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Abstract

This paper re-examines output and productivity growth during the British industrial revolution in the light of recent research. Revised estimates are presented which incorporate new findings on the structure of employment, in particular, that the level of industrialization in the mid-18th century is now known to be considerably higher than was assumed in earlier work. This implies that industrial labour productivity growth was faster than believed by authors of the 1980s but still slower than earlier writers claimed. It is shown that in most important respects the Crafts-Harley view of macroeconomic growth remains basically intact.

Keywords: industrial revolution; productivity growth; take-off

JEL Classification: N13; O47

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1. Introduction

Conventional wisdom about the British Industrial Revolution changed dramatically as a result of research in the 1980s. A new view that described the experience as one of gradual acceleration to a steady but unspectacular growth with rapid productivity advance confined to relatively few sectors was developed by Crafts (1985) and Harley (1982) and refined in Crafts and Harley (1992) whose estimates of the rate of economic growth were a good deal lower than the previous conventional wisdom of Deane and Cole (1962).

The Crafts-Harley view emphasized that the term 'industrial revolution' was an appropriate description but should be understood more in terms of a successful escape from the Malthusian Trap in the face of considerable demographic pressure and rapid structural change culminating in precocious 'industrialization' rather than as a 'take-off' into rapid growth as envisaged by Rostow (1960). Technological progress reflected in total factor productivity (TFP) growth was much more important than capital deepening as a source of growth in labour productivity even if it was less rapid than believers in a 'wave of gadgets' (Ashton, 1948) may have been led to expect. The achievement was remarkable by comparison with anything seen previously but even so was indicative of an economy whose growth potential was quite limited by 20th century standards (Crafts, 1998).

Recent research has made important progress in improving our quantitative information on the economy of the industrial revolution period. Most importantly, we now have much better estimates of structural change (Shaw-Taylor, 2009) which show that employment in the British economy was already much more industrial (and less agricultural) in the mid 18th century than the crude estimates previously available had indicated. Also, a major project by Broadberry et al. (2010), summarized in a working paper with an accompanying database on the web, has compiled improved estimates of long run output growth before and during the industrial revolution. The upshot, as reported by Broadberry et al. (2013), is that industrial labour productivity growth was higher and agricultural productivity growth lower than supposed by Crafts (1985).

Indeed readers of that paper, especially those who absorb the rhetoric without fully appreciating the numbers, could be forgiven for thinking that these new results can rehabilitate a conventional 1960s' view of the industrial revolution. The authors say that their findings "reconcile the output estimates of Crafts and Harley with traditional views of an industrially dynamic industrial revolution" (Broadberry et al., 2013, p. 17) and state that "The once orthodox view that industry was indeed the most dynamic sector during the classic Industrial Revolution is thus reinstated, along with the idea that mechanization based upon technological advance delivered sustained productivity gains to Britain's slowly expanding industrial labour force" (2013, p. 26). In fact, as we shall see, the essence of the Crafts-Harley view is largely maintained and, in some respects, it is reinforced by this new research.

This paper has two principal goals. First, and foremost, the aim is to set out clearly successive vintages of estimates of the growth of real output and productivity during the British industrial revolution with a view to facilitating comparisons between them. Second, against that background, the objective is to explore how far and in what ways the Crafts-Harley view of the industrial

revolution needs to be revised. Finally, the opportunity is taken to highlight a couple of problems or puzzles that emerge from the new estimates.

2. Three Vintages of Output and Productivity Growth Estimates

Tables 1 to 3 present estimates of real output growth, labour force growth and labour productivity growth for agriculture, industry and the whole economy for 1759-1801, 1801-51 and 1801-31. The older numbers from Deane and Cole and from Crafts are largely extracted from earlier work although it should be noted that Crafts did not provide estimates post 1830 but implicitly accepted Deane and Cole's estimates. This approach is also adopted here in extending Crafts' estimates to 1851.

Deane and Cole did not, however, provide explicit estimates for the distribution of the labour force across sectors prior to 1801 although their work was shaped by the social tables of Gregory King, Joseph Massie and Patrick Colquhoun. They believed that employment was overwhelmingly in agriculture in 1700 (1962, p. 137) and, given their estimates for 1801, the implied rate of growth of the industrial labour force during the 18th century was quite rapid and above that assumed by Crafts (1985) who worked with revised social tables produced by Lindert and Williamson (1982) following an analysis of burial records reported in Lindert (1980). To get a sense of what a Deane-and-Cole-vintage estimate might look like for sectoral shares of the labour force in 1759, the method used by Crafts (1985) to use the social tables for this purpose is applied to Massie's unrevised social table with the results reported in parentheses in Table 2.

The construction of the estimates derived from Broadberry et al. needs more discussion. Here the output figures are 5-year averages for centred on the start and end years of the period for which the growth rates are calculated. The labour force percentages for 1759, 1801 and 1851 are taken directly from Broadberry et al. (2013) but no estimate is given for 1831 although this is essential for meaningful comparisons with the earlier work.[1] Filling this gap in future is highly desirable but at present there seems to be no alternative to interpolation. Accordingly the labor force percentages at the sectoral level are taken to be 3/5ths of the distance between 1801 and 1851. This makes both industry and agriculture a slightly larger proportion of total employment than Deane and Cole estimated. To obtain the labour force growth rates, as is conventional, total employment is assumed to grow at the same rate as population and then the numbers in each sector are generated using the sectoral distribution reported in Table 2.[2]

Several points stand out from the estimates of real output growth reported in Table 1. First, with regard to GDP and industrial output growth, the new estimates from Broadberry et al. lie between those of Crafts and Deane and Cole for both 1759-1801 and 1801-51 but only a little higher than Crafts and well below for 1801-51. Second, for the so-called 'classic industrial revolution period' of 1760 to 1830 the average GDP growth rate from Broadberry et al. differs from Crafts by only 0.02% per year and the industrial output growth rate is actually slightly lower, by about 0.1 per cent per

[1] For 1851, Broadberry et al. (2013) used estimates from Shaw-Taylor (2009); for 1759 and 1801 they revised the social tables of Massie and Colquhoun informed by the work of the Cambridge Group and, in particular, adjusted the data to take account of female employment.

[2] This gives labour force growth rates which are different from those implied by the index numbers reported in Broadberry et al. (2013, Table 8) which are incorrect. I am grateful to Steve Broadberry for clarification on this point.

year. Third, the big difference in the new estimates is the much lower growth of agricultural output after 1801 which is largely offset by higher growth of output in services.

In contrast, the Broadberry et al. estimates in Table 2 provide quite a radical revision of the earlier estimates for labour force shares and growth in agriculture and industry. This makes structural change during the industrial revolution less dramatic but it does, however, reinforce the point that Britain was indeed a case of 'precocious industrialization'. The reduction in agriculture's share from 48.0 to 36.8 per cent of employment in 1759 together with the increase in industry's share from 23.8 to 33.9 per cent combined with relatively small changes to the shares in 1851 implies much faster growth of the labour force in agriculture and much lower growth of industrial employment during the industrial revolution than was previously believed. This is a major change, in particular, because of the implications for the locus of productivity growth during the industrial revolution which can be seen in Table 3.

As was highlighted by Broadberry et al. (2013), the big change in Table 3 is that industrial labour productivity growth is higher than that in agriculture throughout, and by a large margin, thus removing the anomalous finding that the opposite was true arrived at in Crafts (1985). This is a new finding which would not have been possible using the data of Deane and Cole's time; the estimates for this vintage in Table 3 show balanced labour productivity growth in agriculture and industry over the whole 1759-1831 period. However, it is also apparent from Table 3 that the new estimates for labour productivity growth in industry are lower than those of Deane and Cole for the first half of the 19th century and this is clearly especially true for 1801-31, despite the uncertainty over the precise labour force shares in 1831. This is not so surprising since we have already seen that Broadberry et al. report distinctly lower industrial output growth post 1801 than did Deane and Cole.

Overall, the picture emerging from the Broadberry et al. estimates is hardly a return to the so-called 'traditional view' of the industrial revolution. The picture of slower growth of output both in the economy overall and in industry compared with Deane and Cole that was presented by Crafts and Harley is endorsed. Similarly, the new estimates of overall labour productivity growth are a little higher than those of Crafts and Harley but are nowhere near to restoring Deane and Cole's story. It follows that the macroeconomic implications of 1980s' revisionism remain with only quite small modifications as will be seen in the next section. There is an important change in the new estimates, which was prompted by the early research findings in Shaw-Taylor (2009), namely, that labour productivity growth in industry was significantly underestimated by Crafts; even so, the new estimates show a more even pace of labour productivity growth during the classic industrial revolution period together with a lower industrial productivity growth rate than in the traditional view, in particular during the early 19th century.

Finally in this section, one rather surprising aspect of the new estimates deserves to be highlighted, namely, that agricultural labour productivity growth is virtually zero during the first half of the 19th century. This does not match the conventional wisdom of quantitative agricultural history or the qualitative descriptions of changes in British agriculture in that period. For example, the careful review of the evidence in Allen (2004) suggested that agricultural labour productivity growth was 0.7 per cent per year in this period with output growth at 1.1 per cent and labour input growth at 0.4 per cent while Overton (1996) pointed to several important sources of improved agricultural labour productivity including a substantial increase in horse power per worker and the rapid diffusion of

new implements and machines which improved labour productivity in harvesting. This suggests that further refinement of the new estimates may yet be required.

3. The Sources of Growth Revisited

By the 1970s, the 'traditional view' of the industrial revolution as reflected in Deane and Cole's estimates was extended through growth accounting techniques notably through chapters written for the pioneering textbook (Feinstein, 1981; McCloskey, 1981) edited by Floud and McCloskey. The results stressed the role of rapid TFP growth in promoting strong growth during the industrial revolution; as McCloskey memorably put it, this was a triumph of 'ingenuity rather than abstention' (1981, p. 108).[3] Since it is calculated as a residual revisions to the estimated rate of growth of real GDP have implications for TFP growth.[4]

Table 4 provides a comparison of different vintages of these growth accounting estimates. The Feinstein (1981) estimates, which are based on Deane and Cole's output growth estimates and his own early capital stock growth estimates (Feinstein, 1978), have been adjusted to allow for land growth and common factor shares have been imposed to facilitate comparisons. The estimates based on Crafts and those constructed using the revised output growth figures from Broadberry et al. both use Feinstein's later capital stock growth estimates (Feinstein, 1988) and the new estimates also use land growth estimates from Allen (2009).[5]

Table 4 shows that the big change from Feinstein to Crafts was in the estimated rate of TFP growth between 1800 and 1830 which was reduced from 1.5 per cent to 0.5 per cent per year. The new estimates are that TFP growth was 0.4 per cent per year for this period. Over this period TFP growth accounts for only about a quarter of output growth which is markedly lower than the 55 per cent estimated by Feinstein but similar to Crafts. This seems to downplay the role of 'ingenuity' compared with McCloskey's claims. If, however, growth accounting is carried out in terms of labour productivity rather than output growth, then Table 5 shows that TFP growth was much more important than capital deepening as a source of labour productivity growth throughout.

McCloskey's position was based not only on TFP growth being rapid and the most important reason why labour productivity increased but also on TFP growth being pervasive in the sense that it was not confined to a few well-known modernized sectors such as cotton textiles but widespread. For the period 1780-1860, McCloskey (1981) estimated that only 44 per cent of an overall TFP growth rate of 1.19 per cent per year could be identified as stemming from modernized sectors in industry and transport. Harley (1999) revisited these calculations to take account of his revised growth estimates and concluded that a more accurate figure was that the modernized sectors accounted for 62 per cent of a total TFP growth rate of 0.55 per cent per year. Table 6 retains Harley's estimates of TFP growth in the modernized sectors but revises overall TFP growth to that implied by the new

[3] This is, of course, consistent with an emphasis on technological progress as the hallmark of the industrial revolution but a rebuttal of the 'capital fundamentalism' of the 1950s, epitomized by Rostow (1960), with its emphasis on growth in the capital stock triggered by a dramatic rise in the share of investment in GDP.

[4] A conventional growth accounting formula is $\Delta Y/Y = s_K \Delta K/K + s_L \Delta L/L + s_N \Delta N/N + \Delta A/A$ where Y is output, K is capital, L is labour, N is land while s_K, s_L and s_N are their factor shares. Given estimates for all these variables, $\Delta A/A$, the rate of TFP growth, is obtained by imposing the equality in the growth accounting equation.

[5] Broadberry et al. (2010) do not attempt new estimates of investment or capital stock growth. Their database does give new estimates for nominal GDP, however, and these imply that investment as a share of output was just slightly lower than previously thought.

estimates. The result is that these sectors (whose weight was about 20 per cent of the economy) now account for 67 per cent of a TFP growth rate of 0.51 per cent per year which imply that average TFP growth across all other sectors of the economy was quite modest.

The bottom line is that the Crafts-Harley view of TFP growth (and technological progress) during the industrial revolution, namely, that it was a good deal slower and more concentrated in a few sectors than used to be believed is basically sustained. Indeed, if anything technological progress was probably slower than TFP growth as measured here because no allowance is made for changes in hours worked or labour quality. Longer hours prior to 1800 (Voth, 2001) and more schooling post 1830 (Mitch, 1999) both point in this direction.

It may seem surprising that the Industrial Revolution delivered such a modest rate of technological progress given the inventions for which it is famous including most obviously those related to the arrival of steam as a general purpose technology (GPT) and Crafts-Harley did not provide a strong enough narrative to address this issue. It should be noted, however, that the well-known stagnation of real wage rates during this period which grew at an average rate of only 0.2 per cent per year between 1760 and 1830 (Allen, 2009) is strong corroborative evidence that TFP growth, which is equal to the weighted average of growth in factor rewards (Barro, 1999), was modest. Moreover, the process of technological advance was characterized by many incremental improvements and learning to realize the potential of the original inventions. This took time in an era where scientific and technological capabilities were still very weak by later standards.

Steam power can now be seen to be an excellent example (Crafts, 2004). As a so-called GPT, it was underwhelming for many years. The estimates in Table 7 show that its impact on productivity growth before 1830 was trivial – as was implied by the detailed quantitative research of von Tunzelmann (1978) and Kanefsky (1979). In 1830, only about 165,000 horsepower were in use, the steam engine capital share was 0.4 per cent and the Domar weight for steam engines was 1.7 per cent. The cost effectiveness and diffusion of steam power was held back by the high coal consumption of the original low-pressure engines and the move to high pressure steam was not generally accomplished until the second half of the 19th century. The science of the steam engine was not well understood and the price of steam power fell very slowly compared with that of electricity or computers in the 20th century, especially before about 1850. The maximum impact of steam power on British productivity growth was delayed until the third quarter of the 19th century – nearly 100 years after James Watt's patent.

4. Conclusions

Recent research has improved our knowledge of key dimensions of the structure of the economy and about economic performance during the British industrial revolution. Revisions to estimates of sectoral shares of employment in the 18th century have had important implications with regard both to estimates of productivity growth in industry and in agriculture and also for our understanding of the speed of industrialization. Improvements in the measurement of output growth have confirmed the basic picture that emerged from work in the 1980s and placed it on a firmer foundation with much greater detail.

It is important to be clear as to how far and in what ways this new research implies the need for revisions to the interpretation of the industrial revolution by Crafts and Harley. The main change is

that, while estimated labour productivity growth at the level of the whole economy is only slightly higher, revised estimates show that industrial labour productivity growth was significantly higher and agricultural labour productivity growth significantly lower than Crafts supposed. The implication is that in the new estimates industrial labour productivity growth was much stronger than growth of agricultural productivity from the mid-18th through the mid-19th century, a finding which has intuitive appeal and satisfactorily resolves an uncomfortable paradoxical conclusion from the dataset of 30 years ago. At the same time, it is important to note that the estimated rate of labour productivity growth in industry is lower than was believed by Deane and Cole and that care needs to be exercised in claiming that traditional views of an industrially dynamic economy have been reinstated.

At the macroeconomic level, in the light of this recent research, the Crafts-Harley view of the industrial revolution remains largely intact. The industrial revolution appears a much less dramatic episode than was once believed. The new estimates imply a similar rate of real GDP growth and of TFP growth to Crafts and Harley and do not reinstate the older Deane and Cole/McCloskey account of overall productivity advance. A Rostovian take-off remains the figment of an over-excited imagination.

There are, however, more revisions still to come which may well further revise the pattern of labour productivity growth at the sectoral level. In particular, when it is possible to use final results from the Cambridge Group's research on the history of occupational structure the distribution of the labour across sectors proposed by Broadberry et al. (2013) will probably be amended somewhat. Also, as we saw earlier, the new-vintage estimates give rather implausible results for the rate of growth of labour productivity in agriculture between 1801 and 1851 which need further thought. We are, after all, still in the realm of controlled conjectures rather than perfect information.

References

Allen, R. C. (2004), "Agriculture during the Industrial Revolution, 1700-1850", in R. Floud and P. Johnson (eds.), *The Cambridge Economic History of Modern Britain*, vol. 1. Cambridge: Cambridge University Press, 96-116.

Allen, R. C. (2009), "Engels' Pause: Technical Change, Capital Accumulation, and Inequality in the British Industrial Revolution", *Explorations in Economic History*, 46, 418-435.

Ashton, T. S. (1948), *The Industrial Revolution, 1760-1830*. London: Oxford University Press.

Barro, R. J. (1999), "Notes on Growth Accounting", *Journal of Economic Growth*, 4, 119-137.

Broadberry, S., Campbell, B., Klein, A., Overton, M. and van Leeuwen, B. (2010), "British Economic Growth, 1270-1870: an Output-Based Approach", University of Warwick CAGE Working Paper No. 35.

Broadberry, S., Campbell, B. M. S.and van Leeuwen, B. (2013), "When Did Britain Industrialize? The Sectoral Distribution of the Labour Force and Labour Productivity in Britain, 1381-1851", *Explorations in Economic History*, 50, 16-27.

Crafts, N. (1985), *British Economic Growth during the Industrial Revolution*. Oxford: Clarendon Press.

Crafts, N. (1998), "Forging Ahead and Falling Behind: the Rise and Relative Decline of the First Industrial Nation", *Journal of Economic Perspectives*, 12(2), 193-210.

Crafts, N. (2002), "The Solow Productivity Paradox in Historical Perspective", CEPR Discussion Paper No. 3142.

Crafts, N. (2004), "Steam as General Purpose Technology: a Growth Accounting Perspective", *Economic Journal*, 114, 338-351.

Crafts N. and Harley, C. K. (1992), "Output Growth and the British Industrial Revolution: a Restatement of the Crafts-Harley View", *Economic History Review*, 45, 703-730.

Deane, P. and Cole W. A. (1962), *British Economic Growth, 1688-1959*. Cambridge: Cambridge University Press.

Edquist, H. (2010), "Does Hedonic Price Indexing Change our Interpretation of Economic History? Evidence from Swedish Electrification", *Economic History Review*, 63, 500-523.

Feinstein, C. H. (1978), "Capital Formation in Great Britain", in P. Mathias and M. M. Postan (eds.), *The Cambridge Economic History of Europe*, vol. 7, part 1. Cambridge: Cambridge University Press, 28-96.

Feinstein, C. H. (1981), "Capital Accumulation and the Industrial Revolution", in R. Floud and D. N. McCloskey (eds.), *The Economic History of Britain since 1700*, vol. 1. Cambridge: Cambridge University Press, 128-142.

Feinstein , C. H. (1988), “National Statistics, 1760-1920”, in C. H. Feinstein and S. Pollard (eds.), *Studies in Capital Formation in the United Kingdom, 1750-1920*. Oxford: Clarendon Press, 259-471.

Harley, C. K. (1982), “British Industrialization before 1841: Evidence of Slower Growth during the Industrial Revolution”, *Journal of Economic History*, 42, 267-289.

Harley, C. K. (1999), “Reassessing the Industrial Revolution: a Macro View”, in J. Mokyr (ed.), *The British Industrial Revolution: an Economic Perspective*. Oxford: Westview Press, 160-205.

Kanefsky, J. (1979), “The Diffusion of Power Technology in British Industry”. Unpublished Ph. D. Dissertation, University of Exeter.

Lindert, P. H. (1980), “English Occupations, 1670-1811”, *Journal of Economic History*, 40, 685-712.

Lindert, P. H. and Williamson, J. G. 91982), “Revising England’s Social table 1688-1812”, *Explorations in Economic History*, 19, 385-408.

Mitch, D. (1999), “The Role of Education and Skill in the Industrial Revolution”, in J. Mokyr (ed.), *The British Industrial Revolution: an Economic Perspective*. Oxford: Westview Press, 241-279.

Oliner, S. D., Sichel, D. E. and Stiroh, K. J. (2007), "Explaining a Productive Decade", *Brookings Papers on Economic Activity,* 1, 81-152.

Oulton, N. (2012), “Long-Term Implications of the ICT Revolution: Applying the Lessons of Growth Theory and Growth Accounting”, Economic Modeling, 29, 1722-1736.

Overton, M. (1996), *Agricultural Revolution in England: the Transformation of the Agrarian Economy 1500-1850*. Cambridge: Cambridge University Press.

Rostow, W. W. (1960), *The Stages of Economic Growth*. Cambridge: Cambridge University Press.

Shaw-Taylor, L. (2009), “The Occupational Structure of England and Wales, 1750-1871: a Preliminary Report”, Cambridge Group for the History of Population and Social Structure Occupations Project Paper No. 19.

Von Tunzelmann, G. N. (1978), *Steam Power and British Industrialization to 1860*. Oxford: Clarendon Press.

Voth, H-J. (2001), “The Longest Years: New Estimates of Labor Input in England, 1760-1830”, *Journal of Economic History*, 61, 1065-1082.

Table 1. Real Output Growth (% per year)

	Agriculture	*Industry*	*GDP*
1759-1801			
Deane and Cole	0.56	1.96	1.36
Crafts	0.44	1.62	1.01
Broadberry et al.	0.68	1.62	1.15
1801-1851			
Deane and Cole	1.80	3.47	2.78
Crafts	1.52	2.47	1.92
Broadberry et al.	0.83	2.76	1.99
1801-1831			
Deane and Cole	1.64	4.44	3.06
Crafts	1.18	2.78	1.90
Broadberry et al.	0.64	2.58	1.68

Sources: Deane and Cole (1962); Crafts (1985) revised by Crafts and Harley (1992); data constructed by Broadberry et al. (2010).

Table 2. Labour Force Shares and Labour Force Growth

a) Shares (%)

	Deane and Cole	***Crafts***	***Broadberry et al.***
1759			
Agriculture	(47.8)	48.0	36.8
Industry	(19.2)	23.8	33.9
1801			
Agriculture	35.9	35.9	31.7
Industry	29.7	29.7	36.4
1831			
Agriculture	24.6	24.6	(26.8)
Industry	40.8	40.8	(41.9)
1851			
Agriculture	21.6	21.6	23.5
Industry	42.3	42.3	45.6

b) Growth (% per year)

	Agriculture	***Industry***	***GDP***
1759-1801			
Deane and Cole	(0.11)	(1.86)	0.81
Crafts	0.06	1.36	0.81
Broadberry et al.	0.44	0.99	0.81
1801-1851			
Deane and Cole	0.43	2.17	1.42
Crafts	0.43	2.17	1.42
Broadberry et al.	0.82	1.80	1.36
1801-1831			
Deane and Cole	0.19	2.57	1.37
Crafts	0.19	2.57	1.37
Broadberry et al.	(0.97)	(1.90)	1.44

Note: the proportions of the labour force in 1759 for Crafts were obtained using the revised social table of Lindert and Williamson (1982) as described in Crafts (1985, p. 14); the proportions attributed to 'Deane and Cole' are based on the same method applied to Massie's original table since the revised social table was not available to them.

Sources:

Part a): Deane and Cole (1962) augmented for 1759, see text; Crafts (1985); Broadberry et al. (2013) with 1831 interpolated.

Part b): Deane and Cole (1962); Crafts (1985); revised version of Broadberry et al. (2013)

Table 3. Labour Productivity Growth (% per year)

	Agriculture	***Industry***	***GDP***
1759-1801			
Deane and Cole	(0.45)	(0.10)	0.55
Crafts	0.38	0.26	0.20
Broadberry et al.	0.24	0.63	0.34
1801-1851			
Deane and Cole	1.37	1.30	1.36
Crafts	1.09	0.30	0.50
Broadberry et al.	0.01	0.96	0.64
1801-1831			
Deane and Cole	1.45	1.87	1.69
Crafts	0.99	0.21	0.53
Broadberry et al.	(-0.33)	(0.68)	(0.24)

Source: derived from Tables 1 and 2.

Table 4. Accounting for Output Growth (% per year)

	Capital Contribution	*Labour Contribution*	*Land Contribution*	*TFP Growth*	*Real GDP Growth*
Feinstein					
1760-1800	0.35*1.0 = 0.35	0.50*0.8 = 0.40	0.15*0.2 = 0.03	0.3	1.1
1800-1830	0.35*1.4 = 0.49	0.50*1.4 = 0.70	0.15*0.4 = 0.06	1.5	2.7
1830-1860	0.35*2.0 = 0.70	0.50*1.4 = 0.70	0.15*0.6 = 0.09	1.0	2.5
Crafts					
1760-1800	0.35*1.0 = 0.35	0.50*0.8 = 0.40	0.15*0.2 = 0.03	0.2	1.0
1800-1830	0.35*1.7 = 0.60	0.50*1.4 = 0.70	0.15*0.4 = 0.06	0.5	1.9
1830-1860	0.35*2.5 = 0.88	0.50*1.4 = 0.70	0.15*0.6 = 0.09	0.8	2.5
New					
1760-1800	0.35*1.0 = 0.35	0.50*0.8 = 0.40	0.15*0.5 = 0.08	0.4	1.2
1800-1830	0.35*1.7 = 0.60	0.50*1.4 = 0.70	0.15*0.1 = 0.02	0.4	1.7
1830-1860	0.35*2.5 = 0.88	0.50*1.4 = 0.70	0.15*0.1 = 0.02	0.7	2.3

Note: all estimates are derived on standard neoclassical assumptions with the weights as follows: capital = 0.35, land = 0.15, labour = 0.5.

Sources: Feinstein (1981) adjusted to 3-factor formula using land growth as in Crafts (1985); Crafts (1985) with revisions from Crafts and Harley (1992); new estimates based on Crafts revised with land growth from Allen (2009) and real GDP growth based on Broadberry et al. (2010).

Table 5. Accounting for Output per Worker Growth (% per year)

	K/L growth	*N/L growth*	*TFP growth*	*Y/L growth*
1760-1800	0.35*0.2 = 0.07	0.15*-0.3 = -0.04	0.4	0.4
1800-1830	0.35*0.3 = 0.10	0.15*-1.3 = -0.20	0.4	0.3
1830-1860	0.35*1.1 = 0.38	0.15*-1.3 = -0.20	0.7	0.9

Sources: as for new estimates in Table 4

Table 6. Contributions to TFP Growth, 1780-1860 (% per year)

	McCloskey	***Harley***	***New***
Modernized Sectors	0.55	0.34	0.34
Other sectors	0.64	0.21	0.17
Total	1.19	0.55	0.51

Note: modernized sectors are textiles, iron, and transport.

Sources: McCloskey (1981); Harley (1999); updated version of Harley to incorporate new output growth estimates from Broadberry et al (2010).

Table 7. GPTs: Contributions to Labour Productivity Growth (% per year)

Steam (UK)	
1760-1830	0.01
1830-1870	0.30
Electricity (USA)	
1899-1919	0.40
1919-1929	0.98
ICT (USA)	
1973-1995	0.74
1995-2006	1.45

Memorandum Item: Real Price Falls (%)

Steam Horsepower	
1760-1830	39.1
1830-1870	60.8
Electric Motors (Sweden)	
1901-1925	38.5
ICT Equipment	
1970-1989	80.6
1989-2007	77.5

Note:

Growth accounting contributions include both capital deepening from use and TFP from production.

Price fall for ICT equipment includes computer, software and telecoms; the price of computers alone fell much faster (22.2% per year in the first period and 18.3% per year in the second period).

Sources:

Growth accounting: Crafts (2002) (2004) and Oliner et al. (2007).

Price falls: Crafts (2004), Edquist (2010) and Oulton (2012).