living) and high population density relative to farmland, an indicator of the extent of proto-industrial employment. Between them, these two variables explain four fifths of the variation in industrial

employment outside London in the early nineteenth century.

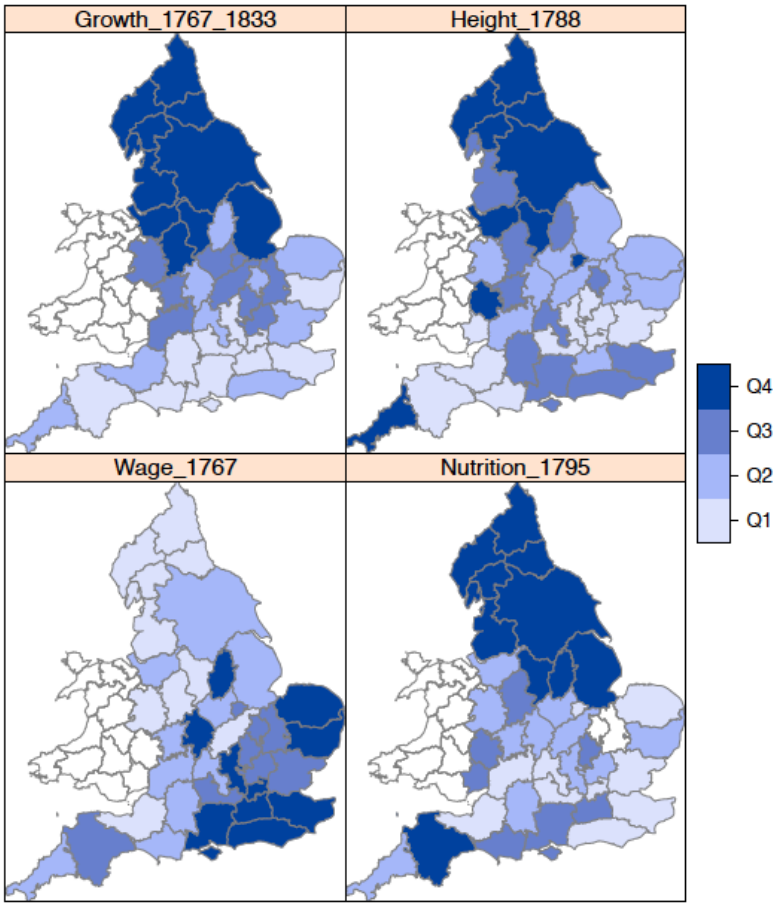


Figure 8. North and South

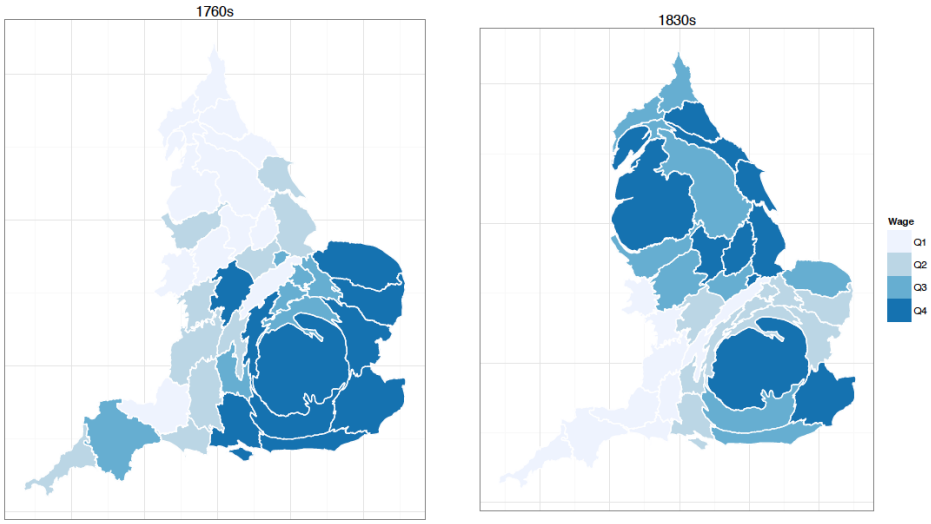


Figure 9. County shares weighted by population and wages in 1760s and 1830s

Easier access to land in the north of England is one of the reasons why nutrition was better there. Smallholdings offered an indispensable supplement to income from other activities, one that could generate some capital for small-scale industrial activity like weaving or watch making, or fund the apprenticeship of children in learning useful skills. In addition, the dairy farming and small-scale industry of northern areas probably generated greater demand for female labour than the wheat growing monoculture of the southeast, further increasing household income. At the same time northern counties with low population density relative to overall area had high densities relative to their agricultural potential. The high populations of these areas were supported by non-agricultural activities, such as spinning and weaving, and metal-working. This density relative to agricultural land therefore serves as a proxy for proto-industrial activity.

The results are consistent with the view that human capability and skills derived from existing proto-industrial activity were central. As noted above, human capital is often dismissed as a source of industrialization on the grounds that English literacy was unimpressive by Continental European standards, but our regression analysis also suggests that literacy had a positive impact on industrialization.

6. Institutions:

An older literature held that two very English institutions—the Old Poor Law and apprenticeship—were impediments to economic growth. The former, it was

believed, spurred excessive population growth, reduced labour supply, and hindered labour mobility; while the latter inhibited technological change, directly through its prohibitions and indirectly through maintaining a supply of cheap trainee labour. A revisionist literature argues that, on the contrary, these institutions supported economic activity and technological change.

The Old Poor Law (OPL), long the brunt of attacks by Malthus and his followers, did a good job of relieving the elderly, alleviating local food shortages, and treating cyclical poverty. Indeed, the dietary regime in OPL workhouses was relatively benign: it involved meat or cheese being provided several times weekly and bread, accompanied by broth and beer (or oatmeal and milk in the north), served twice daily. In practice workhouse fare was far more generous than that indicated by workhouse diet schedules (Ottaway 2013: 2). The expansion of the OPL was probably fuelled by the rising incomes noted earlier, offering the possibilities of shielding an increasing proportion of the population against destitution and attendant social costs. A canvas of mid- to late eighteenth-century data suggests that much of the variation in poor relief across parishes and counties is attributable to differences in resource constraints and the cost of living (Kelly and Ó Gráda 2011). Still, the key institutional features of the OPL emphasized by historians—funding through the parish unit, the link between entitlements and settlement, and local administration as a means of reducing moral hazard and the gap between principal and agent—owed more to history than to rising GDP (Solar 1996). Economic growth may have been a pre-condition for more spending on relief, but the structure of the OPL ensured its effective redistribution. Nor is there much evidence that the OPL spurred population growth and reduced wages, at least before the later eighteenth century: the proportion of never-marrieds

remained above ten per cent and the mean age at which women married remained above 26 years until mid-century (Wrigley and Schofield 1981: 255).

Adam Smith believed that apprenticeships were 'altogether unnecessary' because the acquisition of artisanal skills required no 'long course of instruction'; the Statute of Artificers [1562], the legislation underpinning the system, merely restricted competition and reduced output. However plausible Smith's argument *a priori*, recent research shows that in England, far from being some 'dinosaur of a corporate cretaceous', apprenticeship was an effective vehicle for transmitting artisanal skills before and during the Industrial Revolution. Resilient and adaptable, it was capable of adapting supply to the skills most in demand. Though not affordable by all, it provided many poor boys with the prospect of marketable skills: most of the inventor-entrepreneurs of the early Industrial Revolution were from relatively humble backgrounds, and trained as apprentices (Mathias 1975; Ó Gráda 2014b). The most convincing refutation of Smith's assertions is that the system thrived as a 'voluntary' mechanism in his day, and in several occupations outlasted the guilds and the repeal of the Statute of Artificers in 1814. By and large, the human capital embodied in apprentices complemented the technological changes of the early Industrial Revolution (Smith 1776: I, X[2]; Humphries 2003, 2011; Minns and Wallis 2013; Van der Beek 2014; Epstein 2004; Prest 1960: 87-8).

7. Productivity Growth Before the Industrial Revolution

In the eighteenth century agriculture was still the largest sector of the English economy. Estimates of productivity growth in agriculture before the Industrial Revolution range so widely that very little useful can be inferred from them. Allen (2000), Clark (2002), and Broadberry *et al.* (2014) have constructed competing estimates of output per agricultural worker c. 1700, c. 1750, and c. 1800. Turner *et al.* (2001: 227) have estimates for c. 1750 and c. 1800 based on wheat production only. Clark paints a picture of virtual stagnation during the eighteenth century (Figure 5) as do Turner et al. for 1750-1800, while Allen (2000: 19-21; compare Allen 2005; Crafts 1989) reckons that English agricultural output per worker rose by a quarter, but with a labour productivity growth rate of about 0.6 per cent per annum during the first half of the century giving way to modest decline (of about 0.15 per cent per annum) in the second half. Broadberry *et al.*'s numbers are in stark contrast. They reckon that output per worker grew at 0.70 per cent annually in 1700-50 and 0.37 per cent annually in 1750-1800. Broadberry *et al.*'s squares more readily with traditional stories of productivity gains from parliamentary enclosures, new fodder crops, and improvements in livestock quality (Apostolides *et al.* 2008; Broadberry *et al.* 2014). Against this, Turner *et al.*'s finding that wheat and barley—though not oats—yields failed to rise during the eighteenth century is derived from a rich database of farm accounts, but it also carries the implication that yields were already high by 1700 (Turner *et al.* 2001: 129, 153, 158).

But it does seem plain that some industries did achieve significant productivity growth. Gerhold (1996: 494; see too Bogaert 2014) has estimated productivity growth in road freight at 1.1 per cent annually between the 1730s and the 1800s. Brewing too was transformed before the Industrial Revolution, even though per capita beer

consumption was in decline. The introduction in the 1720s of a new beer variety, porter, led to significant scale economies in brewing, first in London and then in the bigger provincial towns. Mathias has described the invention of porter as 'exactly equivalent in its own industry to coke-smelted iron, mule-spun muslin or 'pressed-ware' in pottery'.[21] Glassmaking is also significant, for two reasons. First, its reliance on coal began early. The beneficiary of a patent using coal-fired furnaces to make 'green glass for windows' spent £30,000 perfecting his method, experimenting with different coals and moving sites accordingly (Barker 1977: 2). Second, plate glass production, a highly capital-intensive activity, was one of the first industries in Britain to benefit from joint-stock legislation in 1773.[22] Estimates of productivity growth in coastal shipping in this era are also subject to an embarrassingly wide margin of error, while recent research on the speed of ocean going sailing ships c. 1750-1830 is consistent with productivity gains, though it does not directly address that issue (Ville 1987; Solar 2013; Kelly and Ó Gráda 2014c).

A more precise but still indirect estimate is possible in the case of pocket watches. During the eighteenth century there was a significant rise in the ownership of pocket watches in England. This arose in part from an increasing interest and value in knowing the time, but watches were also recognized as stores of value and as male fashion items. By the end of the century annual watch consumption in England had reached about 0.2 million (Styles 2007, 2008), or about one for every tenth adult male. In *The Wealth of Nations* Adam Smith invoked watchmaking as a case study of the division of labour in action, claiming that a watch movement that could be had for twenty shillings in his own day was superior to one costing twenty times as much in the mid-seventeenth century (Smith 1976: 260; cited in Cipolla 1970: 144; Foster and

Jones 2011). Smith in effect inferred a twenty-fold growth in productivity from the 95 per cent decline in the price of watches. A more careful analysis of the course of watch prices over roughly the same period suggests that Smith exaggerated, but not by all that much: the real price of watches of all kinds plunged by three-quarters or so during the eighteenth century, implying an annual productivity growth rate of about 1.4 per cent (Kelly and Ó Gráda 2014b). This growth was largely the product of steady, incremental improvements by unknown artisans in an industry in which the division of labour leaves pin making in the shade. In 1817 a Coventry watchmaker described the several divisions of the industry as follows (BPP 1817: 77):

> Movement maker, is divided into frame mounter, brass flatter, pillar maker, crew maker, cock and pittance maker, wheel maker, wheel finisher, barrel maker, barrel arbor maker, pinion maker, balance maker, verge maker, ratch and click maker, and other small steel work; dial maker, copper maker, enameller, painter, hand maker, glass maker, pendant maker; case maker, divided into silver flatter, box maker, case maker, joint finisher; motion maker, divided into bolt maker, slide maker, motion wheel maker, motion maker, spring maker; chain maker, divided into riveter, finisher and preparer; engraver, which is divided into cock and slide engraver, name engraver; cap maker, jeweler, scapement maker, finisher, wheel and fuzee cutter, case spring maker, spring and liner and polisher; key maker, and several other branches to the number of 102 in the whole.

The trajectory in watch prices bears comparison with those of two other consumer durables largely made of silver. Chamberlayne (1676: II, 19) reported, no doubt with some exaggeration, that silver spoons were commonplace in the houses of 'mean mechanicks and ordinary husbandmen' while silver tankards were common in

taverns during the eighteenth century (Howard 1903). Note the implication that productivity change in flatware and tankard production was much slower than in watchmaking: hardly surprisingly, given the far greater scope for specialization in the latter (Figure 9). But whether watchmaking was exceptional, or merely one of several industries registering quiet productivity growth in the era before the Industrial Revolution—a mushroom rather than yeast in the parlance of Harberger (1998; compare Crafts and Harley 1991; Temin 1998)—is an issue beyond the scope of this paper.

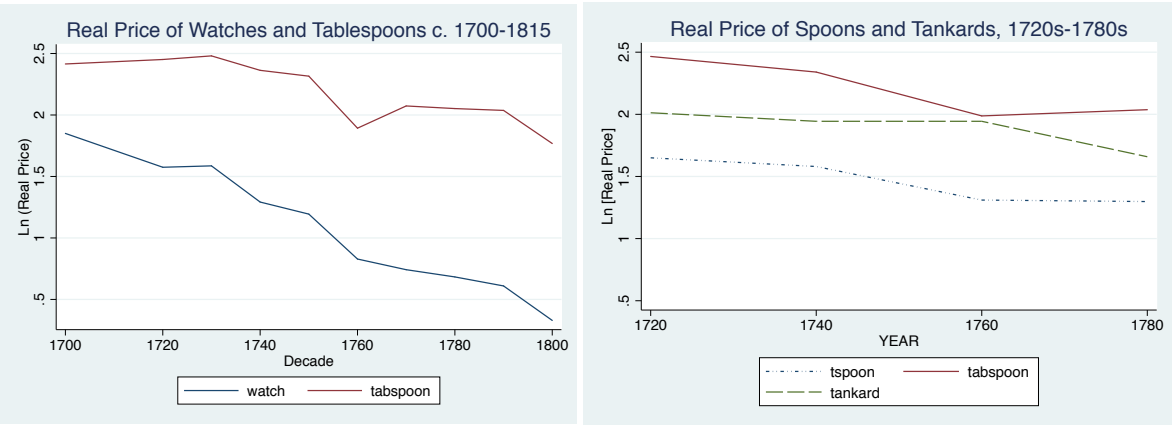


Figure 10. Watches, Spoons, and Tankards c. 1700-1800

8. Conclusion:

Sustained economic growth did not begin in Britain with the Industrial Revolution. It can be traced back to the early seventeenth century. That earlier growth was manifested in urbanization, commercialization, and technological progress in several sectors of the economy. Albeit modest, it both generated and was sustained by an increasing endowment of human capital in the form of a relatively healthy and adaptable and skilled labour force. Healthier and savvier English workers

were better equipped to profit from the technological possibilities available to them, and to build on them. The occasional genius among its artisans was given the scope to capitalize on his talents. Technological change and economic growth stemmed from such human capital rather than Boserupian forces (compare Mokyr 2009: 40-62; Kelly, Mokyr and Ó Gráda 2014a, 2014b; Møller and Sharp 2014). They were the product of England's resource endowment and its institutions.

Bibliography:

A'Hearn, Brian, Joerg Baten, and Dorothee Crayen. 2009. 'Quantifying quantitative literacy: age heaping and the history of human capital', *Journal of Economic History* 69[3]: 783-808.

Allen, Robert C. 2000. 'Economic structure and agricultural productivity in Europe, 1300–1800', *European Review of Economic History* 3[1]: 1-23.

Allen, Robert C. 2005. 'English and Welsh agriculture 1300-1850: output, inputs, and income' [http://www.helsinki.fi/iehc2006/papers3/Allen.pdf].

Allen, Robert C. 2009. *The British Industrial Revolution in Global Perspective*. Cambridge: Cambridge University Press.

Apostolides, Alexander, Stephen Broadberry, Bruce Campbell, Mark Overton, and Bas van Leeuwen 2008. 'English agricultural output and labour productivity, 1250-1850: some preliminary estimates' [http://www.basvanleeuwen.net/bestanden/agriclongrun1250to1850.pdf].

Aspinal, A. 1946. 'The circulation of English newspapers in the early nineteenth century', *Review of English Studies* 22[no. 85]: 29-43.

Aspinall, A. 1948. 'Statistical Accounts of the London Newspapers in the Eighteenth Century' *English Historical Review* 63 [247]: 201-232.

Barham, Tanya, Karen Macours, and John A. Maluccio. 2013. 'Boys' cognitive skill formation and physical growth: long-term experimental evidence on critical ages early childhood interventions', *American Economic Review Papers& Proceeding* 103[3]: 467-71.

Barker, T. C. 1977. *The Glassmakers: Pilkington, the Rise of an International Company 1826-1976*. London: Weidenfeld & Nicholson.

Bailey, F. and Theo C. Barker. 1969. 'The seventeenth-century origins of watch-making in south-west Lancashire', in J. R. Harris, ed. *Liverpool and Merseyside*. London: Cass.

Black, Jeremy. 1991. *The English Press in the Eighteenth Century*. Aldershot: Gregg Revivals.

Blayo, Yves. 1975. 'La mortalité en France de 1740 à 1829' *Population* 30: 123-42.

Bogart, Dan. 2014. 'The transport revolution in industrializing Britain: a survey', in Roderick Floud and Jane Humphries, eds. *The Cambridge Economic History of Britain*, 3rd ed. Cambridge: Cambridge University Press.

Boot, H. M. 1995. 'How skilled were Lancashire cotton factory workers in 1833?' *Economic History Review* 48[2]: 283-303.

Bowden, Peter 1985. 'Statistics', in J. Thirsk, ed. *The Agrarian History of England and Wales*, vol. 5[II], Cambridge: Cambridge University Press, pp. 827-902.

Bowles, Samuel and Herbert Gintis. 2011. *Schooling in Capitalist America: Educational Reform and the Contradictions of Economic Life*, new ed. Chicago: Haymarket Books.

Broadberry, Stephen, Bruce Campbell, and Bas van Leeuwen. 2011. 'When did Britain industrialize? The sectoral distribution of the labour force and labour productivity in Britain 1381-1871' [available at: http://www.lse.ac.uk/economicHistory/pdf/Broadberry/SectoralsharesGB13c.pdf].

Broadberry, Stephen, Bruce Campbell, Alexander Klein, Mark Overton, and Bas van Leeuwen. 2011. 'British economic growth, 1270-1870: an output-based approach'. 18 December [available at: http://www2.lse.ac.uk/economicHistory/pdf/Broadberry/BritishGDPLongRun16a.pdf].

BPP [British Parliamentary Papers].1817. 'Report from the Committee on the Petitions of Watchmakers of Coventry, &c.' (504).

Burnette, Joyce. 2006. 'How skilled were English agricultural labourers in the early nineteenth century?', *Economic History Review,* LIX[4]: 688-716.

Chamberlayne, Edward. 1676. *Angliae Notitia ; or, the Present State of England* London: Martin (available at: http://books.google.com.sg/books?id=UrYJzHdTgfMC&pg=PA211#v=onepage&q&f=false).

Clark, Gregory. 2002. 'Farmland rental values and agrarian history: England and Wales 1500-1912', *European Review of Economic History*, 6(3): 281-309.

Clark, Gregory. 2010. 'The macroeconomic aggregates for England, 1209-2008', *Research in Economic History* 27: 51-140.

Clark, Gregory and Neil Cummins. 2014. 'From Malthus to modernity: wealth, status, and fertility in England 1500-1879', *Journal of Population Economics*, forthcoming.

Crafts, Nicholas F. R. 1989. 'British industrialization in international context' *Journal of Interdisciplinary History* 19[3]: 415-28.

Crafts, N. F. R. and K. Harley. 1992. 'Output growth and the industrial revolution: a restatement of the Crafts-Harley view'. *Economic History Review* 45[4]: 703-30.

Cummins, Neil. 2013. 'Marital fertility and wealth during the fertility transition: rural France 1750-1850',*Economic History Review*, 66(2): 449-476.

Cummins, Neil. 2014. 'Lifespans of the elite, 800-1800', LSE, typescript.

Currie, Janet and Tom Vogl. 2014. 'Early life health and adult circumstances in developing countries'. *Annual Review of Economics*, forthcoming.

Davies, Alun C. 1992. 'Time for a change? Technological persistence in the British watchmaking industry', *Material Culture Review*, 36 <http://journals.hil.unb.ca/index.php/MCR/article/view/17529/22464>.

Epstein, Stephan R. 2004. 'Property rights to technical knowledge in premodern Europe, 1300-1800', *American Economic Review* 94[2]: 382-7.

Erickson, Lee. 1990. 'The Economy of Novel Reading: Jane Austen and the Circulating Library', *Studies in English Literature, 1500-1900* 30[4]: 573-590.

Feather, John. 1985. *The Provincial Book trade in Eighteenth-century England*. Cambridge: Cambridge University Press.

Field, Jacob F. 2013. 'Domestic service, gender, and wages in rural England c. 1700-1860', *Economic History Review*, 66[1]: 249-72.

Floud, Roderick, Robert W. Fogel, Bernard Harris, and Sok Chul Hong. *The Changing Body: Health, Nutrition, and Human Development in the Western World since 1700*. Cambridge: Cambridge University Press, 2011.

Fogel, Robert W. *The Escape form Hunger and Premature Death 1700-2100*. Cambridge: Cambridge University Press, 2004.

Foster, Charles F. and Eric Jones. 2011. Industrialisation and de-industrialisation: England divides (available at: http://mpra.ub.uni-muenchen.de/29247/).

Foster, Charles F. and Eric Jones. 2013. *The Fabric of Society and How it Creates Wealth: Wealth Distribution and Wealth Creation in Europe 100-1800*. Northwich, Cheshire: Arley Hall Press (available at: http://www.arleyhallarchives.co.uk/pdf/fabricofsociety.pdf)

Gardner, Victoria. 2013. 'Stratification of the news-reading market in north-east

England, 1760-1820', *Northern history* 50[2]: 285-306.

Gerhold, Dorian. 1996. 'Productivity change in road transport before and after turnpiking, 1690-1840', *Economic History Review* 49: 491-515.

George, Dorothy. 1953 [1931]. *England in Transition*. Harmondsworth: Penguin.

Hanushek, Eric A and Ludger Woessmann. 2012. 'Do better schools lead to more growth? Cognitive skills, economic outcomes, and causation', *Journal of Economic Growth*, vol. 17[4]: 267-321.

Harberger, Arnold C. 1998. 'A vision of the growth process', *American Economic Review*, 88[1]: 1-32.

Harris, Bernard. 2014. Food for thought: comparing estimates of food availability in England and Wales, 1700-1914. Typescript.

Hatton, Timothy J. 2011. 'Infant mortality and the health of survivors: Britain, 1910-50', *Economic History Review*, 64[3]: 951-72.

Houdaille, Jacques and Louis Henry. 1978. 'Célibat et âge au mariage aux XVIIIe et XIXe siècles en France. I. Célibat définitif' *Population* 33[1]: 43-84.

Hersh, Jonathan and Hans-Joachim Voth. 2008. 'Sweet diversity: colonial goods and the rise in European living standards after 1492. CEPR Discussion Paper 7286.

Horrell, Sara and Deborah Oxley. 2012a. 'Bringing home the bacon? Regional nutrition, stature and gender in the Industrial Revolution', *Economic History Review* 65[4]: 1354-79.

Horrell, Sara and Deborah Oxley. 2012b. 'Hasty pudding versus tasty bread: regional variations in diet and nutrition during the Industrial Revolution', *Local Population Studies*, 89: 9-30.

Houston, Robert A. 1988. *Literacy in Early Modern Europe: Culture and Education 1500-1800* London: Longman.

Howard, Montague. 1903. *Old London Silver: Its History, Its Makers and Its Marks*. London: Batsford, New York: Scribner.

Humphries, Jane. 2003. 'English Apprenticeship: A Neglected Factor in the First Industrial Revolution', in Paul David and Mark Thomas, eds. *Economic Challenges of the Twenty-First Century in Historical Perspective: Celebrating the Scholarly Career of Charles H. Feinstein*, British Academy, pp. 73–102.

Humphries, Jane. 2011. 'Rent seeking or skill creating? Apprenticeship in early industrial Britain', in Perry Gauci, ed. *Regulating the British Economy 1660-1850*. Farnham, Surrey: Ashgate, pp. 235-58.

Hunt, E. H. 1986. 'Industrialization and inequality: regional wages in Britain, 1760–1914'

Journal of Economic History 46: 935–66.

Kelly, Morgan and C. Ó Gráda. 2011. 'The poor law of old England: institutional innovation and demographic regimes', *Journal of Interdisciplinary History*, 41[3]: 339-366.

Kelly, Morgan and C. Ó Gráda. 2012. 'The preventive check in medieval and preindustrial England'. *Journal of Economic History*, 72[4]: 1015-35.

Kelly, Morgan and C. Ó Gráda. 2013. '*Numerare est errare*: agriculture output and food supply before and during the Industrial Revolution', *Journal of Economic History*, 73[4]: 1132-1163.

Kelly, Morgan and C. Ó Gráda. 2014a. 'Living standards and mortality since the middle ages'. *Economic History Review*, 67[2]: 358-81.

Kelly, Morgan and C. Ó Gráda. 2014b. 'Productivity growth before the Industrial Revolution: the example of watchmaking', typescript.

Kelly, Morgan and C. Ó Gráda. 2014c. 'Speed under sail, 1750-1850' UCD Centre for Economic Research WP 2014/10 [http://www.ucd.ie/t4cms/WP14_10.pdf].

Kelly, Morgan, Joel Mokyr, and C. Ó Gráda. 2014a. 'Precocious Albion: a new interpretation of the British Industrial Revolution', *Annual Reviews of Economics*, 6.

Kelly, Morgan, Joel Mokyr, and C. Ó Gráda. 2014b. 'Origins of the Industrial Revolution', typescript.

Klemp, Marc and Jacob Weisdorf. 2012a. 'Fecundity, fertility, and family reconstitution data: the child quantity-quality trade-off during the Industrial Revolution in England', CEPR Discussion Paper No 9121.

Klemp, Marc and Jacob Weisdorf. 2012b. 'The Lasting Damage to Mortality of Early-Life Adversity: Evidence from the English Famine of the Late 1720s', *European Review of Economic History*, 16(3): 233-246.

Long, Jason. 2006. 'The socioeconomic return to primary schooling in Victorian England', *Journal of Economic History* 66[4]: 1026-1053.

McCants, Anne E. C. 2007. 'Exotic goods, popular consumption, and the standard of living: thinking about globalization in the early modern world'. *Journal of World History* 18[4]: 433-62.

Maluccio, John A., John Hoddinott, Jere R. Behrman, Agnes R. Quisumbing, Reynaldo Martorell, and Arye D. Stein. 2009. 'The impact of nutrition during early childhood on education among Guatamalan adults', *Economic Journal* 119: 734-763.

Marshall, John. 1833. *A digest of all the accounts: relating to the population, productions, revenues, financial operations, manufactures, shipping, colonies,*

commerce, &c. &c., of the United Kingdom… London: J. Haddon.

Mathias, Peter. 1959. *The Brewing Industry in England 1700-1830*. Cambridge: Cambridge University Press.

Mathias, Peter. 1975. 'Skills and the diffusion of innovations from Britain in the eighteenth century'. *Transactions of the Royal Historical Society*, 25: 93-113.

Meredith, David and Deborah Oxley. 2014. 'Food and fodder: feeding England, 1700–1900', *Past and Present* 222 (1): 163-214.

Minns, Chris and Patrick Wallis. 2013. 'The price of human capital in a pre-industrial economy: premiums and apprenticeship contracts in 18th century England' *Explorations in Economic History*, 50[3]: 335-350.

Mitch, David. 1992. *The Rise of Popular Literacy in Victorian Englan*d. Philadelphia: University of Pennsylvania Press.

Mitch, David. 1993. 'The role of human capital in the first industrial revolution', in Joel Mokyr, ed. *The British Industrial Revolution: An Economic Perspective*. Boulder: Westview, pp. 267-307.

Mokyr, J. 2010. *The Enlightened Economy.* New Haven: Yale University Press.

Møller, Niels Framroze and Paul Sharp. 2014. 'Malthus in co-integration space:evidence of a post-Malthusian pre-industrial England', *Journal of Economic Growth*, 19[1]: 105-140.

Muldrew, Craig. 2011. *Food, Energy and the Creation of Industriousness: Work and Material Culture in Agrarian England, 1550-1780*. Cambridge: CUP.

Nicholas, Stephen J. and Jacqueline M. Nicholas.1992. 'Male literacy, 'deskilling', and the Industrial Revolution', *Journal of Interdisciplinary History* 23: 1-18.

Nuvolari, Alessandro and Mattia Ricci. 2013. 'Economic Growth in England, 1250-1850: Some New Estimates using a Demand Side Approach', *Rivista di StoriaEconomica* 29: 31-53.

Ó Gráda, C. 2014a. 'Hunger and human capital in England before the Industrial Revolution', in John Nye, Avner Greif, and Lynne Kiesling, eds. *Institutions, Industrialization, and Innovation*. Princeton: Princeton University Press, in press.

Ó Gráda, C. 2014b. 'Did science cause the Industrial Revolution?', *Journal of Economic Literature*, forthcoming.

Ottaway, Susannah. 2013. 'Food and the eighteenth-century workhouse', paper presented at the Anglo-American History Conference, Institute of Historical Research, London, 11-12 July.

Persson, Karl-Gunnar. 1988. *Pre-Industrial Economic Growth, Social Organization and*

Technological Progress in Europe Oxford: Basil Blackwell.

Persson, Karl-Gunnar. 2008. 'The Malthus delusion'. *European Review of Economic History*, 12(2): 165-173.

Prest, John. 1960. *The Industrial Revolution in Coventry*. Oxford: Oxford University Press.

Razzell, Peter. 2014. 'Mortality, population growth and economic development in England, 1600- 1850.' Unpublished.

Reis, Jaime. 2005. 'Economic growth, human capital formation and consumption in Western Europe before 1800', in Robert C. Allen, Tommy Bengtsson and Martin Dribe, eds. *Living Standards in the Past: New Perspectives on Wellbeing in Asia and Europe* Oxford: Oxford University Press, pp. 195-225.

Schofield, Roger. 1973. 'Dimensions of illiteracy 1750-1850', *Explorations in Economic History* 10: 437-54.

Shaw-Taylor, Leigh and E. A. Wrigley. 2014. 'Occupational structure and population change' in R. Floud, Jane Humphries, and Paul Johnson, eds. *The Cambridge Economic History of Modern Britain*, 4th edition. Cambridge: CUP [http://www.geog.cam.ac.uk/research/projects/occupations/abstracts/paper26.pdf].

Shepard, Alexandra and Judith Spicksley. 2011. 'Worth, age, and social status in early modern England', *Economic History Review*, 64[2]: 493-530.

Smith, Adam. 1976 [1776]. *An Inquiry into the Nature and Causes of the Wealth of Nations*. Oxford: Oxford University Press.

Solar, Peter M. 1996. 'Poor relief and English economic development before the industrial revolution', *Economic History Review*, 48[1]: 1-22.

Solar, Peter M. 2013. Opening to the East: Shipping Between Europe and Asia, 1770–1830. *Journal of Economic History* 73[3]: 625-61.

Stephens, W B. 1990.'Literacy in England, Scotland, and Wales, 1500-1900', *History of Education Quarterly* 30[4]: 545-571.

Styles, John. 2007.*The Dress of the People: Everyday Fashion in Eighteenth-Century England*. New Haven: Yale University Press.

Styles, John. 2008. 'Time piece: working men and watches',*History Today* 58[1].

Temin, Peter. 1997. 'Two views of the Industrial Revolution', *Journal of Economic History*, 57[1]: 63-82.

Thirsk, Joan. 1985. 'Agricultural innovations and their diffusion' in J. Thirsk, ed. *The Agrarian History of England and Wales*, vol. 5[II], Cambridge: Cambridge University

Press, pp. 533-89.

Thomas, Keith. 1987. 'Numeracy in early modern England: the Prothero lecture', *Transactions of the Royal Historical Society* 37: 103-132.

Turner, Michael E., John V. Beckett, and Bethanie Afton. 2001. *Farm Production in England, 1700-1914*. Oxford: Oxford University Press.

Van der Beek, Karine. 2014. 'England's eighteenth century demand for high quality workmanship: evidence from apprenticeship, 1710-1770', in John Nye, Avner Greif, and Lynne Kiesling eds., *Institutions, Innovation, and Industrialization: Essays in Economic History and Development*, Princeton: Princeton University Press.

Ville, Simon. 1986. 'Total factor productivity in English shipping: the north-east coal trade, 1700-1870', *Economic History Review*. 39[3]: 355-70.

Weir, David R. 1982. 'Life under pressure: France and England, 1670-1870'. *Journal of Economic History* 44[1]: 27-47.

Wrigley, Edward Anthony. 1967. 'A Simple Model of London's Importance in Changing English Society and Economy 1650-1750' *Past and Present* 37(1): 44-70.

Wrigley, Edward Anthony. 2007. 'English county populations in the later eighteenth century', *Economic History Review*, 60[1]: 35-69.

Wrigley, Edward Anthony and Roger S. Schofield. 1981. *The Population History of England 1541-1871: A Reconstruction*. London: Edward Allen.

Wrigley, Edward Anthony and Roger S. Schofield. 1983. 'English Population History from Family Reconstitution: Summary Results 1600-1799', *Population Studies*, 37[2]: 157-184.

Wrigley, Edward Anthony, Ros S. Davies, James E.Oeppen, and Roger S. Schofield. 1997. *English Population History From Family Reconstitution, 1580-1837* Cambridge: Cambridge University Press.

ENDNOTES

---

[1] These numbers are the best available but not definitive: see Kelly and Ó Gráda 2013; Harris 2014.

[2] Razzell (2014: 10-15) offers some added evidence consistent with a reduction in adult mortality during the eighteenth century that extended to all regions and all socio-economic groups. The second reports the percentages of fathers of spinsters aged

under 21 reported alive (Razzell 2014). The data refer to 20-year averages, except that in the second panel 1720-39 refers to the 1730s only.

[3] The data are taken from Bowden 1985: 864-7.

[4] According to Clark (2010: 56), agriculture's share dropped from 60 per cent c. 1525 to 48 per cent in 1700, 43 per cent in 1800, and 34 per cent in 1851. According to Broadberry, Campbell, and van Leeuwen (2011) the shares in those years were about 58.1, 38.9, 31.7, and 23.5 per cent, while Shaw-Taylor and Wrigley (2014) have proposed percentages of 49.8 c. 1710, 35.7 c. 1817, and 26.9 in 1851. These disparities probably stem in part from whether they exclude (Clark) or include females. Broadberry *et al*. rely on simplifying assumptions about female labour force participation that may inflate their estimate of the non-farming labour force around 1700. Shaw–Taylor and Wrigley offer a compromise estimate. Given the shifting importance of domestic industry, it seems best to include the females.

[5] Comparing Wrigley and Schofield's estimate of the aggregate deaths rate in 1597 and 1598 with the average of those in 1589-1596 and 1599-1606 implies an excess death rate of 10.1 per thousand. In a population of 3.9 million, that would have meant about 40,000 lives lost. By the same token the number of births 'lost' was about 34,500 (derived from Wrigley and Schofield 1981: 531-32).

[6] Muldrew's estimates are more generous still (Muldrew 2011).

[7] The belief that English workers were better fed than their French counterparts was pervasive during the eighteenth century (compare George 1953: 25-28).

[8] Long's analysis of English census data for 1851-1881 is rather an outlier in that it points to significant economic returns to schooling in the mid-Victorian era (Long 2006: 1047).

[9] And this glosses over considerable regional variation within France (Houdaille 1977).

[10] Derived from the British Library's catalogue of early printed books.

[11] The data described in this and in the following paragraph are derived from http://www.lan-opc.org.uk/Prescot/ and *http://www.lan-opc.org.uk/Warrington/stelphin/*.

[12] Thanks to Alex Shepard for insisting on this point.

[13] The data are taken from UK Data Archive, 'Worth' of Witnesses in the English Church Courts, 1550-1728 (SN 5652, compiled by Alex Shepard).

[14] The admission records of St. Luke's Workhouse in Chelsea also survive. The databases are very small, however. The 86 males and 214 females on which there are data in 1743-55 returned *W* values of 1.80 for both males and females; based on 139 males and 252 females, *W* was 1.22 and 1.59 in the 1790s.

Age data are also given in the transcripts of settlement examinations in St. Martins in the Fields. In this case data on women far exceed those on men. In the case of women, the value of Whipple Index fell from 1.96 up to 1736 to 1.41 in the 1790s. These values are based on 713 and 453 observations, respectively.

[15] UK Data Archive SN 6412 Offenders Awaiting Trial at the Old Bailey as Listed in the Newgate Calendars, 1791-1805 (SN 6412, P. King, Open University).

[16] However, as noted earlier, Razzell (2014) argues for a significant increase in English adult life expectancy during the eighteenth century. This could mean that the gap at e_{25} after mid-century was wider than implied by Figure 5.

[17] Houdaille and Henry (1978: 81) imply little change in France in the female percentages never married at aged 50 between the 1760s and the 1810s:

Period	*%*	*Period*	*%*	*Period*	*%*
1765-9	88.2	1775-9	86.8	18785-9	86.0
1795-9	86.4	1805-9	86.9	1815-9	87.6

[18] And Klemp and Weisdorf's ingenious analysis of the fetal origins hypothesis (Klemp and Weisdorf 2012b), based on the same Cambridge Group dataset, yields such an implausible outcome that one worries about the representativeness of their data.

[19] Eden refers to 'the north country fare of milk, potatoes, barley bread and hasty-pudding' [1797: vol. 1, p. 14; see too vol. 3, p. 779 (Westmoreland); vol. 3, p. 822 (Yorkshire West Riding)].

[20] Systematic data on farm size in the eighteenth century are lacking so we measure the prevalence of such smallholdings across counties as the ratio of farms that did not employ labourers to those that did in 1831 (Marshall 1833, 10). Although too late to be ideal, the data corroborate Shaw-Taylor (2012: Table 7-12) and Arthur Young, whose tours imply that typical holdings in small-farm counties were much smaller than those in large-farm counties.

[21] Mathias 1959: 13. Mathias (1959: 373) has also reckoned that brewers were extracting twenty per cent more beer from a given quantity of malt c. 1820 than a century earlier.

[22] Its shaky start drew criticism from Adam Smith, who was opposed to the creation of joint stock companies in manufacturing.

UCD CENTRE FOR ECONOMIC RESEARCH – RECENT WORKING PAPERS

WP13/13 David Madden: 'Born to Win? The Role of Circumstances and Luck in Early Childhood Health Inequalities' September 2013
WP13/14 Ronald B Davies: 'Tariff-induced Transfer Pricing and the CCCTB' September 2013
WP13/15 David Madden: 'Winners and Losers on the Roller-Coaster: Ireland, 2003-2011' September 2013
WP13/16 Sarah Parlane and Ying-Yi Tsai: 'Optimal Contract Orders and Relationship-Specific Investments in Vertical Organizations' October 2013
WP13/17 Olivier Bargain, Eliane El Badaoui, Prudence Kwenda, Eric Strobl and Frank Walsh: 'The Formal Sector Wage Premium and Firm Size for Self-employed Workers' October 2013
WP13/18 Kevin Denny and Cormac Ó Gráda 'Irish Attitudes to Immigration During and After the Boom' December 2013
WP13/19 Cormac Ó Gráda ''Because She Never Let Them In': Irish Immigration a Century Ago and Today' December 2013
WP14/01 Matthew T Cole and Ronald B Davies: 'Foreign Bidders Going Once, Going Twice... Protection in Government Procurement Auctions' February 2014
WP14/02 Eibhlin Hudson, David Madden and Irene Mosca: 'A Formal Investigation of Inequalities in Health Behaviours after age 50 on the Island of Ireland' February 2014
WP14/03 Cormac Ó Gráda: 'Fame e Capitale Umano in Inghilterra prima della Rivoluzione Industriale (Hunger and Human Capital in England before the Industrial Revolution)' February 2014
WP14/04 Martin D O'Brien and Karl Whelan: 'Changes in Bank Leverage: Evidence from US Bank Holding Companies' March 2014
WP14/05 Sandra E Black, Paul J Devereux and Kjell G Salvanes: 'Does Grief Transfer across Generations? - In-Utero Deaths and Child Outcomes' March 2014
WP14/06 Morgan Kelly and Cormac Ó Gráda: 'Debating the Little Ice Age' March 2014
WP14/07 Alan Fernihough, Cormac Ó Gráda and Brendan M Walsh: 'Mixed Marriages in Ireland A Century Ago' March 2014
WP14/08 Doireann Fitzgerald and Stefanie Haller: 'Exporters and Shocks: Dissecting the International Elasticity Puzzle' April 2014
WP14/09 David Candon: 'The Effects of Cancer in the English Labour Market' May 2014
WP14/10 Cormac Ó Gráda and Morgan Kelly: 'Speed under Sail, 1750–1850' May 2014
WP14/11 Johannes Becker and Ronald B Davies: 'A Negotiation-Based Model of Tax-Induced Transfer Pricing' July 2014
WP14/12 Vincent Hogan, Patrick Massey and Shane Massey: 'Analysing Match Attendance in the European Rugby Cup' September 2014
WP14/13 Vincent Hogan, Patrick Massey and Shane Massey: 'Competitive Balance: Results of Two Natural Experiments from Rugby Union' September 2014
WP14/14 Cormac Ó Gráda: 'Did Science Cause the Industrial Revolution?' October 2014
WP14/15 Michael Daly, Liam Delaney, Orla Doyle, Nick Fitzpatrick and Christine O'Farrelly: 'Can Early Intervention Policies Improve Well-being? Evidence from a randomized controlled trial' October 2014
WP14/16 Thérèse McDonnell and Orla Doyle: 'Maternal Employment, Childcare and Childhood Overweight during Infancy' October 2014
WP14/17 Sarah Parlane and Ying-Yi Tsai: 'Optimal Sourcing Orders under Supply Disruptions and the Strategic Use of Buffer Suppliers' October 2014