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The British Iron and Steel Industry, 1870-1914: A Study of the Climacteric in Productivity

One clear advantage of dissecting an event in economic history with an economist's tools is that the sharpness of the tools permits one to cut the event into explained and unexplained parts with fair precision. There is no presumption that the unexplained part will be small, but at least one knows the magnitude of the explanatory job remaining. My dissertation takes this approach to the explanation of the British economic climacteric at the end of the nineteenth century. "It seems clear enough" to D. J. Coppock, as to many other students of the period, "that in the iron and steel industry there was a decline in entrepreneurial talent after the 1870's."[1] The main thread of my study of the iron and steel industry tests this assertion by attempting to explain certain aspects of the industry's history from 1870 to 1914 in economic terms.

The first task is to find some index of performance in the industry. To do this I construct measures of total productivity change in the pig iron, puddled iron, Bessemer steel, and open hearth steel sectors of the industry from 1870 to 1914, using Solow's residual method. Although the method is satisfactory for the pig iron sector, for which there are good data on the quantities of inputs, particularly coke and iron ore, in the other sectors the quantity data are poor. Therefore, I develop a price dual to Solow's quantity primal measure of productivity change and apply it to the ample price data in these sectors.

The measure indicates that productivity change had ceased in all sectors of the industry by 1895. Puddling productivity, indeed, did not grow at all during the period from 1870 to 1914. In Bessemer steel, productivity grew rapidly during the 1860's and 1870's, but had ceased by the middle of the 1880's. In pig iron the cessation came later in the 1880's and in open hearth steel, with productivity growing somewhat slower than Bessemer productivity had grown, it came in the middle of the 1890's.

A number of points can be made on the basis of the productivity measure alone. First, the major innovations in the making of steel products came at the ingot-making stage of production rather than at the rolling and finishing stages. There was some fall in the price of steel products relative to steel ingots, but it was small compared with the great semer and open hearth processes required a great deal of practical perfecting. Finally, the perfecting of the processes rather than a fall in the price of suitable pig iron or the removal of the Bessemer and Siemens royalties produced the great price fall in steel during the 1870's and 1880's. The royalties, for example, were only 10 percent of the price of Bessemer steel in 1870, whereas productivity change in Bessemer steel during the 1860's and 1870's was on the order of 10 percent each year.

Having measured the course of productivity change, I try to explain it. The primary explanation is the course of best practice technology, that is, the course of the knowledge of steel making and iron making. It has often been alleged that in making pig iron and Bessemer steel the United States exploited the available technology better than did Britain. By using the residual method to compare the levels of productivity in the two countries, however, one can show that there was no great difference in productivity until World War I. In open hearth productivity, indeed, Britain was for a long time superior to her American and Continental competitors. From this and similar evidence it appears that technological limits—"a worldwide exhaustion of the innovations of Steam and Steel," if you wish—rather than a failure of British entrepreneurs explains the climacteric in iron and steel productivity.

An alternative explanation is that slower growing demand for British iron and steel reduced the opportunities for investment in machines embodying new techniques. There are two points to be made. First, I show earlier that the rate of growth of new technique was small after the late 1880's and British output did not grow more slowly than output elsewhere until the 1890's. Second, the embodiment effect depends on a change in the rate of entry of fresh capital into the capital stock and the rate of entry was kept from falling a great deal when demand growth slowed in Britain by the sustained high rate of replacement investment.

Another possibility is that the quality of demand for iron and steel discouraged iron and steel manufacturers from innovating rapidly. It is often argued, to take one example, that puddled iron kept its position as a raw material for ship plates much longer than it should have because of irrational preferences for it over steel by consumers and standard-setters like the Admiralty and Lloyd's. It can be shown, however, that the shift from iron to steel in ships was not remarkably slow: The limitations on the use of steel arose from its high price and from certain real difficulties with its quality.

Finally, the market structure in Britain could have hindered productivity change. One version of this argument is that limitations on competition removed the incentive to modernize. I measure in several ways, however, the maximum possible degree of monopoly power in the industry and find that it was negligible down to 1895 and quite small thereafter. The iron and steel industry was competitive before 1914. If there was any connection between productivity and a lack of competition, it was that the climacteric produced a regime of unchanging costs conducive to price-fixing rather than the other way around. It is often argued that the neglect of the basic steel process and Britain's phosphoric ores was a consequence of the limitations on competition. In fact, their neglect was a consequence of the cost of steel inputs: One can show in this case, as in other important cases of divergence between British and foreign techniques, that British techniques suited British economic conditions.

I have emphasized here the central argument of the dissertation, namely, that the exhaustion of technological possibilities explains most of the retardation in iron and steel productivity growth before 1914. I do, however, treat issues of a narrative sort to the side of the central argument. The chapter on demand, for example, examines the timing of the substitution of steel for iron in rails and ships, the rate of growth of the industry's domestic demand, and the magnitude of the effects of productivity change, tariffs, and dumping on foreign demand. In another chapter I examine the effects of World War I on the industry as a postscript to the central argument. The dissertation, in short, combines an inquiry into the climacteric with a selective narrative of the British iron and steel industry in the late nineteenth and early twentieth centuries.

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