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The Anglo-German Industrial Productivity Paradox, 1895-1938: A Restatement and a Possible Resolution

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Abstract

Recent research on international productivity comparisons with historical data has encountered large discrepancies between benchmark comparisons and time series extrapolations from other benchmarks. Broadberry and Burhop (2005) have recently argued that for Hoffmann's (1965) widely accepted time series for German industrial output, there is no such productivity paradox, while for a revision of that series recently suggested by Ritschl (2004), the discrepancy between the Anglo-German benchmark and the time series projection is considerable. Attempting to reconcile the time series evidence and the productivity benchmarks, they discard the revised series in favor of the original, disregarding mounting evidence on its lacking reliability. The present paper restates this productivity paradox and proposes a possible resolution. We draw on recent archival discoveries by Fremdling and Staeglin (2003) and Fremdling (2005) that confirm the revisions to the Hoffmann series. We also draw on recent advances in the reconstruction of a German industry census of 1936, and argue that the productivity paradox is largely the consequence of mismeasurement in all versions of the German series. Correcting for the omissions, much of the Anglo-German productivity paradox disappears.

JEL codes: N10, N60
Keywords: productivity, benchmark comparisons, Britain, Germany

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1. Introduction

Recent research has highlighted the difficulties in reconciling historical benchmark comparisons of industrial productivity across countries with backward extrapolations from more recent benchmarks. Ward and Devereux (2003) have found large discrepancies between an Anglo-American productivity benchmark they presented for the late 19th century and backward extrapolations by Broadberry (1997)[2]. Similar productivity paradoxes might also exist for other cross-country comparisons. While Broadberry (1997) has argued that in the Anglo-German case, time series evidence and benchmark comparisons for the early 20th century fit each other well, a recent revision of the German industrial production index by Ritschl (2004) would again seem to suggest a Ward/Devereux-style productivity paradox. Broadberry and Burhop (2005) argue that this revision leads to an implausibly high German productivity lead on the eve of World War I, while their preferred version of the German time series data would not. This leads them to discard the revised German time series data, disregarding mounting evidence on its biases and lacking reliability.

In contrast to this time series evidence, there is little controversy surrounding comparative productivity benchmarks for Britain and Germany in the early 20th century. Anglo-German benchmark comparisons of productivity by Fremdling (1991) for 1907 and by Broadberry and Fremdling (1990) for 1935/36 found that German manufacturing was roughly at par with Britain before World War I and was slightly ahead of Britain before World War II. This is conventional wisdom, which confirms earlier work by Rostas

[2] For counter-criticism and the subsequent debate, see the comment of Broadberry (2003) and the reply by Ward and Devereux (2004).

(1943), Rostas (1948), and Paige and Bombach (1959), and which has hardly ever been challenged.

There is now a second vintage (or third, counting the seminal contribution of Rostas (1948)) of studies emerging that recalculate the old results with refined methodologies and on a much broader database. Broadberry and Burhop (2005) redo Fremdling's (1991) productivity benchmark comparison for 1907 and arrive at broadly the same results. de Jong and Fremdling (2006) recalculate the 1935 productivity benchmark of Broadberry and Fremdling (1990) for 1935/36. In spite of a much improved methodology, which includes double deflation, i.e. separate deflators for gross output and intermediate inputs, they again arrive at broadly the same results (although in both cases, there are important sectoral differences with the earlier estimates). One might wonder why these results matter. After all, the broad picture has not changed. So at least it seems.

The problem is with the time series for Germany. All time series extrapolations of comparative Anglo-German productivity employ the index of industrial production of Hoffmann (1965), whose series of aggregate and industrial output form the basis of the entries for Germany in the work of Maddison (1991), Maddison (1995), Maddison (2001). While widely used internationally, Hoffmann's series have never been fully accepted in Germany. An older series of Wagenführ (1933) continues to be used for industrial production, while an official income-based national account series is still often employed for research on the 19th and early 20th century[3]. A number of authors, notably Fremdling (1988), Fremdling (1995) and Holtfrerich (1983), pointed to a number of pit-

[3] A backward projection of this series into the 19th century was published in Statistisches Reichsamt (1932).

falls in the Hoffmann estimates and suggested avenues for further revision. In this Journal, Burhop and Wolff (2005) undertook many of these revisions for the 19th century and arrived at remarkable deviations from the various aggregate series suggested by Hoffmann. For the 20th century, Ritschl and Spoerer (1997) presented an alternative estimate of national income beginning in 1901[4]. Recently, Burhop (2005) revised Hoffmann's index of industrial production for the 19th century. For 1913 and the interwar years, Ritschl (2004) presented a revision which corrects for a biased estimate of metal-processing and engineering in Hoffmann's index of industrial production. He employed this result to reconcile Hoffmann's aggregate output series with the national income estimates of Ritschl and Spoerer (1907) for 1913 to 1938. Inserting the revised industrial index into Hoffmann's aggregate output series, almost no systematic differences with the official income series remained.

As a result of these revisions, times series projections of Anglo-German productivity comparisons do not work well anymore. Broadberry and Burhop (2005) find that for the index revision of Ritschl (2004), Germany prior to World War I had an industrial productivity lead over Britain of 40-70%, which looks rather implausible given the benchmark estimates. Even with the more modest index revisions suggested by Burhop (2005), an wider German productivity lead emerges, this time – surprisingly – for the 1890s.

Given this disturbing and arguably confusing evidence, the present paper takes a fresh look at Germany's industrial production index and its implications for time series

[4] A first, still influential revision of this series is Hoffmann and Müller (1959). On a criticism of this revision for the interwar period and a further correction see the appendix in Ritschl (2002).

projections of Anglo-German productivity comparisons. It examines the scope for revisions and chooses the most compelling ones, while discarding others. It restates the Anglo-German productivity paradox and suggests a way out. For the index-theoretic reasons stated by Ward and Devereux (2003), it would seem to be a sheer miracle – and rather accidental – if the productivity paradox could be explained away entirely. However, the present paper finds that (a) the revised German series represents output growth better than Hoffmann (1965) series employed by Broadberry and Burhop (2005), (b) additional revisions suggest themselves from a recent upward revision of 1935/36 output levels, (c) the productivity paradox is much smaller than calculated by Broadberry and Burhop (2005).

This paper is structured as follows. The next section reviews the German industrial production indices along with the corrections suggested by Burhop (2005) and Ritschl (2004), extrapolates Anglo-German productivity backwards from the 1935 benchmark, and restates the productivity paradox. While the resulting discrepancy is remarkably lower than in Broadberry and Burhop (2005), it is still considerable and certainly inconsistent with the 1907 benchmarks.

Section 3 discusses the underlying index revisions in more detail. Based on new archival evidence, the revisions to the Hoffmann index by ritschl (2004) can be further substantiated. At first sight, this would imply that the Anglo/German productivity paradox is worse than previously thought: just returning to the original Hoffmann series and ignoring its bias, as in Broadberry and Burhop (2005), is no longer an option.

Section 4 examines recent evidence that helps explain the productivity puzzle. None of the extant indices reflects the emergence of a large military aircraft industry in

Germany beginning in 1934. Including output and employment of that industry in the total affects the index and, to lesser extent, the 1935 benchmark. As a result, a large portion (but not all) of the Anglo/German productivity paradox disappears.

Section 5 summarizes the conclusions of this paper and presents avenues for further research.

2. The Anglo-German productivity paradox restated

This section reviews the classical industrial production indices by Wagenführ (1933) and Hoffmann (1965), along with the corrections to the Hoffmann index suggested by Burhop (2005) for the 19th century and by Ritschl (2004) for the 20th century. For three of these indices, it projects Anglo-German productivity backwards from the 1935 benchmark, and restates the productivity paradox[5].

The first step is to calculate these indices for comparable industries and calculate the results into employment.[6] In a second step, results are compared to the British series, and an index of comparative productivity based on the 1935 benchmark is calculated (Table 1).

(Table 1 about here)

[5] Burhop's (2005) corrections, although significant for the 19th century, make little difference for the immediate pre-World War I period that we focus on here.

[6] This leaves out utilities and construction. In this way, the indices are comparable to the British industrial production series of Feinstein (1972).

All backward projections from the 1935 benchmark in Table 1 suggest a German productivity lead over Britain on the eve of World War I, which is not borne out by the 1907 benchmark comparisons of Fremdling (1991) and Broadberry and Burhop (2005). The discrepancy still looks acceptable for Hoffmann's (1965) original series[7]. For the revised series, as well as the Wagenführ (1933) estimate, the discrepancy is considerable – although nowhere near the 70% productivity lead suggested by Broadberry and Burhop (2005). The 1907 discrepancy between the backward time series projections and the benchmark comparisons is the Anglo-German productivity paradox.

3. Revisions to Hoffmann's index

One seemingly obvious strategy is to pick the one series that produces the best fit in Table 1, and to discard the rest. This would leave the researcher with the choice of Hoffmann's (1965) original index for Germany, and to possibly accept the revisions of Burhop (2005), which generate a German productivity lead as early as the 1890s but not around the 1907 benchmark. This is the option chosen by Broadberry and Burhop (2005). The price to be paid for this is the choice of a time series that is known to exhibit spurious growth between the 1907 and 1935 benchmarks. Ritschl (2004) examined output in German capital-goods industries across World War I, employing data from the respective industry associations along with a detailed commodity-flow estimate of equipment investment in the German economy by Gehrig (1961). In addition to being consistent with the official statistics of gross investment, the resulting series were also consistent with the

[7] Broadberry (1993) suggests a 10 per cent error margin between a given benchmark and time series projections from a different benchmark. The Hoffmann index would meet this criterion, while the others would not.

data on domestic steel consumption, machinery exports, as well as with Wagenführ's (1933) index of industrial production and the official national income accounts examined in Ritschl (2002). However, they differ strongly from Hoffmann's (1965) estimate for the same industry. As the data in Table 2 bear out, the Hoffmann series of output in metal-processing industry exhibits far higher growth than the revised series.

(Table 2 about here)

The revisions underlying Table 2 are partly based on sales data from Germany's machine building industry association, VDMA, and on Wagenführ's (1933) machinery index[8]. VDMA published a sales figure for 1913 and a series from 1925 to 1928. In 1928, an official industry census for machine building produced slightly lower numbers than VDMA for the same year. These lower numbers are the benchmark from which Gehrig (1961) backward-extrapolated the official machinery index to 1925 (but not to 1913). This procedure tended to underestimate the growth in machinery output between the VDMA benchmark for 1913 and the revised, lower benchmark for 1928. In an attempt to correct the 1913 benchmark, Ritschl (2004) employed companion information from VDMA (1926) to arrive at higher output growth between 1913 and 1928.

Archival research on the VDMA data by Fremdling (2005) provides a new benchmark for gross output of machinery in 1913, along with a consistent series back to 1909. Fremdling's 1913 benchmark is 2609.6 mill M in 1913 as opposed to VDMA's 2800

[8] Wagenführ headed a group on industrial statistics at Berlin's *Institut für Konjunkturforschung.* An updated index is included in Wagemann (1935). Tooze (2001) provides a history of this institution, which carried out business cycle research and conducted monthly industry surveys at a wide coverage, beginning in 1928.

2800 mill. M[9]. The percentage discrepancy between both benchmarks is exactly equal to the discrepancy between VDMA's own sales data for 1928 and the official census.[10] This suggests that the census was conducted for exactly the same reporting group of machine producers for which Fremdling (2005) worked out the 1913 benchmark.

(Table 3 about here)

As Table 3 shows, growth in nominal sales, column (ii), between Fremdling's (2005) 1913 benchmark and the 1928 census benchmark is the same as between the uncorrected VDMA data of column (i). Hence, the VDMA figures overstate levels in both 1913 and 1928 but describe growth between the benchmarks correctly. Deflating by machinery prices, real output of machinery declines slightly between 1913 and 1928, (in column (vi)). The decline is very close to the data in Ritschl (2004), shown in column (vii). The series of Wagenführ (1933) exhibits a larger decline between 1913 and 1928 but is identical between 1913 and the benchmark year of 1935 (column (viii)). Fremdling's (2005) data on machinery sales and output thus fully confirm the existing revisions of Hoffmann's (1965) output in metal-working.

Table 3 also provides Fremdling's sales data for 1909. Converting these into a real output index yields an estimate which is, again, close to the Wagenführ data for the

[9] This latter estimate seems to be derived from the export shares of VDMA's members in 1913, see Fremdling (2005).

[10] Sales according to the 1928 census were 3728 mill. RM. The VDMA figure for the same year is 4000 mill. RM. We obtain Fremdling's corrected 1913 benchmark of 2609.6 mill. M by multiplying the published VDMA figure of 2800 mill. M for that year with the relationship between the 1928 figures: 2800*[3728/4000]=2609.6.

same year. Thus, the revisions also confirm Wagenführ's (1933) index of machinery production, except around 1928.

Burhop (2005) has suggested a number of possible revisions to Hoffmann's index, some of which also refer to metal-working and machine building. This index revision forms the basis for some of the time series projections in Broadberry and Burhop (2005). Burhop employs the same published VDMA sources as above, except for the sales data. He constructs a 1913 benchmark for net value added and for per-capita output in machine building. His estimate of net value added in 1913 is 954 mill. M. Dividing this by the VDMA employment estimate of 460'000, he arrives at a net value added per capita of 2074 M. This is clearly too low. On the basis of an employment of 420'000 to 450'000, Fremdling (2005), working from internal VDMA files, obtains average gross output of 2525 or 2694 mill. M, which averages 2609.6 mill. M. This results in an average gross output per person in the range of 5900 M. Assuming the same proportions as in the 1928 industry census for 1913, net value added was around 60% of gross output. This implies more than 3500 M of net value added per person in machine building, over a third more than Burhop's estimate and almost twice the labor productivity estimate implicit in Hoffmann (1965).

The reason for this discrepancy is the likely underestimation of profits in Burhop's (2005) estimate, who takes corporate profits in machine building industry from published corporate balance sheets, which are notoriously unreliable given the leniency of German accounting laws, see Spoerer (1996), Baten and Schulz (2005). The underestimation of profits is, however, also a reflection of a similar underestimation in Hoffmann (1965). Hoffmann's (1965) index of production in metal-processing industry builds on

employment, multiplied by average wage rates, assuming a profit share that is representative for industry as a whole and constant over time. This approach towards estimating output ignores the substantial shift in wage bargaining power towards labor that took place in Germany after 1918. Ritschl (1990) showed that all available estimates of German national product except for Hoffmann's aggregate output series imply a strong increase in the wage share in national income between 1913 and 1925. This shift is also clearly visible if wage bills are calculated into the expenditure and income series of Hoffmann (1965), as well as the official national income series.

That there is no such shift in Hoffmann's aggregate output series is by construction, as Hoffmann's index of metal processing is built on the assumption of constant wage shares. As discussed in Ritschl (2004), this has major consequences for the behavior of Hoffmann's industrial and aggregate output series. Removing Hoffmann's index of metal processing and implanting a revised, more realistic index, both the index of industrial production and aggregate output behave almost exactly like the other series. The profit squeeze in German industry between 1913 and 1925 is a classical theme in German historiography, and has generated a large literature, see Borchardt (1990). Hoffmann's index merely assumes it away, as does Burhop's revision and its application by Broadberry and Burhop (2005). As soon as Hoffmann's tales on production in metal processing are replaced with actual data, the traditional picture reappears: profits in metal processing were much larger before the war than afterwards, and the output of machinery declined from 1913 to 1928 instead of increasing. Thus, reverting to the original Hoffmann data is no longer an option. There is solid evidence on output in the respective industries across

World War I, which tells a different story. Any time series projection of comparative productivity has to build on this evidence to be minimally credible.

4. A further revision and a new time series projection of productivity

Further revisions to the data suggest themselves from a reassessment of Germany's 1936 industry census by Fremdling and Staeglin (2003). According to their results, the production of military aircraft, along with some minor armament industries, is missing from the industry aggregates of this census, and is instead included in the construction sector. The industries in question employed about 168 thousand people in 1936 and generated sales of about 956 mill. RM. For aircraft industry with 145 thousand people at work, gross output was 883 mill. RM or 6067 RM per capita.[11]

(Table 4 about here)

As Table 4 bears out, aircraft and the smaller armament industries in 1936 were smaller than the auto industry in terms of productivity, but larger in terms of employment.[12] Employment in armament industry was about 28.3% of employment in machine building in that year, with slightly lower productivity. To add aircraft and armament industry to the index of industrial production for 1936, machine building thus seems to be the proper choice. Also, it seems plausible to assume that in the mid-1930s, machinery

[11] German Federal Archives, R3102/3028.

[12] This would suggest that in terms of employment creation, the Third Reich was probably less of a story about cars, roads, and the autobahn, as in Overy (1975), but rather about bomber aircraft and runways.

and aircraft production grew roughly at the same rates. Then, the index 1913=100 for machine building for 1935 increases by 28.3 %, i.e. from 80.9 to 103.75 (see Table 4). This implicitly assumes that there was no aircraft production to speak of in 1913.[13]

The results from this upward revision of German machinery production for the benchmark year of 1935 can now be fed back into the productivity comparisons of Tables 1 and 2. As productivity in aircraft and armament was close to that of machine building, and as machine building was close to the average benchmark, the productivity benchmark of Broadberry and Fremdling (1990) remains mostly unchanged. If anything, a slight downward revision is appropriate (Table 5).

Whether Hoffmann's (1965) employment estimate for 1935 needs to be adjusted as well is doubtful. His estimates are based on the annually published statistics of social security membership by industry[14]. These data are likely to be unaffected by the window-dressing in the published industry census, which came out only in 1939. Hoffmann's estimate of employment in metal processing industry for 1935 is 2.67 million, to which a 168 thousand employed in aircraft and armament industry in 1936, or less for 1935, may or may not have to be added. To be on the safe side we do adjust the employment in metal working industry.

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[13] Inspection of the net value added data from the 1936 census substantiates the revision. Value added in total industry (including construction, where the armament data were hidden, and utilities) at the census was 34.185 bn RM at 1936 prices, or 27.305 bn RM at 1913 prices (author's own calculations from German Federal Archives, R3102. GNP deflator is calculated from Ritschl, 2002, Appendix B). Net value added for the same classification of industry in Hoffmann (1965, p. 455) is virtually identical at 27286 bn RM. Thus, the coverage of value added by the 1936 census and by Hoffmann (1965) is the same.

[14] Statistisches Jahrbuch für das Deutsche Reich, various issues. The industry census of 1936 covers about 82% of Hoffmann's (1965, p. 199) employment (adding about 1.9 million self-employed to the former). The discrepancy is largely due to Hoffmann's (1965) use of a wider employment concept from the employment censuses of 1933 and 1933, which he interpolates by social insurance membership data.

(Table 5 about here)

Table 5 combines the information of Tables 1 and 2 for the revised Hoffmann index, to which output in the aircraft and firearms industries has been added for 1935. As the table bears out, inclusion of these industries does not eliminate the Anglo-German productivity paradox entirely: for 1907, the backward projection from 1935 is still above the benchmark for the revision. However, about 50 per cent of the gap vis a vis the Broadberry/Fremdling (1990) benchmark is closed. For 1907, the time series estimate is now close to the 10 per cent error margin suggested by Broadberry (1993) for such comparisons. To be sure, if the somewhat higher 1935 benchmark of de Jong and Fremdling (2005) is taken as a yardstick, the discrepancy grows considerably. This is true for both the original Hoffmann series and the revision. As none of the available benchmarks for 1907 employ double-deflation techniques, the de Jong and Fremdling benchmark and the 1907 benchmarks are not directly comparable. Irrespective of the benchmark, however, the Anglo/German paradox is not as bad as Broadberry and Burhop (2005) think: once the proper corrections to the time series evidence are made, the benchmarks and the time series projections do not tell wholly irreconcilable stories. All the evidence examined here indicates that Germany enjoyed a growing productivity lead in manufacturing over Britain prior to World War I. Given the paucity of comparable data for 1907 and the inevitable pitfalls in the historical time series, it is hard to know whether the lead was closer to 10 per cent, as suggested by the benchmark, or to a more substantial 25 per cent, as suggested by the time series evidence. However, it seems safe to rule out extreme sce-

narios such as Germany trailing Britain in manufacturing around 1907, or instead forging ahead at 60 to 70 per cent, as one of the calculations in Broadberry and Burhop (2005) suggested.

5. Conclusions and implications for future research

Time series projections and benchmark estimates of comparative productivity for Germany and Britain prior to the First World War do not always seem to coincide well. Only if for Germany a time series with dubious growth characteristics is chosen can the benchmarks and the time series projections be reconciled. This is the Anglo/German industrial productivity paradox, stated by Broadberry and Burhop (2005).

The present paper has restated the paradox. It recalculated the productivity projection from a commonly accepted 1935 benchmark back to 1907, employing the contentious series of Hoffmann (1965) for Germany along with an alternative index by Wagenführ (1933) and a correction of the Hoffmann series recently suggested by Ritschl (2004). While the discrepancies from the 1907 benchmarks are substantially lower than in Broadberry and Burhop (2005), the productivity paradox itself seemed robust: around 1907, there is no deviation to speak of in the case of the original Hoffmann (1965) series, while time series projection using Wagenführ (1933) and Ritschl's (2004) correction of Hoffmann resulted in large (and near-identical) upward discrepancies from the benchmark.

The present paper has also suggested a possible resolution. In the light of recent research on the Anglo/American productivity paradox (see the debate between Ward and Devereux, 2003, 2004, and Broadberry, 2004), major discrepancies between a compara-

tive benchmark and time series projections from a different benchmark would probably be expected as normal. However, recent archival discoveries by Fremdling, documented partly in Fremdling and Staeglin (2003), suggest further revisions of the German time series evidence around the 1935 benchmark. The reason for this is mismeasurement of German industrial output and productivity, caused by the omission of war-related industries from Germany's industrial census in 1936. Correcting for the omission both at the benchmark and in the time series, we find that almost 50 per cent of the Anglo/German productivity paradox for 1907 disappear.

This paper also presented evidence that further substantiates the revisions to Hoffmann's index by Ritschl (2004) for 1913 and the 1920s. Fremdling (2005) has recently reconstructed machinery output in Germany for key years before World War I from archival data. These data confirm existing estimates of machine output that entered into Ritschl's calculations, and make the original Hoffmann series look even less plausible.

The results of this paper, as well as the various corrections to Hoffmann's index suggest the need for a full recalculation of a German industrial production index, combining the various existing revisions with the available archival data. They also highlight the risks inherent in time series projections of comparative productivity from imperfect index numbers. Yet, the results of this paper imply that the Anglo/German industrial productivity paradox is not as bad as it seems, provided the inconsistencies in the existing time series for Germany are ironed out properly.

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Table 1: Productivity in Manufacturing in Germany (D) relative to the UK (extrapolated backwards from Broadberry/Fremdling benchmark for 1935)

	Britain (1913=100, rebased to 1935)			Germany (1913=100, rebased to 1935)							**Germany relative to Britain same year**		
	Employment	Output	Productivity	Employment	Output			Productivity			Productivity (Britain=100)		
					Hoffmann	Wagenfuehr	Hoffmann corrected	Hoffmann	Wagenfuehr	Hoffmann corrected	Hoffmann	Wagenfuehr	Hoffmann corrected
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)	(xii)	(xiii)
1881	77.0	37.0	48.0	54.9	23.1		26.53	42.0		48.3	89.3		102.7
1891	86.4	45.4	52.6	68.9	33.4		37.1	48.6		53.9	94.3		104.7
1895			*56.8*	71.5	40.5	39.8	45.9	56.7	55.7	64.2	101.8	99.9	115.3
1901	93.8	55.2	58.9	83.4	47.5	56.6	54.0	56.9	67.9	64.8	98.6	117.7	112.3
1907			*61.0*	93.4	64.4	73.6	73.0	69.0	78.8	78.1	115.4	131.7	130.7
1911	102.6	64.5	62.9	97.1	73.7	88.0	82.8	75.9	90.7	85.3	123.0	147.0	138.3
1925	97.5	85.6	87.8	110.1	85.3	88.0	89.4	77.4	80.0	81.2	89.9	92.8	94.3
1929	102.1	87.3	85.5	111.5	100.1	103.8	107.8	89.7	93.1	96.7	107.1	111.1	115.4
1935	100	100	100	100	100	100	100	100	100	100	102	102	102

Sources and Methods:

(i-iii) Manufacturing output calculated into employment, from Feinstein (1972). 1895 and 1907 values interpolated
(iv,v) Hoffmann (1965), for categories comparable to Feinstein (1972)
(vi) Wagenfuehr (1933), excluding mining, construction and utilities
(vii) Ritschl (2004)
(xi-xiii) 1935 benchmark from Broadberry and Fremdling (1990).

Table 2: Output in German Metal-Processing Industry

	Machines	Electrical	Motor vecs.	Shipbuilding	Total	*Hoffmann*
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
1913	100	100	100	100	**100**	*100*
1925	69.0	117.1	329.4	62.1	**84.4**	*131.4*
1926	58.7	98.2	275.7	59.1	**72.6**	*103.9*
1927	76.9	126.9	467.0	64.1	**94.0**	*142.6*
1928	97.8	156.9	558.2	73.0	**116.1**	*163.5*
1929	99.8	166.6	559.4	74.5	**119.9**	*170.3*
1930	77.2	125.3	403.0	54.2	**90.7**	*156.9*
1931	57.5	99.6	319.0	25.5	**66.6**	*120.3*
1932	39.0	70.9	236.4	12.7	**45.5**	*84.2*
1933	45.5	75.0	408.9	11.3	**52.8**	*91.6*
1934	60.7	103.4	603.7	26.7	**74.6**	*125.5*
1935	80.1	123.1	815.5	61.5	**100.5**	*163.9*
1936	97.4	136.2	975.0	79.3	**119.4**	*202.6*
1937	122.2	150.0	1152.0	89.4	**141.4**	*239.7*
1938	146.1	192.0	1408.0	88.2	**169.2**	*281.1*

Sources: Ritschl (2004), Hoffmann (1965)

Table 3: Recalculating Output in Machine Building

	Nominal Sales					Prices	Real Output (1913 = 100)		
	VDMA		Fremdling (2005)	Census			VDMA, Fremdling, Census	Ritschl (2004)	Wagenfuehr (1933) / IfK
	mill. M/RM	*Index*	mill. M	mill. M/RI	*Index*				
	(i)		(ii)	(iii)		(v)	(vi)	(vii)	(ix)
1909			1738.2			106.2	62.7		63.9
1913	2800	*100*	2609.6	*2609.6*	*100*	100	100	100	100
1928	4000	*142.9*		3728	*142.9*	144.8	98.7	97.8	94.1
1935				2697	*103.3*	127.8	80.9	80.1	80.2

Sources: Calculated from Ritschl (2004), Fremdling (2005)

Table 4: German Aircraft and Armament Industry in 1936

	Employment	Sales (RM)	Output per capita	Unadjusted Output 1935 (1913=100)	Corrected
	(i)	(ii)	(iii)	(iv)	(v)
Aircraft	145,543	883,000,000	6066.9		
Handguns	22,308	73,903,395	3312.9		
Total not in census	167,851	956,903,395	5700.9		
Shipbuilding	79,887	499,810,437	6256.5	61.5	
Motor vehicles	167,620	1,832,663,702	10933.4	815.5	
Machine Building	593,093	3,770,055,495	6356.6	80.9	
Machines & Armament	760,944	4,726,958,890	6212.0		103.75

Source: (i-iii): German Federal Archives, R 3102/3028, R3102/3540-44
(iv): Table 2, Table 3
(v): = (iv), weighed by employment shares

Table 5: Accounting for the Heinkel Bomber: Revised Relative Productivity Projections for German Manufacturing (extrapolated backwards from Broadberry/Fremdling benchmark for 1935)

	Germany					Germany relative to Britain same year		Productivity benchmarks			
	Employment	Output		Productivity		Productivity (Britain=100)					
		Hoffmann	Hoffmann revised	Hoffmann	Hoffmann revised	Hoffmann	Hoffmann revised	I	II	III	IV
	(i)	(ii)	(iv)	(v)	(vii)	(viii)	(x)				
1881	55.9	23.1	25.7	41.2	46.0	87.1	97.2				
1891	70.2	33.4	36.0	47.7	51.3	92.0	99.0				
1895	72.8	40.5	44.5	55.7	61.1	99.4	109.1				
1901	84.9	47.5	52.4	55.9	61.6	96.3	106.2				
1907	95.2	64.4	70.7	67.7	74.3	112.6	123.6		95		110
1911	98.9	73.7	80.2	74.5	81.1	120.1	130.8				
1925	112.2	84.7	86.7	75.5	77.3	87.2	89.2				
1929	113.6	100.1	104.5	88.1	92.0	104.5	109.2				
1935	100	100	100	100	100	101.45	101.45	102		109	

Sources and Methods:

(i,ii) Hoffmann (1965), for categories comparable to Feinstein (1972)
(iii) Wagenfuehr (1933), excluding mining, utilities, and construction
(iv) Ritschl (2004)
(v-x) from (v-vii), calculated into the employment estimate in (iv).
1935 benchmark from Broadberry and Fremdling (1990), adjusted for productivity in aircraft industry.

Productivity benchmarks:

I Broadberry and Fremdling (1990)
II Fremdling (1991)
III de Jong and Fremdling (2005)
IV Broadberry and Burhop (2005)

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