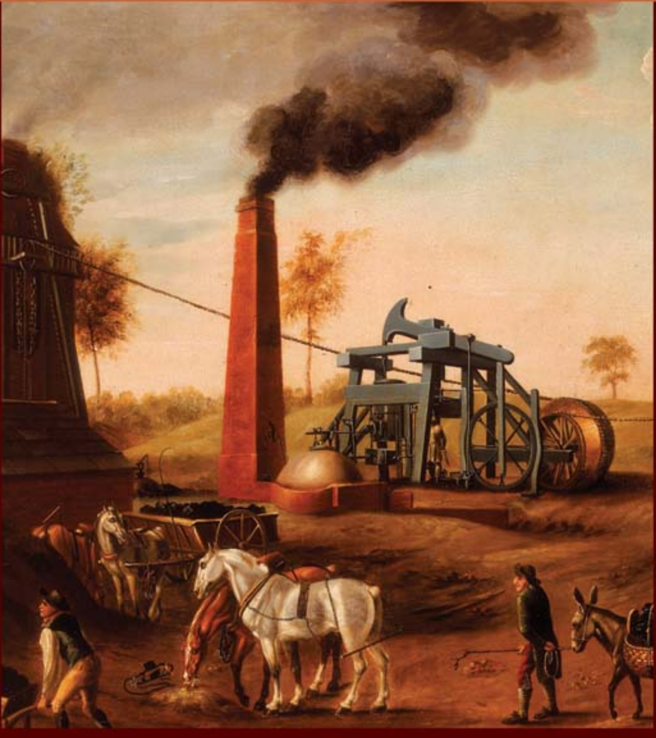
NEW APPROACHES TO ECONOMIC AND SOCIAL HISTORY

THE BRITISH INDUSTRIAL REVOLUTION IN GLOBAL PERSPECTIVE

Robert C. Allen



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The British Industrial Revolution in Global Perspective

Why did the Industrial Revolution take place in eighteenth-century Britain and not elsewhere in Europe or Asia? In this convincing new account Robert Allen argues that the British Industrial Revolution was a successful response to the global economy of the seventeenth and eighteenth centuries. He shows that in Britain wages were high and capital and energy cheap in comparison to other countries in Europe and Asia. As a result the breakthrough technologies of the Industrial Revolution – the steam engine, the cotton mill, and the substitution of coal for wood in metal production – were uniquely profitable to invent and use in Britain. The high wage economy of pre-industrial Britain also fostered industrial development since more people could afford schooling and apprenticeships. It was only when British engineers made these new technologies more cost-effective during the nineteenth century that the Industrial Revolution would spread around the world.

Robert C. Allen is Professor of Economic History at Oxford University and a fellow of Nuffield College. His books include *Enclosure and the Yeoman: The Agricultural Development of the South Midlands, 1450–1850* (1992), and *Farm to Factory: A Re-interpretation of the Soviet Industrial Revolution* (2003), both of which won the Ranki Prize of the Economic History Association.

Surname	First name	Industry
Spode	Josiah I	ceramics
Spode	Josiah II	ceramics
Strutt	Jedediah	textiles
Strutt	William	machines
Taylor	Clement	chemicals
Tennant	Charles	chemicals
Tompion	Thomas	horology
Trevithick	Richard	steam
Wall	John	ceramics
Ward	Joshua	chemicals
Wilkinson	Isaac	metals
Wilkinson	John	machines
Wyatt	John	textiles

11 *From Industrial Revolution to modern economic growth*

> The industrially more developed country presents to the less developed country a picture of the latter's future.
>
> Karl Marx, *Capital*, vol. I, preface

I have argued that the famous inventions of the British Industrial Revolution were responses to Britain's unique economic environment and would not have been developed anywhere else. This is one reason that the Industrial Revolution was *British*. But why did those inventions matter? The French were certainly active inventors, and the Scientific Revolution was a pan-European phenomenon. Wouldn't the French, or the Germans, or the Italians, have produced an industrial revolution by another route? Weren't there alternative paths to the twentieth century?

These questions are closely related to another important question asked by Mokyr: why didn't the Industrial Revolution peter out after 1815? He is right that there were previous occasions when important inventions were made. The result, however, was a one-shot rise in productivity that did not translate into sustained economic growth. The nineteenth century was different – the First Industrial Revolution turned into Modern Economic Growth. Why? Mokyr's answer is that scientific knowledge increased enough to allow continuous invention. Technological improvement was certainly at the heart of the matter, but it was not due to discoveries in science – at least not before 1900. The reason that incomes continued to grow in the hundred years after Waterloo was because Britain's pre-1815 inventions were particularly transformative, much more so than continental inventions. That is a second reason that the Industrial Revolution was *British* and also the reason that growth continued throughout the nineteenth century.

Cotton was the wonder industry of the Industrial Revolution – so much so that Gerschenkron (1962), for instance, claimed that economic growth in advanced countries was based on the expansion of consumer goods, while growth in backward countries was based on producer goods. This is an unfortunate conclusion, however, for the great achievement of the British Industrial Revolution was, in fact, the creation of the first large engineering industry that could mass-produce productivity-raising machinery.[1] Machinery production was the basis of three developments that were the immediate explanations of the continuation of economic growth until the First World War. Those developments were: (1) the general mechanization of industry; (2) the railroad; and (3) steam-powered iron ships. The first raised productivity in the British economy itself; the second and third created the global economy and the international division of labour that were responsible for significant rises in living standards across Europe (O'Rourke and Williamson 1999). Steam technology accounted for close to half of the growth in labour productivity in Britain in the second half of the nineteenth century (Crafts 2004).

The nineteenth-century engineering industry was a spin-off from the coal industry. All three of the developments that raised productivity in the nineteenth century depended on two things – the steam engine and cheap iron. Both of these, as we have seen, were closely related to coal. The steam engine was invented to drain coal mines, and it burnt coal. Cheap iron required the substitution of coke for charcoal and was prompted by cheap coal. (A further tie-in with coal was geological – Britain's iron deposits were often found in proximity to coal deposits.) There were more connections: the railroad, in particular, was a spin-off from the coal industry. Railways were invented in the seventeenth century to haul coal in mines and from mines to canals or rivers. Once established, railways invited continuous experimentation to improve road beds and rails. Iron rails were developed in the eighteenth century as a result, and alternative dimensions and profiles were explored. Furthermore, the need for traction provided the first market for locomotives. There was no market for steam-powered land vehicles because roads were unpaved and too uneven to support a steam vehicle (as Cugnot and Trevithick discovered). Railways, however, provided a controlled surface on which steam vehicles could function, and colliery railways were the first purchasers of steam locomotives. When George Stephenson developed the Rocket for the Rainhill trials, he tested his

[1] Hoffman (1955, pp. 72–4) calculated that producer goods industries as a whole grew more rapidly than consumer goods industries in industrializing Britain.

design ideas by incorporating them in locomotives he was building for coal railways. In this way, the commercialization of primitive versions of technology promoted further development as R&D expenses were absorbed as normal business costs.

Cotton played a supporting role in the growth of the engineering industry for two reasons. The first is that it grew to immense size. This was a consequence of global competition. In the early eighteenth century, Britain produced only a tiny fraction of the world's cotton. The main producers were in Asia. As a result, the price elasticity of demand for English cotton was extremely large. If Britain could become competitive, it could expand production enormously by replacing Indian and Chinese producers. Mechanization led to that outcome (Broadberry and Gupta 2006). The result was a huge industry, widespread urbanization (with such external benefits as that conveyed), and a boost to the high wage economy. Mechanization in other activities did not have the same potential. The Jacquard loom, a renowned French invention of the period, cut production costs in lace and knitwear and, thereby, induced some increase in output. But knitting was not a global industry, and the price elasticity of demand was only modest, so output expansion was limited. One reason that British cotton technology was so transformative was that cotton was a global industry with more price-responsive demand than other textiles.

The growth and size of the cotton industry in conjunction with its dependence on machinery sustained the engineering industry by providing it with a large and growing market for equipment. The history of the cotton industry was one of relentlessly improving machine design – first with carding and spinning and later with weaving. Improved machines translated into high investment and demand for equipment. By the 1840s, the initial dependence of cotton manufacturers on water power gave way to steam-powered mills (von Tunzelmann 1978, pp. 175–225). By the middle of the nineteenth century, Britain had a lopsided industrial structure. Cotton was produced in highly mechanized factories, while much of the rest of manufacturing was relatively untransformed. In the mid-nineteenth century, machines spread across the whole of British manufacturing (one of the causes of the continuing rise in income).

There was a great paradox in the history of technology during the Industrial Revolution. As we have emphasized, the macro-inventions of the eighteenth century were biased improvements that increased the demand for capital and energy relative to labour. Since capital and energy were relatively cheap in Britain, it was worth developing the macro-inventions there and worth using them in their early, primitive forms. These forms were not cost-effective elsewhere where labour was cheaper and energy dearer. However, British engineers improved this technology. They studied it, modified it, and made it more efficient. This local learning often saved the input that was used excessively in the early years of the invention's life and which restricted its use to Britain. As the coal consumption of rotary steam power declined from 35 pounds per horsepower-hour to 5 pounds, it paid to apply steam power in more and more uses. This was why mechanization spread beyond the cotton textile industry in the middle of the nineteenth century. But the decline in coal consumption meant a geographical spread as well as an industrial spread. Old-fashioned, thermally inefficient steam engines were not 'appropriate' technology for countries where coal was expensive. These countries did not have to invent an 'appropriate' technology for their conditions, however. The irony is that the British did it for them. As the steam engine became more fuel-efficient, it was taken up in more countries – even those where coal was expensive. In that way, the Industrial Revolution spread around the globe. The genius of British engineering undid Britain's comparative advantage.

It is important that the British inventions of the eighteenth century – cheap iron and the steam engine, in particular – were so transformative, because the technologies invented in France – in paper production, glass and knitting – were not. The French innovations did not lead to general mechanization or globalization. One of the social benefits of an invention is the door it opens to further improvements. British technology in the eighteenth century had much greater possibilities in this regard than French inventions or those made anywhere else. The British were not more rational or prescient than the French in developing coal-based technologies: The British were simply luckier in their geology. The knock-on effect was large, however: there is no reason to believe that French technology would have led to the engineering industry, the general mechanization of industrial processes, the railway, the steamship or the global economy. In other words, there was only one route to the twentieth century – and it traversed northern Britain.

References

Abel, Wilhelm (1980). *Agricultural Fluctuations in Europe from the Thirteenth to the Twentieth Centuries*, trans. by Olive Ordish, London, Methuen.

Acemoglu, Daron (2002). 'Directed Technical Change', *Review of Economic Studies*, vol. 69, pp. 781–809.

(2003). 'Factor Prices and Technical Change: From Induced Innovations to Recent Debates', in Philippe Aghion *et al.* (eds.), *Knowledge, Information and Expectations in Modern Macroeconomics: In Honor of Edmund Phelps*, Princeton, NJ, Princeton University Press.

(2007). 'Equilibrium Bias of Technology', *Econometrica*, vol. 75, pp. 1371–409.

Acemoglu, Daron, Johnson, Simon, and Robinson, James (2005). 'The Rise of Europe: Atlantic Trade, Institutional Change and Economic Growth', *American Economic Review*, vol. 95, pp. 546–79.

A'Hearn, Brian (2003). 'Anthropometric Evidence on Living Standards in Northern Italy, 1730–1860', *Journal of Economic History*, vol. 63, pp. 351–81.

Allen, Robert C. (1983). 'Collective Invention', *Journal of Economic Behavior and Organization*, vol. 4, pp. 1–24.

(1988). 'The Growth of Labor Productivity in Early Modern English Agriculture', *Explorations in Economic History*, vol. 25, pp. 117–46.

(1992). *Enclosure and the Yeoman*, Oxford, Clarendon Press.

(1994). 'Agriculture During the Industrial Revolution', in Roderick Floud and D. N. McCloskey (eds.), *The Economic History of Britain Since 1700*, vol. I, *1700–1860*, Cambridge, Cambridge University Press, second edition, pp. 96–122.

(1999). 'Tracking the Agricultural Revolution', *Economic History Review*, 2nd series, vol. 52, pp. 209–35.

(2000). 'Economic Structure and Agricultural Productivity in Europe, 1300–1800', *European Review of Economic History*, vol. 3, pp. 1–25.

(2001). 'The Great Divergence in European Wages and Prices from the Middle Ages to the First World War', *Explorations in Economic History*, vol. 38, October 2001, pp. 411–47.