Living Standards During the Industrial Revolution: An Economist's Guide

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The Industrial Revolution is a topic of renewed interest for growth economists. After the first wave of "new growth" theory that addressed the causes of sustained increases in productivity, more attention has been given to an important additional stylized fact: that rapid growth itself is new in historical terms. A radical discontinuity separates thousands of years of by and large stagnant living standards from the industrial era. Increasingly in the last few years, models have attempted to capture these long-run dynamics to try to explain how the world changed from a state where growth was fleeting and limited to one where it has become permanent and decisive. At the same time, economic historians have re-evaluated changes in living standards during the British Industrial Revolution (the canonical case). The new picture that emerges has become increasingly consistent over the last decade, and it differs drastically from earlier descriptions. This paper briefly summarizes the two literatures, contrasts the results obtained, and makes suggestions for a new set of "stylized facts" that could usefully guide future theoretical and empirical work on the Industrial Revolution.

I. Discontinuity Models and the Industrial Revolution

Theoretical models of long-run economic change began by positing a slow acceleration of growth, driven by larger population size and more numerous inventions (Michael Kremer, 1993). More recent models have argued for a drastic shift from Malthusian to post-Malthusian regime instead. While living standards remain more or less stagnant, the slow accumulation of capital or knowledge ensures that the point of "take-off" is sooner or later reached (Oded Galor and David N. Weil, 2000; Charles I. Jones, 2001; Gary D. Hansen and Edward C. Prescott, 2002; Robert E. Lucas, Jr., 2002). A demographic transition then enables rapid per capita output growth, which is either mechanically "hard-wired" into the models or derived explicitly from utility-maximizing behavior.

The most egregious contradiction between fact and theory concerns the standard assumption that larger population size and more rapid technological progress go hand in hand. Except in a very long-run setting such as in Kremer (1993), there is very little evidence to support this claim. The Industrial Revolution did not occur in the most populous country, nor the most populous continent, nor does the rate of technological progress since 1850 seem to depend in any clear fashion on the number of people alive. None of the models that endogenize the rate of technological progress via the size of the population has anything to say about why 14th century China was not "first." Also, economic incentives for research activity were clearly not crucial, at least in the canonical British case; in most cases, patent protection proved weak by any standard. A potentially richer approach would emphasize the emergence of technological progress as a cumulative process (where the advances of earlier generations are not regularly forgotten) and of open science (thus reducing duplication of research) in Europe from the 15th century onward. Detailed institutional analysis of how useful knowledge was generated, possibly along the lines of Joel Mokyr (2002), should explore the preconditions and ways in which technological progress became cumulative, rapid, and directed toward economically useful activities.

In many long-run growth models, the alternative to technological progress is the more rapid acquisition of human capital. Yet this factor also receives scant support from the

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available data, at least for the period before 1850. David Mitch (1999) shows that skill premia were stagnant or actually declined. Also, school enrollment ratios were low overall in Europe and particularly disappointing in Britain. The vast majority of school and university graduates entered the church or pursued other rent-seeking activities. Nor did the level of formal schooling change during the classic period of the Industrial Revolution, the period between 1750 and 1830. As Mokyr (1990 p. 240) remarked: "If England led the rest of the world in the Industrial Revolution, it was despite, not because of, her formal education system." Unless one conceptualizes human capital very broadly as any embodied ability to absorb new processes and to copy technological inventions made elsewhere, current models make it hard to understand the timing or the location of industrialization. Finally, recent models that, because of the link with human capital, argue that the Industrial Revolution and the demographic transition are almost synonymous are difficult to square with the cross-sectional evidence. For example, France, despite experiencing a very early decline in fertility, only industrialized relatively late.

II. Living Standards and Economic Growth During the Industrial Revolution

Just as growth theorists have begun to model the Industrial Revolution as a dramatic discontinuity, economic historians have found more and more evidence that growth was slow and improvements in the standard of living were very limited. The results of research over the last two decades suggest a set of five stylized facts that may be useful in guiding future theoretical work.

A. *Slow Productivity and Output Growth*

Many discontinuity models see the Industrial Revolution as synonymous with the advent of rapid growth in per capita output and incomes. This is especially true when they are based on the switch from a backward to a "modern" sector. The overwhelming weight of the evidence suggests that the period 1750–1850 was one of surprisingly slow growth in per capita terms. Also, the view that per capita incomes stagnated before the Industrial Revolution is only correct when viewed from a present-day angle. England in 1780 was markedly richer than it had been in 1066, for example. Aggregate output rose by between 0.6 and 1.9 percent per year during 1760–1830, markedly less than the first generation of quantitative economic historians had thought (Table 1). Most of it was absorbed by higher population growth. Total-factor-productivity (TFP) growth was miniscule, as most of the productivity increase was driven by higher capital and labor inputs. Earlier scholars had believed that, from 1800 at least, surging total factor productivity accounted for at least half of output growth, and that capital input also grew very quickly. Actual rates of output and TFP growth were not only disappointing by the standards of economic performance in the OECD post-1945, but also compared to those of other industrializing countries in the second half of the 19th century. Since aggregate productivity growth was so low, the contrast between traditional sectors on the one hand and the "revolutionary" sectors on the other becomes even starker—a clear case of "mushroom," not "yeast-like" technological change. Growth and rates of productivity change only accelerated after 1850, when the classic period of the Industrial Revolution ends.

The timing of productivity and output growth in most European countries during the 18th and 19th centuries therefore suggests that the transition to steady growth in per capita income proceeded in three phases: from a Malthusian to a post-Malthusian state, when population growth no longer depressed living standards,

TABLE 1—OUTPUT AND PRODUCTIVITY GROWTH DURING THE INDUSTRIAL REVOLUTION

Period	Charles Feinstein (1981)	N. F. R. Crafts (1985)	Crafts and C. K. Harley (1992)	Pol Antràs and Voth (2003)
A. *Output:*				
1760–1800	1.1	1	1	
1801–1831	2.7	2	1.9	
1831–1860	2.5	2.5	2.5	
B. *Productivity:*				
1760–1800	0.2	0.2	0.1	0.27
1801–1831	1.3	0.7	0.35	0.54
1831–1860	0.8	1	0.8	0.33

TABLE 2—WEEKLY WORKING HOURS IN THE DEVELOPING WORLD AND INDUSTRIALIZING EUROPE

Country	GNP per capita (1985$)	Hours/week
Developing countries		
Sri Lanka, 1985	370	47.4
Ecuador, 1985	1,150	44
Korea, 1985	2,260	49.0
Thailand, 1985	1,020	48.6
Egypt, 1985	620	56
Kenya, 1985	300	42
Bolivia, 1985	440	44.9
Chile, 1985	1,410	43.1
Uruguay, 1985	1,500	43.4
Paraguay, 1985	1,130	47
Costa Rica, 1985	1,270	43
Poland, 1985	2,020	38.3
Portugal, 1985	2,220	38.8
Average:	1,208.5	45
European countries pre-1913		
Germany, 1820–1830	937	75
Germany, 1870–1880	1,300	72
United Kingdom, 1856	1,888	65
United Kingdom, 1873	2,610	56
France, 1856	1,379	72
France, 1910	2,734	60
United States, 1832	1,048	67.8
United States, 1880	2,247	60.5
Average:	1,768	66
Index (developing countries = 100):	146	147

followed by the "modern" period of sustained increases in output per head (Galor and Weil, 2000).

B. *Stagnant Living Standards*

Initial work suggested that real wages rose by approximately 50 percent between 1780 and 1830, with even faster growth thereafter. More recent results by Charles Feinstein (1998) demonstrate convincingly that real wages probably increased by less than 20 percent—easily within the range of earlier historical experience. Also, household budget surveys and alternative indexes of living standards such as the human development index (HDI) strongly suggest that gains in living standards, broadly defined, were very small. This finding is reinforced by evidence that English heights probably stagnated or fell, even if the issue remains contentious. As

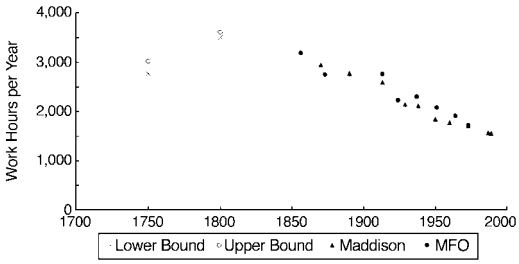

FIGURE 1. WORKING HOURS IN ENGLAND, 1750–1990

Note: References for the plotted points attributed to Maddison and to MFO (Matthews et al.) are provided in Voth (2001 p. 132).

Voth (2003) argues, the turning point in aggregate living standards was probably not reached before the 1830's.

The trend in wages and well-being is therefore no longer at variance with the overwhelming evidence that output growth was slow. Low rates of growth in factor incomes reinforce the findings from the history of output and TFP growth. Putting together the pieces of the puzzle and using the dual approach, Pol Antràs and Voth (2003) demonstrate that TFP growth probably never exceeded 0.6 percent per year during the years 1770–1860 (Table 2). One of the few models that rationalizes the coincidence of a broad, structural transformation with depressed living standards is that of Antonio Ciccone (1996).

C. *Rising Labor Input*

During the Industrial Revolution, Europeans began to work longer—much longer. The age of the "dark satanic mills" saw adults toiling more than 3,200 hours per year, and child labor and women's work were common. By the standards of human history and of today's Third World, hours were extraordinarily long (Table 2, Fig. 1). While output per hour worked is very similar, 19th-century Europeans spent nearly 1.5 times as much time toiling in factories, offices, and workshops and on the fields as do workers in today's Third World. New research strongly suggests that these very long working hours per capita were themselves the result of rapid changes that coincided with the beginning of the transformation of the English economy

(Voth, 2001). While hours were not short in 1750, they increased by approximately 20–35 percent over the following century. This reinforces the pessimistic interpretation of living standards, since leisure declined while material consumption hardly rose. Increasing working hours also directly contradict Jones (2001), who assumes falling labor input per capita as time devoted to child-rearing increased. Instead, it appears that longer working hours of men, women, and children were highly compatible with a massive demographic expansion.

D. *Structural Change*

Employment in agriculture as a percentage of the population declined rapidly. By 1850, only one in four Britons still worked the land, while a century earlier, half the population was still employed in agriculture. The British agricultural labor share in 1750 itself was unusually low: at similar levels of per capita income, most European countries had more than two-thirds of the workforce employed on the land. Because the revolutionizing sectors themselves were still very small, even toward the end of the period, most of the employment growth took place in traditional manufacturing in service industries. The reallocation of labor was sufficiently rapid to reduce the income gap between the primary and the other sectors to zero by 1840.

E. *Rapid Demographic Growth Apparently Unrelated to Living Standards*

Population growth in England accelerated markedly after 1750, with the population doubling between 1750 and 1830. Since neither real wages nor more comprehensive measures of living standards such as HDI show much growth over the period, the demographic explosion is hard to rationalize in economic models. Changes in fertility, not mortality, were decisive (Edward Anthony Wrigley et al., 1997), contradicting classic models of the first phase of the demographic transition. If larger family size had been a response to better living conditions, it would represent a powerful "smoking gun" in favor of increasing well-being. However, fertility apparently only responded weakly (and belatedly) to changes in wages (Wrigley and Richard Schofield, 1981). According to more recent work, the relationship may be even weaker than originally thought (Ronald Lee and Michael Anderson, 1999). Temporary shocks to the demographic-economic system (such as a sudden drop in mortality because of mild winters) took a long time to "die out," reverberating in the system for up to a century.

III. Implications

The Industrial Revolution in most growth models shares few similarities with the economic events unfolding in England in the 18th century. There is little support for a single, sharp discontinuity involving rapid TFP growth, for increasing human or physical capital accumulation, greater skill premia, or fertility limitation. If one adopts a three-stage conceptualization of the economic past, then the Industrial Revolution in the work of most theorists is probably best thought of as the period after 1850, and not the century preceding it. Progress may be more likely to come not from modeling all of the economic past over the last millenia as dominated by a single discontinuity, but adopting a three-stage model and by focusing on the dynamics during the transition itself.

The five important stylized facts suggest that essential elements of the transformation could usefully be captured by extensions of big-push-models (Kevin Murphy et al., 1989). Longer hours and a considerably larger economy due to population growth should have augmented demand. One further attraction of models based on market size is their cross-sectional implications. If a minimum amount of effective demand for goods with high income elasticities and greater potential for technological improvement is crucial, it becomes easier to rationalize why England was "first." More populous than the equally wealthy Dutch, and much richer than the more populous France, by 1750 England probably did have the greatest market size for those goods whose production subsequently became more efficient. Higher working hours per person would have raised market size disproportionately if income elasticities were high, as household budget surveys analyzed by Sara Horrell (1996) strongly suggest they were. One of the few models that captures the

importance of rising labor input is that of Sergio Rebelo (1991), who shows that the accumulation of broad capital (and hence, growth) should be more rapid where working hours are higher.[1]

A second potentially fruitful avenue for future research could explore the link between the nature of technological change and demographic growth. Instead of requiring an ever-rising skill level in the workforce, the Industrial Revolution appears to have been quite compatible with the use of relatively unskilled labor. The balance of the evidence, summarized by Daron Acemoglu (2002), suggests that technological change during the 19th century was more skill-replacing than skill-using. If the nature of technological change initially reduced the direct and indirect cost of rearing children (by turning them into a source of revenue for the family, and thereby also lowering the need to supervise them), it becomes much less difficult to square broadly stagnant real wages with rising fertility.

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[1] Other implications of Rebelo's (1991) model are arguably harder to square with the history of the Industrial Revolution (see Crafts, 1995).

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