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British Relative Economic Decline in the Aftermath of German Unification

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Abstract

From 1871 to 1913, German economic growth was faster than that of the UK. This represented a successful catch-up of the leading European economy but there was still a significant productivity gap at the end of the period. Slower UK growth should be seen as largely unavoidable but there was a serious weakness in the national innovation system. On the whole, the greater openness of the British economy was advantageous and a move to protectionist policies would have been damaging. The expansion of German industrial production and exports only had a small negative impact on UK national income.

Keywords: economic growth; productivity performance; trade rivalry; Victorian failure

JEL Classification: N13; O52

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1. Introduction

Between 1871 and 1913 economic growth in the UK was considerably slower than in Germany and the UK was overtaken by the United States in terms of real GDP per person. While labour productivity growth in the UK slowed down quite markedly in the 1870s and failed to pick up as the second industrial revolution gathered pace, the opposite was the case in Germany. By 1913 Germany had reduced the gap in real GDP person with the UK quite considerably and had established a productivity lead in the industrial sector. Evidently, the relative economic decline of the UK which was to continue through much of the 20th century had already begun.

There is a strong tradition in British economic history which alleges that late Victorian (and Edwardian) Britain 'failed' and that, as a result, economic growth was retarded. This claim was vigorously disputed by the early cliometricians but it cannot be regarded as completely refuted, especially with the advent of endogenous growth economics. The suggestion of failure typically entails the hypothesis that British institutions and/or government policies compared unfavourably with those of other countries, notably including Germany, and needed reform. In particular, it has been suggested that the UK could have benefited from a German-style banking system, that German policies to promote scientific and technological education were superior in the era of the second industrial revolution, and that the UK was ill-advised to maintain free-trade when its main rivals including Germany were protectionist.

A prominent feature of the decades before World War I, especially for contemporaries, was the growing Anglo-German trade rivalry. The populist *Made in Germany* (Williams, 1896) reflected a widespread angst that German prowess in manufactures was undermining Britain's position in the world economy and advocated an end to free trade. The UK share of world exports of manufactures fell while that of Germany increased and Germany rather than the UK established a comparative advantage in several new industries. If there were direct adverse effects of the development of the German economy on British economic growth, the trade channel has been seen by some as the obvious possibility.

In what follows, I start in section 2 by setting out the details of comparative growth and productivity performance for German and the UK in the period 1871 to 1913. Then in section 3, I review the extensive literature on a possible growth failure in Britain during these years and highlight some areas of concern but concluding that there was no massive growth failure. After that, in section 4 I examine the implications of Anglo-German trade rivalry for UK growth performance finding that there is no strong evidence that this had serious implications.

2. Comparative Growth and Productivity Performance

Over the period 1871 to 1913 the growth of real GDP per person was 1.48 per cent per year in Germany compared with 0.81 per cent per year in the UK. Faster German growth came in the context of an initially much lower level of real income and entailed catching up of the UK such that real GDP per person rose from 56.2 per cent of the UK level in 1871 to 74.1 per cent by 1913 (Table 1).

As might be expected, Table 2 shows that faster growth of real GDP per person is largely accounted for by superior growth of labour productivity in Germany which averaged 1.75 per cent per year over the period 1871-1913 compared with 1.06 per cent per year in the UK during 1873-1913 (Table 2). Table 2 also reports that labour productivity growth in Germany speeded up after 1871 whereas in the UK the opposite was the case. Indeed, econometric analysis of UK labour productivity growth based on output per hour worked finds that trend growth declined from 2.15 per cent per year in 1869 to 0.84 per cent in 1890 such that the so-called 'climacteric' was in the 1870s not after 1899 as is sometimes claimed (Crafts and Mills, 2020).

According to the growth accounting exercise which is implemented in Table 2, both capital deepening and crude TFP contributions to labour productivity growth were larger in Germany than the UK with the latter accounting for a substantial share (64 per cent) of German outperformance over the whole period. The gap in TFP growth between the two countries is quite considerable (0.68 percentage points) during the years from the late 19th century to World War I at which point German TFP growth was sustained but UK TFP growth weakened appreciably. An obvious point to note is that a sizeable part of the excess of TFP growth in Germany compared with the UK came from structural shift associated with a decline in the share of low-productivity employment in agriculture which was an important component of catch-up growth. Schulze (2007) estimated that structural shift contributed 0.36 percentage points per year to German productivity growth between 1871 and 1910 whereas the discussion in Matthews et al. (1982, p.266) implies that it accounted for only 0.06 percentage points per year in the UK between 1873 and 1913.

Ideally, a contribution from labour quality should be included in the accounting but a full treatment of this is not feasible. However, a crude allowance for the impact of education can be attempted. This suggests that rising years of schooling added a bit more to productivity growth (captured in Table 2 by TFP) in the UK where it increased from 4.13 years in 1870 to 6.35 years in 1910 than in Germany where it went from 5.25 years in 1879 to 6.92 years in 1910 (Morrisson and Murtin, 2009). If an additional year of schooling is assumed to raise labour quality by 6 per cent, the contribution to labour productivity growth would have been 0.17 per cent per year in Germany and 0.22 per cent per year in the UK over the 40-year period.

Capital deepening also contributed more to labour productivity growth in Germany than in the UK (0.25 percentage points per year) according to the estimates in Table 2. To some extent this might be expected as a corollary of faster TFP growth but its also reflects a significant difference in the decisions made by investors in the two countries, as is reported in Table 3. Over the whole period Germany invested 12.8 per cent of GDP at home and 2.0 per cent abroad compared with 8.0 and 4.7 per cent, respectively, for the UK. Savings were a larger share of GDP in Germany but more importantly a much higher proportion of savings were invested at home. Accordingly, the UK had a much larger stock of foreign assets in 1913 and net property income from abroad was a much greater proportion of GDP (8.6 per cent versus 1.9 per cent).[1]

A complementary analysis of contributions to the difference in labour productivity levels (based on output per worker) is reported in Table 4. This shows the gap between the two countries in 1910 is almost all due to higher TFP in the UK. Although the UK was investing heavily abroad at this point, the contribution of capital per worker was similar in both Germany and the UK. Interestingly, given common preconceptions to the contrary, there is also little difference in the contribution of labour quality. Slightly more German workers had intermediate skills (9.7 versus 7.5 per cent) but slightly more British workers had higher skills (0.9 versus 0.6 per cent) (Broadberry, 2003). The lower level of TFP in Germany may well largely reflect inefficiency in the use of factor inputs rather than an inferior level of technology but this awaits further analysis. In any event, it tends to support the suggestion that faster German TFP growth in the preceding decades was largely based on catch-up rather than superior technological progress.

It is also interesting to look at comparative productivity levels at the sectoral level as in Table 5. Here the standout feature is that Germany performed very well in industry but was slow to catch up in agriculture and services. In 1911, a large low-productivity agricultural sector was a major reason for

[1] This implies that German GNP per person was 69.6 per cent of the UK level in 1913 compared with 74.1 per cent on a GDP basis as in Table 1.

Germany's labour and TFP productivity gaps with the UK with the services sector making a somewhat smaller contribution. On the other hand, German industrial labour productivity was already ahead of the UK level by 1901. As can be seen in Table 6 relative productivity levels within manufacturing varied a great deal in the early 20th century with a marked German superiority in cement, chemicals, iron and steel and non-ferrous metals but a British lead in the other activities which can be quantified.

3. Did Victorian Britain Fail?

The heading of this section is also the title of a famous article written by McCloskey. In it he claimed that in the pre-First World War period the British economy was 'growing as rapidly as permitted by the growth of its resources and the effective exploitation of the available technology' (1970a, p. 451). This conclusion was based on three very neoclassical arguments. First, using the insights of the traditional growth model, it was argued that devoting more resources to home investment would have run into diminishing returns. Second, it was claimed that the technical choices made by British firms were efficient and that the highly competitive market environment ensured that there would be no serious and persistent errors at the industry level while the capital market operated to equalize returns at the margin to different types of investment. Third, it was maintained that British productivity growth was similar to that in the United States, apart from an inconsequential slowdown in the Edwardian period, and in any case could not have been any higher as would be the case with exogenous technological progress. At the same time, in another paper (McCloskey 1970b) he calculated that any loss to UK national income from German industrialization was trivial - no more than 0.2% in 1913 – and concluded that technology not exports was the key to British prosperity.

If McCloskey is right, then faster German productivity growth prior to World War I was to be expected given its scope for catch-up, was inevitable once Germany embarked on modern economic growth and did not have any adverse consequences for the UK. Allegations of a growth failure continued after McCloskey's intervention including entrepreneurial failure leading to sluggish development and adoption of new technology (Landes, 1998), capital market failure with excessive foreign investment but too little finance of domestic industry (Kennedy, 1987), and an inadequate national innovation system with sub-optimal investment in human capital and R & D (Pollard, 1989).

Some parts of McCloskey's defence of British growth performance stand up well to scrutiny. It is a staple of the literature that the only well-established failure to adopt cost-effective new technology, namely, not to switch from the Leblanc to the Solvay process in soda manufacture, was in a cartelized activity and this is seen as underlining the point that competition was an antidote to entrepreneurial failure (Magee, 2004). In the most-studied choices of technology, the evidence seems clear-cut that the British industry was rational to stick with mule spinning for the vast majority of its cotton textiles production (Ciliberto, 2010; Leunig, 2001) and that the delay in adopting the basic process for steelmaking was justified (Broadberry, 1997; Wengenroth, 1994).

Although the new economic history has largely succeeded in rejecting claims of managerial failure in the pre-1914 British economy, complete exoneration would be going too far. For example, Crafts et al. (2008) quantified the excess of actual over minimum feasible costs for a sample of 14 major railway companies and concluded that median cost inefficiency was 10.2% in 1900, equivalent to about 1% of GDP. Two salient features of the railway sector were that competition was weak and so were shareholders in companies that were notable for the separation of ownership and control. This entailed significant principal-agent problems as railway managers had considerable scope to pursue their own objectives and to fail to minimize costs at least while profits remained 'acceptable'.

It has also become clear that there was no major capital market failure. Foreign investment accounted for about a third of all British savings but this was justified by the returns available and the diversification of risk that was achieved.[2] British investors would not have been well served by switching out of foreign assets and into new domestic industries (Chabot and Kurz, 2010; Edelstein, 1982). The financial system was not markedly inferior to that of Germany despite oft-repeated claims to that effect. In a specialized capital market, the clearing banks provided valuable support to industry through financing working capital while longer term finance could be obtained through corporate bonds and equities and, of course, through retained earnings (Chambers, 2014). The market value of corporations was 256 per cent of GDP in 1910 (Hannah, 2015) and the stock of corporate bonds had grown to 22 per cent of GDP in 1909 compared with only 0.5 per cent 50 years earlier (Coyle and Turner, 2013). Universal banks in Germany did not make a significant difference to the performance of firms with which they had close relationships or supply major amounts of finance for industrialization (Edwards and Ogilvie, 1996; Fohlin, 2007).

Clearly, improvements were necessary but perhaps not in the direction of adopting a German-style banking system. For example, company law was inadequate in various respects which meant company accounts did not present adequate information (Edwards, 1989) and that the market for new issues was inefficient (Foreman-Peck, 1990). Accordingly, an adequate market for corporate control through takeovers did not exist (Hannah, 1974).

McCloskey's claims that British productivity performance was on a par with that of the United States are not borne out by the estimates now available. As was reported in Table 2, labour productivity growth in the UK fell from 2.06 per cent per year in 1856-73 to 1.18 per cent in 1873-99 and 0.84 per cent in 1899-1913, whereas the United States recorded 2.11 per cent per year in 1874-99 and 1.72 per cent in 1899-1913 (Kendrick, 1961).[3] A critic of UK performance might look at Table 1 and stress the failure of productivity growth to accelerate in the early 20th century and to match the much faster TFP growth achieved by the United States (1.7 per cent per year in 1899-1929 and 2.3 per cent per year in 1929-41) as the second industrial revolution took hold.

The estimates in Table 7 suggest that the United States had attained a higher TFP level then the UK by 1911 except in the service sector. The large TFP gap in manufacturing is especially striking and at first sight this may seem to connote British failure. However, this is rather misleading since these estimates reflect the direct impacts of scale economies and natural resources and also of technologies that were developed in the American environment to exploit scale and cheap energy (Abramovitz and David, 2001) but were not appropriate for British conditions. Cain and Paterson (1986) found that from 1850 to 1920 technological change in American manufacturing generated economies of scale and entailed pervasive materials- and capital-using and labour-saving biases. Moreover, the network of cumulative technological learning was essentially a national one at this time (Nelson and Wright, 1992).[4] In the second industrial revolution, this underwrote clear American advantages in much cheaper electricity (Ristucccia and Solomou, 2014) , which promoted the diffusion of electric motors and the associated transformation of American factories, and in mass production of cars, which was not viable in the much smaller (and more working-class) British market (Bowden, 1991).

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[2] These are the conclusions of two recent studies employing modern portfolio theory. Goetzman and Ukhov (2006) found that foreign diversification permitted a big increase in the Sharpe ratio while Chabot and Kurz (2010) calculated that the diversification gains were equivalent to a sizeable increase in wealth.

[3] These estimates are for output per man year in the private domestic economy (Kendrick 1961, pp. 333-334).

[4] This amounts to an argument that technology was not universal. Using this as a defence of McCloskey is somewhat ironic because it is not the standard neoclassical assumption.

McCloskey's argument was fundamentally based on an exogenous growth model and the proposition that faster UK TFP growth was not possible. The subsequent development of endogenous growth economics complicates matters. On the one hand, an analysis of this kind might explain the unmatched acceleration of American TFP growth as unavoidable given an economic environment that was more conducive to innovative effort and tended to produce innovations that were unsuited to British conditions. On the other hand, it might point to policy interventions (perhaps made by rivals such as Germany and the United States) that could have raised British TFP growth but were not pursued.

In the early 20th century, the United States had several obvious advantages that endogenous innovation theories might stress because they influenced the expected profitability of costly innovative effort. These included a much larger domestic market and capital stock, and a greater availability of engineers and science/technology graduates. Large markets encouraged independent inventors (Nicholas, 2010) and partly explain the higher R & D spending of firms in the United States, perhaps 0.25% of GDP (in a much bigger economy) compared with 0.02%. American factor endowments encouraged 'directed technical change' which was often not appropriate for use in British conditions but increased the transatlantic TFP and income gaps. Labour scarcity in the United States may even have increased the rate of technological change (Acemoglu, 2010). These arguments go against the notion of an avoidable failure.

However, the UK's national innovation system left a good deal to be desired, compared unfavourably with that of Germany, and would have benefited from more pro-active government policy to boost technological progress. This is where an approach based on endogenous growth might undermine McCloskey's position especially in the context of the 2nd industrial revolution as technological progress became increasingly science-based. The UK's technological performance was mediocre as is confirmed by the patenting data (Nicholas, 2014). While in 1883 the UK share of foreign patents in the United States was 34.6 per cent against 18.7 per cent for Germany by 1913 the UK share was 23.3 per cent compared with 34.0 per cent Germany's (Pavitt and Soete, 1982).

Although small beginnings were made in promoting scientific research, for example, through the National Physical Laboratory (1899) and the Medical Research Council (1913), public expenditure on science and technology was only 0.06 per cent of GDP in 1914. This undoubtedly implied that there was too little government support for R & D, a pro-growth activity where social returns exceed private returns. There was a rapid expansion of scientific and technical education beginning in the late 19th century with significant investments in municipal technical colleges, polytechnics, and red-brick universities but in 1910 there were only 3000 science and technology students in UK universities compared with 25000 in Germany (Pollard, 1989). The responsiveness of the German university system may have been a key factor behind success in synthetic dyes in particular and the chemical industry more generally, a sector in which German outperformance of the UK was very clear both in world market share (Brenner and Murmann, 2016) and patenting (Cantwell, 1991). The build-up of knowledge stocks reflected in patenting was also a significant factor in the export success of German mechanical engineering (Labuske and Streb, 2008). Meanwhile, German foreign direct investment in the UK reveals strong ownership advantages in the science-based industries of the second industrial revolution (Hagen, 1999).

Overall, it still seems reasonable to conclude that there was no massive growth failure in the pre-1914 UK economy. American outperformance probably had its roots in unique American advantages based in a favourable configuration of factor prices and market size rather than serious errors by British business or governments. That said, McCloskey (1970) surely went too far and glossed over weaknesses in productivity performance.

4. Economic Implications of Anglo-German Trade Rivalry

In the years 1880 to 1913 Germany overtook the UK in terms of its share of world manufacturing production which increased from 4.9 per cent to 14.8 per cent while that of the UK fell from 22.9 per cent to 13.6 per cent (Bairoch, 1982). This was accompanied by a narrowing of the gap in shares of world manufacturing exports which for Germany rose from 22.4 per cent in 1899 to 26.6 per cent in 1913 compared with 33.2 and 30.2 per cent, respectively, for the UK. Losses of market share reduced UK exports by $0.36 billion (about 18 per cent) and raised German exports by $0.33 billion over the same period (Maizels, 1963). In the early 20th century, the revealed comparative advantage of the UK remained in the old export staples of the industrial-revolution era, especially textiles, while that of Germany included new industries such as chemicals and electricals (Crafts, 1989; Varian, 2020).

The industrialization of Germany was understood by many at the time as a threat to British economic prospects. It provoked demands for the imposition of tariffs on German imports (Hoffman, 1933) and intensified demands for protection made by groups such as the Tariff Reform League. A more sophisticated version of the case for intervention was put forward by Richardson (1965) who argued that the UK economy was 'over-committed to its old industries' and needed infant-industry trade policies to encourage the growth of new industries. In fact, the proponents of tariffs were heavily defeated in the 1906 election, the UK remained a 'free-trade' economy until World War I and only became seriously protectionist in 1932.

Both Germany and (much more so) the United States employed protectionist policies. In 1913 average German and American tariffs on manufactured imports were 13 and 44 per cent, respectively (Bairoch, 1993). It has often been claimed that protection was highly favourable for American economic growth and was central to the ascent of the United States to world economic leadership (Chang, 2003). By implication, the UK's free trade stance was a mistake. However, detailed analysis suggests otherwise. Crafts (2018) noted that slower productivity growth in UK manufacturing compared with the United States was intra-sectoral and not a result of having too small a new-industry sector.[5] Irwin (2001) pointed out that faster productivity growth in the United States mainly accrued in non-traded sectors which did not benefit from protection and that American policies did not add up to a successful infant-industry strategy.

Germany was less protectionist than the average of western European countries (Hungerland and Lampe, 2020) but it did protect agriculture more than manufacturing. Lehmann and O'Rourke (2011) estimate average tariff rates of 12 per cent and 5 per cent, respectively, on the eve of World War I. This suggests both that the imposition of tariffs was not a successful infant industry policy and that structural change (an important part of catch-up growth in Germany) was retarded.[6] Protectionist policies also contributed to trade as a share of GDP being lower in Germany (41% in 1913) than in the UK (56%). This can be expected to have had a cost to Germany in terms of lower income and productivity – amounting to about 7 per cent of GDP using the elasticity of 0.2 estimated by Feyrer (2009).[7]

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[5] Indeed, if the sectoral composition of American manufacturing had been the same as in the UK, in 1899-1909 its total manufacturing labour productivity growth would have *increased* from 1.65 to 1.73 per cent per year.

[6] Dedinger (2006) explored the issue of the impact of protection on changes in Germany's comparative advantage in exporting and concluded that it was negligible. However, Webb (1980) asserted that the elimination of competition through tariff protection and cartels encouraged investment in technologies that were capital and scale-intensive thus raising productivity in the German steel industry.

[7] This is smaller than the often-cited estimate of 0.5 to 0.75 in Feyrer (2019) but is seen by the author as more applicable to a case where trade in goods is the relevant channel of influence.

More generally, careful econometric analysis of the cross-country evidence does not support the hypothesis that higher tariffs raised growth rates in this period – if anything it points to the opposite conclusion (Schularick and Solomou, 2011). This may reflect the tendency for protection not to be tightly focused on a few selected sectors with excellent growth prospects or positive externalities for the rest of the economy (Tena-Junguito, 2010).

Similar problems would surely have undermined any British attempt to use protectionism to promote faster growth. The political economy of tariff protection was such that the proposals that had the most political support such as those made by Joseph Chamberlain would have actually tended to divert employment towards traditional sectors such as agriculture and textiles which were relatively labour intensive rather than new growth industries (Thomas, 1984).[8] A general tariff policy would have weakened competition in product markets with potentially adverse effects on productivity performance. In any case, if the real problem was market failures that implied too little investment in human capital and R & D, then the right response was policy intervention by government to address these failures directly.

Although there are endogenous growth models in which protection of manufacturing could improve long-run productivity performance, it seems unlikely that this would have been the outcome for the late-Victorian UK economy. American overtaking was not down to protectionism. The adoption of protection in the face of German economic advance would have been an adverse impact of German economic development on Britain but it did not happen.

A traditional explanation for slower UK economic growth from the 1870s is that it resulted from a slowdown in export growth (Coppock, 1956; Meyer, 1955). The volume of British exports grew at 5.9 per cent per year from 1831 to 1857, 3.5 per cent from 1857 to 1873 but only 2.6 per cent per year during 1873 to 1913. To a considerable extent, this reflected a weakening of exports to industrial countries especially in Europe whose share of UK exports fell from 35 per cent in 1865-74 to 24 per cent in 1905-13 (Feinstein, 1996). It may be reasonable to regard this as an exogenous shock which could have had adverse consequences but a causal link from this shock to weaker UK productivity growth has not been established.[9]

McCloskey (1970b) made an admittedly crude estimate of the impact of foreign industrialization on British national income. The methodology was partial equilibrium comparative statics with intelligent guesses at relevant elasticities of demand and supply for manufactured exports (treated as a composite commodity). The result was that, if rest of the world manufacturing output was reduced to the 1870 level in 1913, the UK loss of producer surplus minus gains to consumers and output from redeployment of resources used in exporting manufactures would amount at most to 3.9 and probably less than 2 per cent of national income. The loss from just reducing German manufacturing output to the 1870 level would have been about one-eighth of the total. This exercise could potentially be improved upon using modern computable general equilibrium modelling.

5. Conclusions

[8] Thomas estimated that employment in agriculture and textiles would have risen by 45441 and 149851, respectively, while employment in chemicals, motor & cycle, and engineering would have risen by 241, 3102, and 10619, respectively, had a Chamberlain tariff been introduced in 1907 reflecting the pattern of effective protection that this would have entailed.

[9] Feinstein (1996) noted that when export growth revived in the early 20th century UK productivity growth continued to slow down.

Economic growth in Germany was considerably faster than in the UK after 1871. To a large extent this represents successful catch-up growth at a time when UK productivity growth had slowed down from its mid-19th century peak. Nevertheless, in 1913 real GDP per person and labour productivity in Germany were still well below the UK level. At that point, Germany was held back by a relatively large and low-productivity agricultural sector. In contrast, Germany overtook the UK in industrial labour productivity around the turn of the 20th century and was more successful than the UK in developing new industries such as chemicals.

The claim that relatively slow growth connotes a British failure has been hotly disputed. While complete exoneration of British performance would definitely be going too far, it is fair to say that a number of well-known criticisms have been refuted including capital market failure, slowness to adopt new technology and retention of free trade. The UK's main weakness was its national innovation system where more pro-active government policies to address market failures would have been appropriate. That said, in any case it was probably not possible to match the big advance in productivity growth achieved by the United States in the early 20th century.

There is no strong reason to think that Germany's successful economic development had important adverse effects on the British economy even though by the early 20th century Germany's industrial strength was increasingly regarded as a threat by British commentators and politicians. The most obvious way in which the UK might have suffered is through international trade and the loss of economic rents obtained by its exporters. However, the only attempt to quantify this loss found that its impact was very small.

References

Abramovitz, M. and David, P. A. (2001), "Two Centuries of American Macroeconomic Growth: from Exploitation of Resource Abundance to Knowledge-Driven Development", Stanford Institute for Economic Policy Research Discussion Paper No. 01-05.

Acemoglu, D. (2010), "When Does Labor Scarcity Encourage Innovation?", *Journal of Political Economy*, 118, 1037-1076.

Bairoch, P. (1982), "International Industrialisation Levels from 1750 to 1980", *Journal of European Economic History*, 11, 269-331.

Bairoch, P. (1993), *Economics and World History: Myths and Paradoxes*. Brighton: Wheatsheaf.

Bowden, S. M. (1991), "Demand and Supply Constraints in the Interwar UK Car Industry: did the Manufacturers Get It Right?", *Business History*, 33, 241-267.

Brenner, T. and Murmann, J.P. (2016), "Using Simulation Experiments to Test Historical Explanations: the Development of the German Dye Industry, 1857-1913", *Journal of Evolutionary Economics*, 26, 907-932.

Broadberry, S. N. (1997), *The Productivity Race*. Cambridge: Cambridge University Press.

Broadberry, S. N. (2003), "Human Capital and Productivity Performance: Britain, the United States and Germany, 1870-1990", in P. A. David and M. Thomas (eds.), *The Economic Future in Historical Perspective*. Oxford: Oxford University Press, 103-133.

Broadberry, S. (2006), *Market Services and the Productivity Race, 1850-2000*. Cambridge: Cambridge University Press.

Burhop, C. and Wolff, G.B. (2005), "A Compromise Estimate of German Net National Product, 1851-1913, and its Implications for Growth and Business Cycles", *Journal of Economic History*, 65, 613-657.

Broadberry, S. and Burhop, C. (2008), "Resolving the Anglo-German Industrial Productivity Puzzle, 1895-1935: a Response to Professor Ritschl", *Journal of Economic History*, 68, 930-934.

Cain, L. P. and Paterson, D. G. (1986), "Biased Technical Change, Scale, and Factor Proportions in American Industry, 1850-1919", *Journal of Economic History*, 46, 153-164.

Cantwell, J. (1991), "Historical Trends in International Patterns of Technological Innovation" in J. Foreman-Peck (ed.), *New Perspectives on the Late-Victorian Economy*. Cambridge: Cambridge University Press, 37-72.

Chabot, B. R. and Kurz, C. J. (2010), "That's Where the Money Was: Foreign Bias and English Investment Abroad, 1866-1907", *Economic Journal*, 120, 1056-1079.

Chambers, D. (2014), "The City and the Corporate Economy since 1870", In R. Floud, J. Humphries and P. Johnson (eds.), *The Cambridge Economic History of Modern Britain*, vol. 2. Cambridge: Cambridge University Press, 255-278.

Chang, H-J. (2003), "Kicking Away the Ladder: Infant Industry Promotion in Historical Perspective", *Oxford Development Studies*, 31, 21-32.

Ciliberto, F. (2010), “Were British Cotton Entrepreneurs Technologically Backward?: Firm-Based Evidence on the Adoption of Ring Spinning”, *Explorations in Economic History*, 47, 487-504.

Coppock, D.J. (1956), “The Climacteric of the 1890s: a Critical Note”, *The Manchester School*, 24, 1-31.

Coyle, C. and Turner, J. D. (2013), “Law, Politics, and Financial Development: the Great Reversal of the UK Corporate Debt Market”, *Journal of Economic History*, 73, 810-846.

Crafts, N. (1989), "Revealed Comparative Advantage in Manufacturing, 1899-1950", *Journal of European Economic History* (1989), 18, 127-137.

Crafts, N. (2018), *Forging Ahead, Falling Behind and Fighting Back: British Economic Growth from the Industrial Revolution to the Financial Crisis*. Cambridge: Cambridge University Press.

Crafts, N. (2020), “The Sources of British Economic Growth since the Industrial Revolution: Not the Same Old Story”, *Journal of Economic Surveys*, forthcoming.

Crafts, N., Leunig, T. and Mulatu, A. (2008), “Were British Railway Companies Well-Managed in the Early Twentieth Century?”, *Economic History Review*, 61, 842-866.

Crafts, N. and Mills, T.C. (2020), “Sooner than You Think: the Pre-1914 UK Productivity Slowdown was Victorian not Edwardian”, *European Review of Economic History*, forthcoming.

Dedinger, B. (2006), “From Virtual Free Trade to Virtual Protectionism, or, Did Protection have any Part in Germany’s Rise to Commercial Power, 1850 to 1913?”, in J-P. Dormois and P. Lains (eds.), *Classical Trade Protectionism, 1815-1914*. London: Routledge.

Edelstein, M. (1982), *Overseas Investment in the Age of High Imperialism: the United Kingdom, 1850-1914*. New York: Columbia University Press.

Edwards, J.R. (1989), *A History of Financial Accounting*. London: Routledge.

Edwards, J. and Ogilvie, S. (1996), “Universal Banks and German Industrialization: a Reappraisal”, *Economic History Review*, 49, 427-446.

Feinstein, C.H. (1996), “Exports and British Economic Growth (1850-1914)”, in P. Mathias and J.A. Davis (eds.), *International Trade and British Economic Growth*. Oxford: Blackwell, 76-95.

Feyrer, J. (2009), Distance, Trade and Income – the 1967 to 1975 Closing of the Suez Canal as a Natural Experiment”, NBER Working Paper No. 15557.

Feyrer, J. (2019), “Trade and Income: Exploiting Time Series in Geography”, *American Economic Journal: Applied Economics,* 11(4), 1-35.

Fohlin, C. (2007), *Finance Capitalism and Germany’s Rise to Industrial Power*. Cambridge: Cambridge University Press.

Foreman-Peck, J. (1990), “The 1856 Companies Act and the Birth and Death of Firms”, in P. Jobert and M. Moss (eds.), *The Birth and Death of Companies: an Historical Perspective*. Carnforth: Parthenon Publishing Group, 33-46.

Goetzmann, W. N. and Ukhov, A. D. (2006), “British Investment Overseas 1870-1913: a Modern Portfolio Theory Approach”, *Review of Finance*, 10, 261-300.

Hagen, A. (1999), “German Direct Investment in the UK, 1871-1918”, *Business History*, 41(2), 37-68.

Hannah, L. (1974), "Takeover Bids in Britain before 1950: an Exercise in Business Pre-History", *Business History*, 16, 65-77.

Hannah, L. (2015), "A Global Corporate Census: Publicly Traded and Close Companies in 1910", *Economic History Review*, 68, 548-573.

Hofman, R.J.S. (1933), *Great Britain and the German Trade Rivalry, 1875-1914.* Philadelphia: University of Pennsylvania Press.

Hoffmann, W.G. (1965), Das Wachstum der deutschen Wirtschaft seit der Mitte des 19. Jahrhunderts. Berlin: Springer.

Huberman, M. and Minns, C. (2007), "The Times They are not Changin': Days and Hours of Work in the Old and New Worlds, 1870-2000", *Explorations in Economic History*, 44, 538-567.

Hungerland, W_F. and Lampe, M. (2020), "Germany's Experience with Foreign Trade and Globalization before and after 1871", in J.C. Hesse, U. Pfister, M. Spoerer and N. Wolf (eds.), *National Unification, Institutional Change, and Economic Development: Germany in Comparative Perspective*, forthcoming.

Irwin, D. A. (2001), "Tariffs and Growth in Late Nineteenth-Century America", *The World Economy*, 24, 15-30.

Jorda, P., Schularick, M. and Taylor, A.M. (2019), *Jorda-Schularick-Taylor Macrohistory Database* http://www.macrohistory.net/data/

Kendrick, J. W. (1961), *Productivity Trends in the United States*. Princeton, NJ.: Princeton University Press.

Kennedy, W. P. (1987), *Industrial Structure, Capital Markets and the Origins of British Industrial Decline*. Cambridge: Cambridge University Press.

Labuske, K. and Streb, J. (2008), "Technological Creativity and Cheap Labour? Explaining the Growing International Competitiveness of German Mechanical Engineering before World War I", *German Economic Review*, 9, 65-86.

Landes, D. S. (1998), *The Wealth and Poverty of Nations*. London: Little Brown.

Lehmann, S.H. and O'Rourke, K.H. (2011), "The Structure of Protection and Growth in the Late Nineteenth Century", *Review of Economics and Statistics*, 93, 606-616.

Leunig, T. (2001), "New Answers to Old Questions: Explaining the Slow Adoption of Ring Spinning in Lancashire, 1890-1913", *Journal of Economic History*, 61, 439-466.

Maddison, A. (2010), *Historical Statistics of the World Economy, 1-2008AD*. http:// www.ggdc.net/maddison

Magee, G. (2004), "Manufacturing and Technological Change", in R. Floud and P. Johnson (eds.), *The Cambridge Economic History of Modern Britain*, vol. 2. Cambridge: Cambridge University Press, 74-98.

Maizels, A. Industrial Growth and World Trade. Cambridge: Cambridge University Pree.

Matthews, R. C.O., Feinstein, C. H. and Odling-Smee, J. C. (1982), *British Economic Growth 1856-1973*. Stanford: Stanford University Press.

McCloskey, D. N. (1970a), "Did Victorian Britain Fail?", *Economic History Review*, 23, 446-459.

McCloskey, D.N. (1970b), "Britain's Loss from Foreign Industrialization: a Provisional Estimate", *Explorations in Economic History*, 8, 141-152.

Meyer, J.R. (1955), "An Input-Output Approach to Evaluating the Influence of Exports on Britain's Industrial Production in the Late Nineteenth Century", *Explorations in Entrepreneurial History*, 8, 12-34.

Morrisson, C. and Murtin, F. (2009), "The Century of Education", *Journal of Human Capital*, 3, 1-42.

Nelson, R.R. and Wright, G. (1992), "The Rise and Fall of American Technological Leadership: the Postwar Era in Historical Perspective", *Journal of Economic Literature* 30, 1931-1964.

Nicholas, T. (2010), "The Role of Independent Invention in U. S. Technological Development, 1880-1930", *Journal of Economic History*, 70, 57-82.

Nicholas, T. (2014), "Technology, Innovation and Economic Growth in Britain since 1870", in R. Floud, J. Humphries and P. Johnson (eds.), *The Cambridge Economic History of Modern Britain*, vol. 2. Cambridge: Cambridge University Press, 181-204.

Obstfeld, M. and Taylor, A.M. (2004), *Global Capital Markets: Integration, Crisis, and Growth*. Cambridge: Cambridge University Press.

Pavitt, K. and Soete, L. (1982), "International Differences in Economic Growth and the International Location of Innovation", in H. Giersch (ed.), *Emerging Technologies*. Tübingen: Mohr, 105-133.

Pfister, U. (2020), "The Crafts-Harley View of German Industrialization: an Independent Estimate of the Income Side of Net National Product, 1851-1913", *European Review of Economic History*, forthcoming.

Pollard, S. (1989), *Britain's Prime and Britain's Decline: the British Economy 1870-1914*. London: Edward Arnold.

Ristuccia, C.A. and Solomou, S. (2014), "Can General Purpose Technology Theory Explain Economic Growth? Electrical Power as a Case Study", *European Review of Economic History*, 18, 227-247.

Schularick, M. and Solomou, S. (2011), "Tariffs and Economic Growth in the First Era of Globalization", *Journal of Economic Growth*, 16, 33-70.

Schulze, M.S. (2007), "Origins of Catch-Up Failure: Comparative Productivity Growth in the Habsburg Empire, 1870-1910", *European Review of Economic History*, 11, 189-218.

Tena-Junguito, A. (2010), "Bairoch Revisited: Tariff Structure and Growth in the Late Nineteenth Century", *European Review of Economic History*, 14, 111-143.

Thomas, M. (1984), "An Input-Output Approach to the British Economy, 1890-1914", D. Phil. Thesis, University of Oxford.

Thomas, R. and Dimsdale, N. (2017), "A Millennium of UK Data", Bank of England OBRA Dataset. http://www.bankofengland.co.uk/research/Pages/onebank/threecenturies.aspx

Varian, B.D. (2020), "The Manufacturing Comparative Advantages of Late-Victorian Britain", *Cliometrica*, forthcoming.

Webb, S.B. (1980), “Tariffs, Cartels, Technology, and Growth in the German Steel Industry, 1879 to 1914”, *Journal of Economic History*, 40, 309-329.

Wengenroth, U. (1994), *Enterprise and Technology: the German and British Steel Industries, 1865-1895*. Cambridge: Cambridge University Press.

Williams, E. E. (1896), *Made in Germany*. London: William Heinemann.

Woltjer, P. J. (2013), “Taking Over: a New US/UK Productivity Benchmark and the Nature of American Leadership c. 1910”, Groningen Growth and Development Centre Research Memorandum No. 140.

Table 1. Growth of Real GDP/Person, 1871-1913 (% per year)

Germany	1.48
UK	0.81
Memorandum Item	
Real GDP/Person, Germany/UK ($1990GK)	
1871	56.2
1913	74.1

Sources: Maddison (2010), Pfister (2020), Thomas and Dimsdale (2017)

Table 2. Growth Accounting Estimates (% per year)

	Capital Deepening	*Crude TFP Growth*	*Y/HW Growth*
Germany			
1851-1871	0.39	0.39	0.78
1871-1898	0.55	1.13	1.68
1898-1913	0.79	1.10	1.89
1871-1913	0.63	1.12	1.75
UK			
1856-1873	0.72	1.34	2.06
1873-1899	0.37	0.81	1.18
1899-1913	0.42	0.42	0.84
1873-1913	0.38	0.68	1.06

Notes: Derived using a standard neoclassical methodology which imposes the identity $\Delta\ln(Y/HW) = \alpha\Delta\ln(K/HW) + \Delta\ln A$ where K is capital, HW is hours worked, Y is real output and A is (crude) total factor productivity (TFP). Crude TFP indicates that labour quality is not separately accounted but subsumed into TFP. Labour productivity growth for Germany in 1851-1871 is growth of real output per worker.

Sources: Germany based on output growth from Pfister (2020), capital stock growth from Burhop and Wolff (2005), labour force growth from Hoffmann (1965) and hours worked per year from Huberman and Minns (2007). UK from Crafts (2020).

Table 3. Savings and Investment (%GDP)

	Domestic Investment	***Foreign Investment***	***Savings***
Germany			
1871-1898	11.7	2.2	13.9
1898-1913	14.8	1.6	16.4
1871-1913	12.8	2.0	14.8
UK			
1873-1899	7.9	4.3	12.2
1899-1913	8.4	5.4	13.8
1873-1913	8.0	4.7	12.7
Memorandum Item			
Foreign Capital Stock, 1913 ($bn.)			
Germany	6.7		
UK	19.5		

Note: foreign investment equals balance of payments current account surplus.

Sources: Jorda et al. (2019), Obstfeld and Taylor (2004).

Table 4. Contributions to Germany/UK Labour Productivity Gap, 1910

	Labour Quality	***Capital***	***TFP***	***Total***
Agriculture	0.0	-5.8	-26.9	-32.7
Industry	1.6	18.9	1.5	22.0
Services	0.5	-2.3	-16.9	-18.7
GDP	-0.1	0.2	-24.6	-24.5

Note: These estimates are derived using the standard neoclassical formula for levels accounting: $\ln(Y/L)^G - \ln(Y/L)^{UK} = \alpha(\ln(K/L)^G - \ln(K/L)^{UK}) + \beta(\ln(HK/L)^G - \ln(HK/L)^{UK}) + (\ln A^G - \ln A^{UK})$. This is implemented using labour quality estimates based on shares of the labour force with no skills, intermediate skills, and higher skills weighted by their relative wages. Labour productivity is measured per worker, $\alpha = 0.4$ and $\beta = 0.6$.

Source: Broadberry (2003)

Table 5. Relative Productivity in Germany at the Sectoral Level (UK = 100)

	Agriculture	*Industry*	*Services*	*GDP*
Y/L				
1871	55.7	91.7	62.8	59.5
1881	54.7	93.7	61.3	57.3
1891	53.7	99.3	64.4	60.5
1901	67.2	105.0	71.9	68.4
1911	67.3	127.7	73.4	75.5
TFP				
1871	58.3	86.0	69.7	61.6
1891	59.8	86.1	71.9	63.2
1911	71.4	102.6	83.2	75.3
Memorandum Item: Shares of Employment (%)				
Germany				
1871	49.5	29.1	21.4	
1913	34.5	37.9	27.6	
UK				
1871	22.2	42.4	35.4	
1911	11.8	44.1	44.1	

Note: Labour productivity is measured per worker.

Source: Broadberry (2006)

Table 6. Relative Labour Productivity in Manufacturing c. 1907 (UK = 100)

General Chemicals	126.6
Coke	98.9
Iron and Steel	137.8
Nonferrous Metals	157.9
Motor Vehicles	89.7
Cotton	87.3
Silk	74.9
Leather	67.8
Brewing	90.5
Tobacco	28.3
Sugar	47.3
Cement	124.1
Total Manufacturing	108.4

Source: Broadberry and Burhop (2008)

Table 7. USA/UK Productivity Levels in 1911 (UK = 100)

	Labour Productivity	***TFP***
Agriculture	181	208
Industry	206	161
Manufacturing	214	185
Services	119	79
GDP	138	106

Sources: Broadberry (2006) revised in accordance with Woltjer (2013)