Resolving The Anglo-German Industrial Productivity Puzzle, 1895-1935: A Response To Professor Ritschl

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RESOLVING THE ANGLO-GERMAN INDUSTRIAL PRODUCTIVITY PUZZLE, 1895-1935: A RESPONSE TO PROFESSOR RITSCHL

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I. INTRODUCTION

This paper offers a critical appraisal of the claim of Ritschl (2008) to have found a "possible resolution" to what he calls the "Anglo-German industrial productivity puzzle". To understand the origins of this term, it is necessary to describe some recent developments in comparisons of industrial labour productivity between Britain and Germany. The Anglo-German industrial productivity puzzle really arose as the result of a new industrial production index produced by Ritschl (2004), which differed very substantially from the widely used index of Hoffmann (1965). Broadberry and Burhop (2007) pointed out that if the Ritschl (2004) index is combined with an index of German employment from Hoffmann (1965) and time series of UK output and employment from Feinstein (1972), it implies an implausibly high German labour productivity lead over Britain in 1907, when projected back from a widely accepted Germany/UK labour productivity benchmark for 1935/36.

This 1935/36 benchmark was established originally by Rostas (1948), but was later reworked by Broadberry and Fremdling (1990), and has recently been further reworked by Fremdling et al. (2007a). All three studies, despite their different methodologies, agree that labour productivity in British and German industry was broadly equal in 1935/36. The finding of substantially higher German labour productivity in 1907 when projecting back with the Ritschl (2004) index created a puzzle for at least two reasons. First, other comparative information from the pre-World War I period, such as wages, seems difficult to square with much higher German labour productivity at this time. This view can be seen in the earlier work of Fremdling (1991), who argued for lower German labour productivity in industry during the whole period 1855-1913. But second, a direct benchmark estimate produced by Broadberry and Burhop (2007), using production census information for Britain and industrial survey material of similar quality for Germany, suggested broadly equal labour productivity in 1907.

Broadberry and Burhop (2007) also showed that if the Hoffmann industrial output index was used instead of the Ritschl (2004) index for Germany, the puzzle largely disappeared. In this case, the time series projection more or less agreed with the direct benchmark estimate for 1907, with broadly equal labour productivity in Britain and Germany. Hence when faced with a choice between the Ritschl (2004) and Hoffmann (1965) indices, international comparative considerations dictate that Hoffmann should be preferred to Ritschl.

Ritschl (2008) is clearly uncomfortable with this conclusion, since he and others have been highly critical of the German historical national accounts produced by Hoffmann (1965), from which the industrial production index is taken (Fremdling, 1988; 2007a; Ritschl and Spoerer, 1997). Ritschl (2008) now proposes some further changes to the German industrial output index, which move it closer to the Hoffmann (1965) index, and thus reduce the scale of the discrepancy with the Broadberry and Burhop (2007) benchmark for 1907. However, to remove the remaining discrepancy, Ritschl (2008) proposes a number of amendments to the 1907 benchmark, which have the effect of raising the German labour productivity lead in 1907 from the 5 per cent found by Broadberry and Burhop (2007) to a range of 20-28 per cent. But this would be very difficult to square with the evidence on wages and the other nominal indicators which underpinned the approach of Fremdling (1991), to which Broadberry and Burhop (2007: 330-332) also devoted a section, but which Ritschl (2008) ignores.

This paper proceeds as follows. In section II we first consider the changes proposed by Ritschl (2008) to the Broadberry and Burhop (2007) benchmark for 1907, since this was the major focus of our earlier paper. Although we accept some minor changes, they do not have a major impact on the overall Germany/UK comparative productivity level presented in Broadberry and Burhop (2007). For manufacturing, which is our primary focus, the changes have the effect of raising the German productivity lead from 5.0 per cent to 8.4 per cent. Hence in section III we go on to critically evaluate the changes to the German manufacturing output index proposed by Ritschl (2008), something which we did not attempt in our earlier paper.

Although we agree with Ritschl that it is possible to construct an index of output in metal processing from component sub-indices of output, we show that his claims of a radical effect on the overall index for manufacturing output depends on his weighting procedure. Using the weighting scheme suggested by Fremdling and Stäglin's (2003) corrections to sectoral value added in the 1936 production census, together with Fremdling's (2007a) revised employment figured for 1933 and 1925, we show that the long term trends in labour productivity in manufacturing and total industry remain much as suggested by Hoffmann (1965) between 1907 and 1936, although German productivity was somewhat lower in 1925 than Hoffmann thought. This means that the picture of broadly equal labour productivity in British and German manufacturing which emerges from the 1907 benchmark is confirmed by time series projection from the 1935/36 benchmark, as in Broadbery and Burhop (2007). Section IV returns to the wider context of nominal income levels in Britain and Germany before World War I, while section V offers some concluding comments.

II. PROPOSED CHANGES TO THE 1907 BENCHMARK

Ritschl (2008) proposes a number of changes to the Broadberry and Burhop (2007) benchmark for 1907, which taken together, have the effect of increasing the German labour productivity lead in manufacturing from 5% to a range of 20-28%. The difference is not that large, particularly when set against the US productivity lead over Britain of more than 100% in 1907, established by Broadberry (1993; 1997), but it does nevertheless mark a shift away from broad equality. It therefore needs to be placed under critical scrutiny in this section.

The first basic difference between the Broadberry and Burhop (2007) and Ritschl (2008) benchmarks concerns our preference for the German industrial survey sources wherever possible. This is important because it means that we can be sure that the output and employment refer to the same production units, a really crucial requirement for the accurate measurement of labour productivity. In our view, it is not worth sacrificing this advantage to obtain data for 1907 rather than 1908 or some other alleged benefit of an alternative source of employment data. Also, it should be borne in mind that whereas the industrial census data refer to average employment during the whole year for which output was recorded, the employment census data refer to a single date.

More specifically, the 1907 employment census shows manufacturing employment of 5,465,356 in firms with six or more employees on 12 June 1907.[1] The industrial census is based on the accident insurance statistics, which show an average

[1] Kaiserliches Statistisches Amt (1910: 53), industry groups IV to XIV and XVII.

manufacturing employment of 5,867,707 in 1907. Moreover, the accident insurance statistics as well as the industrial census data transform this figure into full-time equivalent employment of 5,243,800.[2] This indicates that the measurement of employment varies substantially among sources and concepts used. In addition, coverage of firms and employment differs even on an industry level. For example, the 1907 employment census gives a total of 14,241 employees in 146 firms with six or more employees producing motor vehicles.[3] The industrial census for the same year counts 69 firms employing 13,423 full time equivalent employees.[4] Consequently, matching employment data from the employment census with output data from the industrial census leads to mis-measurement of productivity. Moreover, the matching problem becomes more severe when we take into account that the employment census was conducted in 1907, whereas most of the output data were collected in 1908-10.

Furthermore, if anything, this reliance on the German industrial surveys is likely to bias our benchmark in favour of Germany, since these surveys excluded the craft sector and most small firms, where productivity was lower than in the large industrial firms.

This leads us to consider a second point, which is the correction applied by Ritschl (2008) to allow for the difference in benchmark years between Britain and Germany. To ensure consistency of sources for output and employment, we used data for 1908 and 1910 for some German industries. Ritschl (2008: 18) argues that this biases our results against Germany on the grounds that these industries went into recession after 1907. Yet it is clear from Hoffmann's (1965) data on both output and

[2] Reichsversicherungsamt (1909: 10), industry groups II to VI and VII to XIII.
[3] Kaiserliches Statistisches Amt (1910: 55), industry group VI c 3.
[4] Kaiserliches Statistisches Amt (1913: 65).

employment that labour productivity continued to increase after 1907, so that our use of later years for Germany must bias the benchmark in favour of Germany. We pointed this out in the text of Broadberry and Burhop (2007: 322) and repeat it here. For manufacturing as a whole, German labour productivity in 1908 was 2.7 per cent higher than in 1907, while by 1910 it was 6.0 per cent higher than in 1907 (Broadberry, 1997: 43). Labour productivity also increased in each year between 1907 and 1910 in chemicals and metal processing, the industries specifically mentioned by Ritschl (Hoffmann, 1965: 196-198, 392). Ritschl (2008: 20) nevertheless somehow manages to find that German productivity was lower in the later years, so that applying his cyclical adjustment raises the German productivity lead from 5 per cent to 12 per cent, or about one-third of his total proposed adjustment. This is wholly inappropriate, and any adjustment would have to be in the opposite direction.

Ritschl (2008: 20) draws attention to the issue of multi-product firms, and asserts that this leads us to overstate employment in Germany because not all workers were producing the final product. However, the direction of the bias is unclear. If workers were allocated to the industry in which they were mainly engaged, then for any particular industry there would be both included workers who were not producing wholly for that industry (hence leading to an understatement of productivity) and output produced by workers who were allocated to other industries (hence leading to an overstatement of productivity). Any gain in precision by turning to the alternative occupational census data will be offset by a loss of precision by giving up the common source for the employment and output data. And for industry as a whole, any increase in productivity in one branch must surely be offset by a decrease in another branch, since the net effect of reallocating labour across multi-product firms must be zero. This spurious adjustment adds another 8 percentage points to the German productivity advantage.

Ritschl (2008: 22) also proposes an adjustment to take account of the smaller cut-off-point in the size of firms in the German occupation census. This adds another 8 percentage points to the German productivity lead, which is completely out of line with similar adjustments for other comparisons, including that of Fremdling et al. (2007a) for the 1935/36 Anglo-German benchmark. But, more importantly, the adjustment is totally unwarranted, since, as noted earlier, we relied mainly on the industrial surveys, which had a higher cut-off point than the British production census. If anything, the adjustment should be in the other direction, but in any case much, much smaller.

Nevertheless, Ritschl (2008) does provide a useful critical survey of our estimates for particular industries, and we have taken on board some of his suggestions. As a result, we provide an updated version of our 1907 benchmark in Table 1, together with our original estimates and Ritschl's proposed revisions. The changes which we have made in response to Ritschl's critical evaluation are limited to four industries, cotton, cement, salt mining and iron ore mining, and details are provided in Appendix 1, together with a detailed commentary on Ritschl's proposed changes for other industries. The overall effect is to raise the Germany/UK labour productivity lead in 1907 from 5 per cent in our original study to 8.4 percent. This remains some distance from the 20-28 per cent lead suggested by Ritschl (2008).

III. PROPOSED CHANGES TO THE GERMAN PRODUCTION INDEX

We are thus persuaded that the problem lies in the industrial production series presented by Ritschl (2008). His latest revisions to the production index presented in Ritschl (2004) reduce the scale of the discrepancy that we pointed to in our earlier paper, but they do not eliminate it. We thus turn our attention now to a detailed critical appraisal of Ritschl's (2004; 2008) work on the German production index.

We proceed to modify the Hoffmann index in three ways. First, we incorporate the revisions made by Fremdling et al. (2007a, 2007b) to the 1936 benchmark estimate of German industrial net value added. Second, we employ Fremdling's (2007a) revised estimates of industrial employment. These changes are in line with the direction of change between Ritschl (2004) and Ritschl (2008). Third, we incorporate Ritschl's (2004) modifications regarding the output of the metal processing industry during the inter-war period. However, crucially, we employ a weighting scheme for metal processing which is consistent with the revised weighting scheme used for combining metal processing with the rest of manufacturing.

Hoffmann's (1965) industrial production index is based on physical output series for all industrial branches except the metal processing industry, which covers a large swathe of industry, including mechanical and electrical engineering, motor vehicle production, shipbuilding and aircraft production. Time series of physical output are combined into an industrial production index by multiplying them with a weighting matrix. The weights for each industrial branch are calculated as the product of the net value added per employee of this branch in 1936 and its employment in 1907 (weights for the years 1896-1925) and 1933 (weights for the period 1925-59), respectively. Recent work by Fremdling and his co-authors has shown that

Hoffmann's estimates regarding the 1936 labour productivity as well as his 1933 employment figures are distorted. Incorporating Fremdling et al.'s (2007a) and Fremdling's (2007a) labour productivity and labour force estimates yields the weighting matrix for the manufacturing output index displayed in Table 2.

In addition, Ritschl (2004: 214) proposes a substantial modification to Hoffmann's output index for the metal processing industry. Hoffmann's index for this branch was not based on physical output data, but rested, rather, on labour income data and the assumption of a constant labour income share. Ritschl (2004) argues that the assumption of a constant labour share is implausible and proposes a new output index for the metal processing industry. Ritschl (2004) uses sales data for mechanical engineering, electrical engineering, and motor vehicles as well as physical output data for shipbuilding. Ritschl (2008) also makes an allowance for the rapid expansion of aircraft production from 1933. We agree with the basic procedure employed by Ritschl and also utilise his sales and output data. However, Ritschl (2004: 214) aggregates the sub-indices into the output index for the metal processing industry using a different weighting scheme from that used in the rest of the industrial production index. First, Ritschl combines output of the mechanical and electrical engineering industries using gross output in 1913 as weights. Second, the resulting index for mechanical and electrical engineering is combined with the sub-indices for motor vehicle production and shipbuilding using 1928 weights. Third, the new metal processing industry index is incorporated into Hoffmann's (1965) industrial production index using Hoffmann's 1933/36 weights.

We adopt a more uniform weighting procedure. In a first step, since the metal processing industry is to be combined with other industries using 1933/36 weights for the period after 1925 and 1907/36 weights for the period 1895-1925, we apply a similar procedure to the construction of the output index for metal processing. Again, the corrected value added and employment data of Fremdling et al. (2007b) and Fremdling (2007a) are used. The time series and weights for mechanical engineering, electrical engineering, motor vehicle production, aircraft production, and shipbuilding are displayed in Table 3. The series are reported here with 1933 set equal to 100, because although we lack a complete series for aircraft production, we include an index based on the growth of employment between 1933 and 1936, for comparability with Ritschl (2008). Converting the overall index for metal processing to a 1913 base for ease of comparison with the literature, the new index of metal processing output takes a value of 95.9 in 1925 compared with Hoffmann’s index value of 1925 = 131.4. On the other hand, the new index is somewhat higher than Ritschl’s (2004) index, which had a level of 1925 = 84.4.

In a second step, we incorporate the new index for the metal processing industry from Table 3 into a new index for manufacturing output in Germany for the period 1895-1938, using the new weighting scheme from Table 2. The new index of manufacturing output and Hoffmann’s original index are presented in Appendix 2 and plotted in Figure 1. Our recalculation of manufacturing output confirms qualitatively one of Ritschl’s (2004) central results, that manufacturing/industrial output was lower during the interwar period than suggested by Hoffmann’s figures. Furthermore, the decline in industrial/manufacturing output during World War I and the hyperinflation period was larger than Hoffmann’s figures suggest.

According to the new index, by 1936 output was nearly 13 per cent lower than Hoffmann believed. However, this does not translate into a 13 per cent effect on labour productivity, because the new output weights are derived from changes to the employment data. This, in turn, has implications for the main focus of this paper, the comparative Germany/UK manufacturing labour productivity level during the first half of the twentieth century. Since Fremdling (2007a) provides employment data only for employment census years, we cannot now calculate a full time series of comparative productivity and focus instead on 1925, 1933 and 1936. In addition, we calculate a time-series projection for 1907 using Hoffmann's (1965: 196) data for that year, having checked that they are consistent with the employment census for 1907 (Kaiserliches Statistishes Amt, 1910). The results are presented in Table 4.

Starting from the widely accepted Germany/UK comparative labour productivity level in manufacturing of 102 in 1936, the new time series projection for 1907 of 112.5 is quite close to our new 1907 benchmark estimate of comparative manufacturing labour productivity of 108.4, and certainly well within the 10% margin of error which is usual in this type of work. For 1925, the new projections show a comparative productivity level of 93.4, only slightly below Broadberry's (1997) estimate of 95.2. Similarly, the new projection for 1933 of 98.5 is only slightly lower than Broadberry's (1997) estimate of 100.6. What happens here is that over the long period 1907 to 1936, Hoffmann's over-estimation of output growth is partly cancelled out by his over-estimation of employment growth, so that the long run comparative labour productivity picture is much as suggested by Broadberry (1997).

Thus, taking account of Ritschl's (2008) sub-indices of output within the metal processing sector, but weighting them in a consistent fashion, and incorporating Fremdling's (2007a) revisions to employment in the interwar period, we arrive at time series projections which are entirely consistent with the two benchmark estimates for 1935/36 and 1907. All the evidence thus points squarely to roughly equal manufacturing labour productivity in Britain and Germany during the first half of the twentieth century, the main conclusion of Broadberry and Burhop (2007).

IV. NOMINAL INCOMES

Finally, it is worth emphasising a further point. As well as consistency between the benchmarks and the time series projections, it is important to demonstrate consistency with the information on nominal incomes in Britain and Germany before 1914. This is an issue which Ritschl (2008) simply does not address, but which formed a whole section of Broadberry and Burhop (2007: 330-332). Since Ritschl (2008) does not challenge us on this evidence, we do not repeat it here, but provide additional evidence in a more direct form. This evidence is entirely independent of the historical national accounting framework.

The Board of Trade (1908) conducted an enquiry into wages and the cost of living in Germany in 1905, and made a direct comparison between Britain and Germany in that year. The money wages were converted at the exchange rate and then adjusted for PPP by comparing prices converted at the exchange rate. Table 8 sets out the weekly money wages for a number of industrial trades, including the engineering and printing trades in manufacturing. For the average of these trades, the Board of Trade found German wages to be 83 per cent of the British level, although the average was somewhat higher in engineering. Indeed, for unskilled labourers, the weekly money wage was the same in the two countries. Since the Board of Trade found the price level to be higher in Germany, this translated unambiguously into a higher real wage in Britain.

Given the lower money wages in Germany, it is difficult to see how labour productivity could have been much higher in Germany. This is particularly true in industries like cotton textiles, where Britain remained highly competitive in world markets right through to the outbreak of World War I. As Broadberry and Burhop (2007) argued, the nominal income data can just about be stretched to be consistent with broadly equal labour productivity in Britain and Germany at this time. A substantial German labour productivity lead simply does not seem credible.

V. CONCLUDING COMMENTS

In this paper, we reaffirm the central claim of Broadberry and Burhop (2007) that manufacturing labour productivity was broadly equal in Britain and Germany during the first half of the twentieth century. We first reject Ritschl's (2008) attempt to revise our 1907 benchmark substantially upwards. Although we accept one or two of Ritschl's (2008) criticisms of our original benchmark, these have the effect of increasing it only from 105.0 to 108.4, still a long way from the range of 120-128 claimed by Ritschl.

The second part of this paper then provides a critical appraisal of Ritschl's new index of manufacturing output. We are able to accept the sub-indices for the individual parts of the metal processing sector that Ritschl proposes, but apply a consistent weighting procedure. Although this leads to somewhat slower growth of output than in the original Hoffmann (1965) index, the scale of the revision is more modest than that suggested by Ritschl. Furthermore, Hoffmann's overstatement of the growth of manufacturing output was partly offset by an equivalent overstatement of the growth of employment, as noted by Fremdling (2007a). The net effect of the changes to output and employment is to change the long run path of labour productivity in German manufacturing only slightly from that claimed by Hoffmann (1965). Hence the main finding of Broadberry and Burhop (2007), that labour productivity was broadly equal in British and German manufacturing during the first half of the twentieth century, is upheld. There is no Anglo-German industrial productivity puzzle for the period 1895-1935: time series projection from the 1935/36 benchmark is perfectly consistent with the 1907 benchmark, even if Hoffmann's (1965) series for metal processing is replaced. Finally, we note that Ritschl's (2008) view of substantially higher German industrial labour productivity in 1907 would be hard to square with the evidence of nominal incomes in the two countries.

TABLE 1: Comparative Germany/U.K. labor productivity circa 1907 (UK =100)

	Original Broadberry-Burhop	Ritschl	Revised Broadberry-Burhop
General chemicals	126.6	134.3	126.6
Coke	98.9	123.5	98.9
CHEMICALS & ALLIED	113.9	130.5	113.9
Iron & steel	137.8	144.0	137.8
Non-ferrous metals	157.9	221.5	157.9
Motor vehicles	89.7	135.2	89.7
METALS & ENGINEERING	139.2	152.1	139.2
Cotton	85.6	128.4	87.3
Silk	74.9	93.7	74.9
Leather	67.8	100.8	67.8
TEXTILES & CLOTHING	82.3	121.7	83.6
Brewing	90.5	102.7	90.5
Tobacco	28.3	38.4	28.3
Sugar	47.3	47.3	47.3
FOOD, DRINK & TOBACCO	66.9	73.0	66.9
Cement	108.1	124.2	124.1
OTHER MANUFACTURING	108.1		124.1
TOTAL MANUFACTURING	105.0	128.0	108.4
Salt mining	57.8	130.1	106.8
Coal mining	78.5	95.5	78.5
Iron ore mining	91.0	129.8	77.0
MINING	78.7	97.9	77.7
TOTAL INDUSTRY	101.8	124.5	104.7

Sources: Broadberry and Burhop (2007: 321); Ritschl (2008: Table 7); Appendix 1.

TABLE 2: Index weights for Germany's manufacturing output index

Branch	Col. 1: 1936 net output (1,000 RM)	Col. 2: 1936 employment	Col. 3: 1936 labour productivity (RM)	Col. 4: 1933 employment	Col. 5: 1907 employment	Col. 6: Index weight for 1925-59	Col. 7: Index weight for 1896-1925
Building materials	1,178,260	355,374	3,316	401,000	822,000	4.49%	8.14%
Ferrous and non-ferrous iron and steel trades	4,764,873	1,079,853	4,413	1,736,000	389,000	26.04%	5.13%
Engineering, shipbuilding, and vehicles trades (metal processing)	6,177,892	1,385,384	4,459		1,605,000		21.37%
Chemical and allied trades	2,419,791	285,151	8,486	298,000	229,000	8.55%	5.80%
Textile trades	2,831,552	906,187	3,125	857,000	1,087,000	9.05%	10.14%
Leather trades	402,611	92,946	4,332	48,000	59,000	0.70%	0.76%
Clothing trades	1,075,729	350,110	3,073	1,117,000	1,527,000	11.60%	14.01%
Timber trade	952,451	323,009	2,949	607,000	894,000	6.05%	7.87%
Paper, printing, and stationary trades	1,509,823	371,910	4,060	188,000	242,000	2.58%	2.93%
Food, drink, and tobacco trades	3,543,298	549,244	6,451	1,419,000	1,238,000	30.94%	23.85%
Total / Average	**24,856,280**	**5,699,168**	**4,361**	**6,671,000**	**8,092,000**	**100%**	**100%**

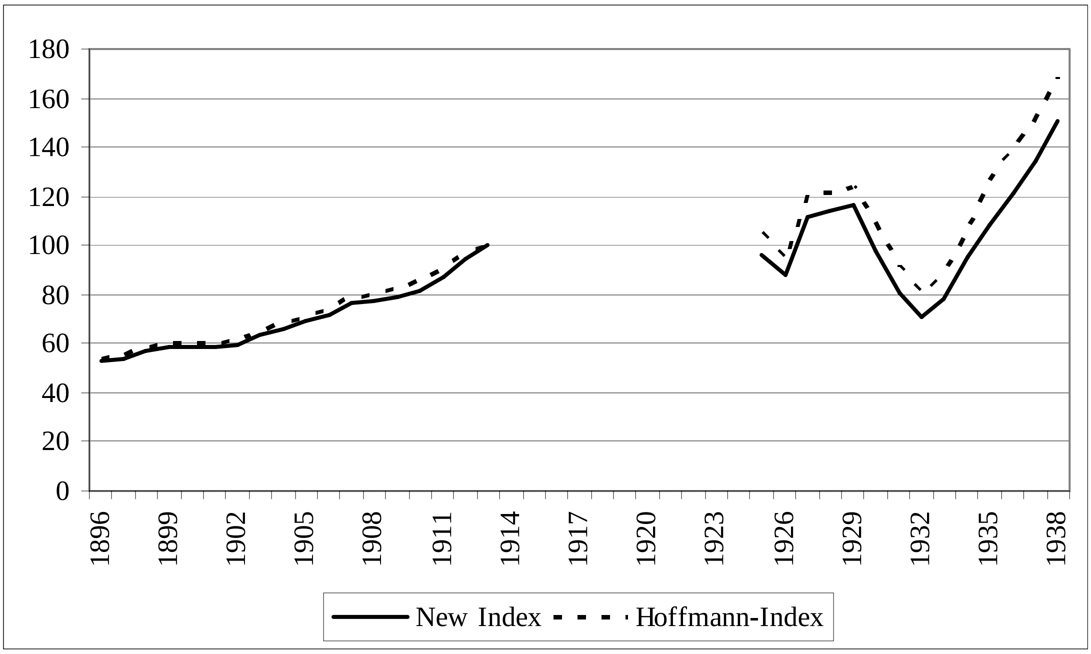
Sources: Col. 1 and 2: Fremdling et al. (2007a: 368); Col. 3: = Col.1 / Col. 2; Col. 4: Fremdling (2007: 178); Col. 5: Hoffmann (1965: 196); Col. 6 =Col. 3 * Col.4; Col. 7 = Col.3 * Col.5. 1925/ 59 weights for metal production (11.34 %) and metal processing (14.70 %) according to their relative net output in 1936.

TABLE 3: Output index for German metal processing, 1913-1938 (1933=100)

	Mechanical Engineering	Electrical Engineering	Motor vehicles	Aircrafts	Shipbuilding	Total
1933 weights	56.94%	31.21%	10.00%	0.70 %	1.86%	100.00%
1907 weights	70.48%	19.53%	4.92%	0.00 %	5.07%	100.00%
1913	219.8	133.3	24.5		885.0	158.7
1925	151.6	156.1	80.6		549.6	152.2
1926	129.0	130.9	67.4		523.0	130.7
1927	169.0	169.2	114.2		567.3	170.9
1928	214.9	209.2	136.5		646.0	213.3
1929	219.3	222.1	136.8		659.3	220.1
1930	169.7	167.1	98.6		479.6	167.5
1931	126.4	132.8	78.0		225.7	125.4
1932	85.7	94.5	57.8		112.4	86.1
1933	100.0	100.0	100.0	100.0	100.0	100.0
1934	133.4	137.9	147.6		236.3	138.1
1935	176.0	164.1	199.4		544.2	181.5
1936	214.1	181.6	238.4	1,939.9	701.8	227.4
1937	268.6	200.0	281.7		791.2	258.1
1938	321.1	256.0	344.3		780.5	311.6

Sources: Weights: 1936 value added and employment from Fremdling et al. (2007b); 1933 employment from Statistisches Reichsamt (1937). 1907 employment from Kaiserliches Statistisches Amt (1910). Time series: mechanical and electrical engineering from Ritschl (2004: 214), Fremdling (2007c); motor vehicles and shipbuilding from Hoffmann (1965:358); aircraft from Fremdling et al. (2007b) and Statistisches Reichsamt (1937).

FIGURE 1: Indices of manufacturing output in Germany, 1896-1938



Sources: Hoffmann (1965); Appendix 2.

TABLE 4: Projections of Germany/UK comparative labour productivity in manufacturing

	1907	1925	1933	1936
UK index of manufacturing output (1913=100)	88.8	111.8	119.6	155.7
UK index of manufacturing employment (1913=100)	93.0	93.4	89.4	101.1
UK index of manufacturing labour productivity (1936=100)	62.0	77.7	86.9	100.0
German index of manufacturing output (1913=100)	76.6	96.1	78.6	121.4
German index of manufacturing employment (1913=100)	92.6	111.8	77.6	100.5
German index of manufacturing labour productivity (1936=100)	68.4	71.1	83.8	100.0
Comparative Germany/UK manufacturing labour productivity (UK=100)	112.5	93.4	98.5	102.0

Sources: UK output and employment indices from Broadberry (1997: 43-44). German output index: own calculation, see text. German employment own calculations using data from Hoffmann (1965: 196) for 1907 and Fremdling (2007: 178) for 1925, 1933 and 1936.

TABLE 5: Predominant weekly money wages in British and German Industry, 1905

	Germany (s./d.)	Britain (s./d.)	Ratio of mean predominant wage (Britain = 100)
Building trades			
Bricklayers	26s. 11d. to 31s. 3d.	37s. 6d. to 40s. 6d.	75
Masons	26s. 11d. to 31s. 3d.	37s. 2d. to 39s. 4d.	75
Carpenters	26s. 11d. to 31s. 3d.	36s. 2d. to 39s. 4d.	77
Plumbers	24s. to 28s. 6d.	35s. 4d. to 39s. 9d.	70
Painters	24s. to 29s. 8d	31s. 6d. to 37s. 6d.	78
Labourers	19s. 6d. to 24s.	23s. 6d. to 27s.	86
Engineering trades			
Fitters	26s. to 32s.	32s. to 36s.	85
Turners	27s. to 33s.	32s. to 36s.	88
Smiths	28s. 6d. to 33s.	32s. to 36s.	90
Patternmakers	25s. 6d. to 35s.	34s. to 38s.	77
Labourers	18s. to 22s.	18s. to 22s.	100
Printing trade			
Compositors	24s. 9d. to 25s. 11d.	28s. to 33s.	83
All the above trades (average)			83

Source: Board of Trade (1908: xliv).

APPENDIX 1: INDUSTRY LEVEL DETAILS FOR 1907 BENCHMARK

In this section we set out our response to Ritschl's (2008) detailed commentary on our data for individual industries included in the 1907 benchmark. For a general overview, see the main text.

1. General chemicals
Ritschl uses 1907 output data from Kaiserliches Statistisches Amt (1909: 99) and 1907 census of occupation data from Kaiserliches Statistisches Amt (1910). This has only a very small effect on the comparative productivity level. We prefer to retain the advantage of taking the output and employment data from the same source.

2. Coke
Ritschl mentions the inclusion of other products in the German data, but we have already allowed for this by adjusting employment down in line with the share of coke in the value of output. Again, using occupation census data means giving up the advantage of taking output and employment from the same source. Furthermore, since productivity increased between 1907 and 1908, this produces a small upward rather than downward bias to German productivity in our estimate.

3. Iron and steel
Ritschl prefers to use 1907 data for Germany and to use physical output rather than deflating net output. His results are nevertheless almost identical to ours. The finding that the results are almost identical follow from the very similar shares of net output in gross output in the two countries, which was already apparent in our data set. Again, we prefer to retain output and employment data from the same source.

4. Non-ferrous metals
This was already the industry with the biggest German labour productivity lead in our sample. The key to productivity comparisons is careful matching of products, which is why we restricted our analysis to unwrought copper and unrefined zinc. For the other products which Ritschl suggests using, we found implausible PPPs, suggestive of poor matching. We prefer to take our output and employment data from a single source.

5. Motor vehicles
Broadberry and Burhop (2007: 338) stated clearly in the appendix that the German data for motor vehicles are for 1909, but omitted to change this in the text, since in an earlier version we had used the 1907 volumes. However, since the value and unit price data are only available for 1909, we preferred to use the data from that year for consistency. Again, to ensure that we are dealing with output and employment from the same firms, we used the 1909 employment data from the industrial survey.

6. Cotton
Ritschl (2008) suggests that Germany had a substantial labour productivity lead over Britain in cotton in 1907. But if this were the case, it is hard to see how Britain could have been so dominant in export markets (including Germany), despite paying higher wages. Leunig (2003) argues that if anything, Broadberry (1997) understates British productivity in cotton spinning, because of the high quality of the British output. Nevertheless, Ritschl (2008: 34) rightly points to a mistake in our spreadsheet, where

employment in “Bigognespinnerei” was mis-transcribed as 9493 instead of 6493. Correcting this results in a slightly higher German productivity. However, Ritschl misunderstands the nature of the adjustment to allow for the absence of German data on cloth. The reduction of employment in line with the share of yarn in the value of output was not intended to treat yarn output as a proxy for cloth output, but merely to measure productivity in the spinning sector, which is what Ritschl (2008: 19) says he is aiming to do. The corrected data are shown below:

	U.K.		Germany	
	Units	Values	Units	Values
Output volume	000 lb	1,487,367	000 kg	358,935
Output value	£000	78,304	M000	644,464
Unit value	£ per lb	0.05	M per kg	1,80
Industry output value	£000	174,610	M000	644,464
Industry employment	000	572.062	000	156.432
Adjusted employment	000	256.542	000	156.432
Output per employee	lb	5,798		
Output per employee	kg	2,630	kg	2,295

Comparing output per employee of 2,295 kg in Germany with 2,630 kg in the United Kingdom yields a comparative Germany/U.K. labor productivity ratio of 87.3. German data are for 1907, compared with out earlier estimate of 85.6.

Sources: UK: Board of Trade (1912: 337-339); Germany, output: Kaiserliches Statistisches Amt (1909: 80; 1910: 253-254; Germany, employment: Kaiserliches Statistisches Amt (1913: 69).

7. Silk

As in cotton, we adjusted the British employment data in line with the share of yarn in the value of output, which is the appropriate way of dealing with the absence of volume data on cloth output. A narrower focus on the German spinning data would lower the German productivity, since spinning accounted for a lower share of the weight of total silk output than its share of total silk employment. It is therefore surprising that Ritschl adjusts the German productivity position upwards.

8. Leather

Ritschl (2008: 35) claims that the British data refer only to tanned leather, but this is not the case. The reason for the incomplete coverage of the industry is that some of the output was recorded in square feet, dozens or yards. Furthermore, we already adjusted the British employment data to take account of this incomplete coverage. As described in the text, we do not accept the basis of the other adjustments at the industry level.

9. Brewing

The British data have already been adjusted to take account of the other activities such as bottling, by reducing employment in line with the share of matched output in total output. We prefer to stick with the German employment and output data from the same source. The adjustments suggested by Ritschl are in any case quite small.

10. Tobacco

The adjustments suggested by Ritschl for this sector are quite small. We prefer to stick with our estimates which take output and employment from the same sources, which do not include the small firms for which Ritschl suggests making allowance.

11. Sugar
Ritschl does not propose any adjustments for this industry.

12. Cement
Ritschl suggests that German productivity is pulled down by the inclusion of quarry workers. Excluding these workers from the comparison raises the comparative Germany/U.K. labor productivity ratio to 124.1, rather than the 108.1 in Broadberry and Burhop (2007).

13. Salt mining
The British data refer to "the production of salt at mines and brine pits and the refining of salt at salt works". We now match this with saleable products from salt mining including chlorine potassic works for Germany. The German data are for 1909.

	U.K.		Germany	
	Units	Values	Units	Values
Output volume	000 tons	1,278	000 tonnes	5,042
Output value	£000	650	M000	134,682
Unit value	£ per ton	0.51	M per tonne	26.71
Industry output value	£000	667	M000	220,192
Industry employment	000	4.736	000	27.445
Adjusted employment	000	4.615	000	16.787
Output per employee	tons	277		
Output per employee	tonnes	281	tonnes	300

Comparing output per employee of 300 tonnes in Germany with 281 tonnes in the United Kingdom yields a comparative Germany/U.K. labor productivity ratio of 106.8. German data are for 1909.

Sources: U.K.: Board of Trade (1912: 81); Germany: Kaiserliches Statistisches Amt (1913: 44).

14. Coal mining
We prefer to use output and employment data from the same source.

15. Iron ore mining
Ritschl rightly points out that there are additional UK data in Board of Trade (1912: 76) which were returned under the Metalliferous Mines Regulation Act. However, it should be noted that this has the effect of raising rather than reducing the British productivity advantage. We retain the German data for 1908 to ensure that output and employment are for the same firms. The revised data are as follows:

	U.K.		Germany	
	Units	Values	Units	Values
Output volume	000 tons	6,802	000 tonnes	18,830
Output value	£000	1,987	M000	84,275
Unit value	£ per ton	0.29	M per tonne	4.48
Industry output value	£000	1,999	M000	84,275
Industry employment	000	11.252	000	39.594
Adjusted employment	000	11.184	000	39.594
Output per employee	tons	608		
Output per employee	tonnes	618	tonnes	476

Comparing output per employee of 476 tonnes in Germany with 618 tonnes in the United Kingdom yields a comparative Germany/U.K. labor productivity ratio of 77.0, compared with our earlier estimate of 91.0. German data are for 1908.

Sources: UK: Board of Trade (1912: 76); Germany: Kaiserliches Statistisches Amt (1913: 2).

APPENDIX 2: New index of output in German manufacturing (1913=100)

	New index	Hoffmann index
1895	50.1	51.3
1896	52.6	54.0
1897	53.9	55.3
1898	56.9	58.6
1899	58.6	60.2
1900	58.5	60.1
1901	58.6	60.1
1902	59.7	61.3
1903	63.6	65.5
1904	66.2	68.2
1905	69.0	71.2
1906	71.3	73.8
1907	76.6	79.2
1908	77.6	80.1
1909	79.1	82.0
1910	81.1	85.2
1911	86.8	90.4
1912	94.8	97.2
1913	100.0	100.0
1925	96.1	104.7
1926	88.1	93.8
1927	111.9	120.3
1928	114.2	121.6
1929	116.4	123.6
1930	97.4	109.3
1931	81.0	91.5
1932	70.5	79.7
1933	78.6	87.8
1934	95.6	105.8
1935	108.1	126.5
1936	121.4	139.6
1937	134.7	151.2
1938	151.1	168.5

Sources: New Index: see text; Hoffmann Index: Broadberry (1997: 43-44).

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