Spurious Growth in German Output Data

1913-1938

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Abstract:

A substantial body of research agrees that unit wage cost in the industrialized economies increased substantially after World War I. For Germany, the popular industrial output estimates of Hoffmann (1965) is partly based on the assumption of constant wage shares, and shows rather high growth of the German inter-war economy relative to 1913. This paper constructs alternative estimates for the affected metal-working sectors, and finds far lower output levels and growth. The change is strong enough to remove the growth bias also from Hoffmann's figures of overall industry and the aggregate economy. After correcting for spurious growth in metal-processing industry, Hoffmann's output estimates are broadly in line with the contemporary output and national income statistics.

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I. Introduction

Stagnant levels of output and incomplete recoveries in the inter-war business cycle have received fresh attention in recent work. Building on the work of Borchardt [1979/1991], Fisher and Hornstein [2001] calibrate an augmented RBC model of Germany's inter-war economy. They find that sluggish productivity combined with high wage cost to explain the depth of Germany's inter-war depression. In the very different context of a dynamic Phillips curve, Dimsdale, Horsewood and van Riel [2004] arrive at the same conclusion. Cole and Ohanian [1999; 2002] find that output in Great Britain and the United States failed to recover to historical trends after the Great Depression. Beaudry and Portier [2002] find that the labor policies of the Popular Front government contributed to stagnant output levels in France during the 1930s. A common perspective shared by these papers is that productivity growth was low already during the 1920s and failed to recover back to trend before World War II.

At least on some accounts, German data appear to be an exception. The most widely accepted series, compiled by a group around Hoffmann [1965] from reconstructed data, shows an impressive increase in national product and industrial output during the late 1920s and again after 1933. Growth of the manufacturing series is largely driven by metal-processing industry, whose output as estimated by Hoffmann grew by 70% between 1913 and 1929 and more than tripled during the whole period from 1913 to1939. As Germany was the world's second largest industrial economy at the time, this apparently more favorable performance seems important, all the more so as it contrasts starkly with its rather less favorable political history at the time. Can a driving force be identified that explains the rapid recovery exhibited in the data? Was Germany an international growth engine? Did Germany make a difference?

This paper argues that growth in German output data between 1913 and 1938 is largely spurious. It arises from what would seem a reasonable assumption in constructing the data, the constancy of factor shares over time. Hoffmann [1965] estimated output in German metal-processing industry (i.e. machine building, automobiles, shipbuilding, electrical and optical industry) from wages and employment, assuming a constant wage-income ratio. This assumption appears innocuous under competitive conditions and a Cobb-Douglas production function, which together yield constant factor shares. It is equally harmless under more general constant returns to scale technologies along a steady state growth path (in which the profit rate and the capital-output ratio remain constant, again implying constant factor shares). It is, however, not innocuous and prone to introduce bias as soon as factor shares change systematically.

Recent work by Bentolila and Saint-Paul [2003] on wage bargaining in the presence of a CES production technology has highlighted the sources of fluctuations of factor shares over the business cycle. If the elastiticies of factor substitution differ from one and trade unions and employers bargain over wages and employment jointly, profits will absorb the productivity shocks. As the employment adjustment channel is shut down, the income shares of capital and labor are affected. Any output or income estimate that is based on the assumption of constant factor shares is then likely to mismeasure output.

Indeed there is ample international evidence of adverse productivity shocks, increased trade union power, and rising wage shares after World War I. In an influential paper, Borchardt [1979/1991] noticed on the basis of different data that unit labor cost in Weimar Germany during the late 1920s was far above long term trends. His claim was that these abnormally high wages contributed to the particular severity of the Great Depression in Germany. This generated almost 15 years of controversy among German historians, see Spoerer [1994] for a review. Employing contemporaneous semi-official income and product data for Germany, Broadberry and Ritschl [1995] examined comparative evidence for Britain and Germany and found patterns of wage pressure during the 1920s to be very similar across both countries. In both countries, a surge in trade union membership, collective wage bargaining and the eight-hour day appeared to have tilted the functional distribution of income in favor of labor.

The German economy indeed exhibits very much the same patterns as elsewhere, provided output and income are measured properly. The present paper will show that discrepancies between the official data and Hoffmann’s index mostly disappear once output in metal processing is estimated independently of factor incomes. The rest of this paper is structured as follows. Section II discusses the basic elements of Hoffmann's index in more detail. Section III focuses on an attempt of Balderston [1993] to reconstruct Hoffmann's estimate of metal-processing output, and compares these with contemporary data from both official and industry sources. Section IV constructs a new index of metal-processing output from these contemporary sources and inserts the results into Hoffmann's index of industrial production. Section V goes one step further by tracing the effects of this correction on Hoffmann's output-account estimate of German net domestic product, and Section VI concludes with some remarks on possible avenues for future research.

II. Hoffmann's Index of Industrial Production: Basic Concepts

Existing data on manufacturing output for inter-war Germany come from two sources. Contemporary statistics were compiled by the Statistical Office (*Statistisches Reichsamt*) and its research affiliate, *Institut für Konjunkturforschung* (IfK)[1]. This business cycle research institute collected monthly and quarterly industrial statistics and produced an index of industrial production based on 1928 weights. Wagenführ [1933] calculated a simplified version of this index back to 1861. A refined version of the same index was rebased to 1936 after an industry census and later became the starting basis for the industrial production indices of both postwar Germanies.

The second source is provided by the estimates of Hoffmann [1965], who calculated various different estimates of German national accounts including an output account and an index of industrial production. Being part of the international comparative national accounts project under the guidance of Simon Kuznets, Hoffmann's data on German industrial output soon gained general recognition and are reproduced in all major international compilations of historical output series (most prominently, Mitchell [1975], Maddison [1995]). Figure 1 plots both estimates against one another.

(Figure 1 about here)

Both series are calculated for changing territory, excluding, inter alia, the mining and industry districts of Upper Silesia after 1920, and the Saar district between 1920 and 1935. Apparently there exists a level effect in 1925 that drives a wedge between Hoffmann's data and the official series of industrial production. Also, growth in Hoffmann’s series during the 1930s is slightly higher. Tracing this displacement effect on a sector-by-sector basis, one of the most dynamic series is Hoffmann's estimate of value added in metal processing industry. Hoffmann stipulates that output in this sector almost tripled between 1913 and 1938. As metal-processing accounts enters his index of industrial production with a weight of 17%, this is evidently a major factor determining the dynamics of the aggregate as a whole.

To calculate output of metal-processing industry, Hoffmann chooses the rather indirect way of inferring output from employment and a self-constructed earnings series under the assumption of constant wage shares. This assumption looks fine when viewed from the perspective of Cobb-Douglas production functions or of steady state growth with Harrod-neutral progress. However, it is less innocuous under more general CES technologies and collective bargaining, see Bentolila and Saint-Paul [2003], as it introduces potential bias towards the hypothesis of no change.

This problem has plagued the German debates about wage shares and unit labor cost in the Weimar Republic. Borchardt [1979/1991] had employed a national income series (from Glismann [1978]) that was constructed independently of Hoffmann's output data and found strong evidence of rising unit labor cost. Holtfrerich [1984] recalculated labor unit cost data from Hoffmann's output series and found no increase over 1913. In a comparison of the different output and income estimates, Ritschl [1990] singled out Hoffmann's output data as the only estimate under which the labor share remains roughly constant relative to 1913.

Why Hoffmann chooses to proceed this way is not entirely clear, as there exists a wealth of time series on output in the various subsectors of metal processing in Germany. The official index of industrial production includes data on shipbuilding, automobile production, and machine building. Series on electrical industry and the – far smaller – optical industry are available from 1928 on at an annual basis[2]. Both series were completed for 1913 and 1925-27 by a group around Gehrig [1961] at Munich's IFO institute.

Rather than employing this information, Hoffmann interpolates census data on employment in a very broad classification of metal-processing, which includes also electrical and optical industry. For the interwar years, the annual interpolating series is even aggregated over both metal making (mainly, iron and steel) and metal processing. Balderston [1993] has attempted to reconstruct Hoffmann's interpolation method. Table 1 reproduces Balderston's method in simplified fashion.

(Table1 about here)

The first two columns in Table 1 show employment in metal making and metal processing. As no independent annual observations for metal processing are available, Hoffmann [1965, p. 198] uses the breakdown of 1913 (81%) and applies it to the subsequent years. To arrive at output, Hoffmann imputes an – again, rather indirect – estimate of product wages, see Balderston [1993]. Multiplying this index of product wages in col. (v) by estimated employment in metal processing in col. (iv) yields an estimate of real output in (vi). As can be seen by comparison with Hoffmann's own output estimate (vii), Balderston's reconstruction of the method works fine to 1927 but not thereafter.

It is apparent that this estimation strategy critically depends on two things, first, on the validity of the employment figures themselves, and second, on output per person being strictly proportional to the real wage. The first assumption is evidently problematic enough. As to the second assumption, it is equivalent to stipulating that technology was Cobb-Douglas and that shifts in the distributional position of labor were absent. This assumption seems to be more of a problem than Hoffmann had anticipated.

III. An alternative estimate: the IfK data

To produce a better estimate, attention needs to be focused on machine building and electrical industry only, as deviations between Hoffmann and Wagenfuehr for shipbuilding industry do not seem to matter very much. Balderston [1993] has extended Hoffmann's estimation procedure to machine building, attempting to infer output from employment in that sector. His method, shown in Table 2, is to multiply estimated employment (i) by an estimate of output per worker (ii). The output index he obtains this way for the 1913-1925 period is then spliced to nominal value added from 1925, which he deflates by a self-constructed index of unit export values for machinery. As a result, machinery output in 1925 is estimated to have been about 10% higher than in 1913. Also, Balderston's data show machine building to have increased by 27% from 1925 to 1928.

(Table 2 about here)

These estimates do not square well with contemporary data of machinery output (Table 3). The German machinery producers' association, VDMA, produced figures on gross sales from questionnaires among its members, which later were also included in the official statistics (i). The VDMA also collected data on the tonnage of machinery produced, from which it produced an estimate of real output in 1925 at 1913 prices (ii). Later research by Gehrig [1961] combined these data and later VDMA reports into a time series (iii) of gross sales from 1925 to 1938, which exhibits slightly lower levels almost throughout. Deflation is by the official series of machinery prices (iv). Series (v-vii) show three different estimates of machinery output at constant prices. For 1925, volumes range from 64% to 75% of the output level of 1913. We adopt the original VDMA (vi) figure for of 1925 as a compromise estimate and splice Gehrig's estimate of machinery output to its 1925 level. The resulting time series of machinery output (viii) is only slightly higher than Gehrig's deflated series in (vii).

(Table 3 about here)

The difference of our recalculation (viii) with Gehrig's series (vii) rests on how machinery sales for 1925 are deflated. Balderston [1993] appears to dismiss the official price index of machinery as too low, and constructs his own, higher deflator from export unit values. VDMA's deflated machinery output data for 1925, shown in (ii) and (v), suggests a similar correction. Calculating deflated sales (in ii) into nominal sales (in i), we find the implicit price deflator for 1925 to be equal to 150.0 instead of 138. Splicing Gehrig's deflated series to this estimate implicitly adjusts the price index in (iii) upwards by twelve index points. This is very much in line with the unit export values reported in Balderston [1993, p. 112]. Still, there is little discrepancy of the result with Wagenführ's index of machinery production (ix), at least for the Weimar years. Our new index is constantly about three or four index points higher, but no more than that. Only in the mid-1930s does the revised estimate exhibit somewhat higher growth than the IfK estimate. This may be due to an underestimation of the actual price level in the official index of machinery prices (iv) after 1936. However, results of Fremdling and Staeglin [2003] on the industry census of 1936 suggest that there might be an underreporting problem in the official output data beginning in 1936.

Regarding the comparison between 1925 and 1913, Balderston [1993, p. 448 f.] dismisses the VDMA figures as too low. However, he accepts the same figures for the years from 1925 on. What appears to speak in favor of Balderston's skepticism are the employment data - at least at first sight. If both his employment figures and the VDMA output data were true, he argues, per-capita output in 1925 would have been only 64% of its pre-war level, which he dismisses as implausible. Due to changes in the industry classification system, reliable time series on employment in machine building are apparently not to be had. VDMA's own estimates of blue-collar workers employed are shown in Table 4, series (i). These can be supplemented with employment figures (iii) from the 1928 census of machine building, which however appears to apply to a slightly different classification. Balderston therefore calculates his own employment data from the annual reports of factory inspectors. These data cover all establishments with 10 or more workers in machine building and its adjacent industries, including electrical and optical industry. The reporting base changed in 1926 to 5 or more workers, which induces Balderston [1993, p. 444] to upward adjust his employment data for the previous years[3]. Balderston finds employment in 1928 to have been almost 30% higher than in 1913 (series (vii) in Table 4)[4].

(Table 4 about here)

Recalculating the data, we find the evidence on employment in that sector to be less impressive. The factory inspectors' reports switched from counting blue-collar workers to including all employees in 1926, without giving much notice of the change. In Table 4, column (iv) provides a consistent series on blue-collar employment only, which shows that employment in total metal working industry in 1928 was a mere 12 percent higher than in 1913. We neglect the widening of the reporting base in 1926, which would induce a further downward correction of the index (e.g., to 108 rather than 112 index points in 1928). The series also suggests that some time in 1925 and 1926, employment in that sector fell by almost a third.

Indeed, the stabilization crisis of 1925/1926 must have been a deep one, and was accompanied by structural changes in the labor market. Labor time reductions in the wake of the eight hour day had been significant, amounting to about 10%, see Balderston [1993, p. 438]; VDMA [1927, p. 38]. The post-stabilization slump in machine building was accompanied by a fall in orders of about 40%, see VDMA [1926a, p. 17]. VDMA estimates indicate that beginning in 1925, almost 30% of the blue-collar workers in the industry lost their jobs, while another 37% were put on part time labor. As a result, over 50% of the remaining workforce in early 1926 was on short time. VDMA also reported regularly on the degree of under-utilization of capacity. According to this measure, firms operated below 60% of capacity in 1925 and at a low of 55% of capacity in early 1926, before recovery set in.

There is also companion evidence of an initial upturn in 1924. The last year of hyperinflation had brought a severe setback to postwar reconstruction, as after the French occupation of the Ruhr, output of this industrial heartland of Germany had dropped dramatically. By the beginning of 1924, the political struggle about the resources of the Ruhr had ended and recovery was under way. After a short interruption due to monetary tightening in the second quarter of 1924, orders increased by over 60% up until early 1925, when the crisis set in. This fits well with the commonly accepted interpretation of German industry having come out of the hyperinflation with an overhang of labor. Real labor cost came only to be felt when monetary tightness and the high-tax system implemented in 1924 began to have their effects. VDMA's publications are full of complaints about tax burdens, interest rates, and the attempts by fiscal and monetary authorities to stem capital inflows into Germany. Later in 1926, these lobbying of German industry against these restrictions proved successful. Tax cuts were implemented and new spending programs launched, and Schacht's attempts as president of the Reichsbank to halt the surge of foreign borrowing were thwarted, see Hertz-Eichenrode [1982], Ritschl [2002].

A third and obvious way of checking into the validity of the VDMA output data would be to examine investment activity in German industry during the inflation period. The course of investment during the hyperinflation has itself been the subject matter of debate. Abelshauser [1978] argued that there must have been an investment boom during the inflation years, especially during 1921/22. However, the point for an investment boom would not be easy to make. As Figure 1 above shows, industrial output in Germany in the wake of World War I was dismally low. Starting out from less than 40% of the pre-war level in 1919, it recovered to 70% in 1922. No doubt this was a boom of sorts in growth rates, but levels of output remained critically low. Gehrig [1961] has produced an estimate of German capital stock for the war and post-war period, which again shows very low levels of real capital formation in the first fiye post-war years. As shown by Spoerer [1997, p. 284], investment during the inflation period remained low also in relative terms: the investment-output ratio calculated from these data was markedly lower than in any year between 1925 and 1929.

This evidence is also corroborated by a microstudy of major German machine building companies. Lindenlaub [1985] has shown that during the inflation years, capacity increased mainly through additional labor, whereas investment remained about 30-50 % below pre-war levels. This, he argues, was less than depreciation, to the effect that after the stabilization of 1924, capital stock was technically obsolete. By implication, the ratio of capital to labor in efficiency units seems to have declined, as did the investment-output ratio. Of course the sample drawn by Lindenlaub is far too small to be representative. However, it covers some of the leading German machinery producers, including Krupp (known to the world by its steel division but also for its war production), Deutz (which had commissioned development of the first Otto gasoline engine), M.A.N. (which had commissioned development of the first Diesel engine), and Maschinenfabrik Esslingen, a major locomotive builder. These companies were all either in the railway business or supplied engines for seaships. As both the railways' rolling stocks and the German merchant fleet had been sharply reduced as part of Germany's reparations and therefore needed to be restocked, each of these firms must have fared better than the rest of the industry. Hence it seems safe to conclude that investment in these companies was slightly higher than the industry average. Still, even for these industry leaders, the overall investment record for the inflation period is poor.

A further, though necessarily crude way to infer machine building activity indirectly is by measuring output and consumption of iron and steel. This indicator had figured prominently in German business-cycle research where it was employed as a short-term business cycle predictor (a classical piece on this is Spiethoff [1924]). It was used again by Gehrig [1961] to proxy output of machine building during the inflation years.

Plotting our estimates of machine building activity from Table 3 together with indices of steel output, we find an obvious co-movement: there is precious little room for any underreporting in the machinery data; all series move closely together and exhibit the same levels relative to 1913 (Figure 2).

(Figure 2 about here)

Looking for a possible explanation of Germany's low iron and steel output relative to 1913, the main factor were territorial losses. In 1920, Lorraine was returned to France, parts of Silesia went to Poland, and the Sarre district was put under international control (up to 1935). All three provinces had large heavy-industry capacities, and together accounted for 35% of Germany's steel output of 1913, see Wagenführ [1933]. Figure 3 plots steel output on Germany's reduced 1921 territory against an index of British steel production, with a striking result: once the territorial correction is applied to the data, German steel industry experienced pretty much the same development as its British counterpart.

(Figure 3 about here)

By 1922, German iron and steel output had almost recovered to its pre-war level when measured on post-war territory. Output dropped by almost 50% in 1923, which is mostly due to passive resistance against the French occupation of the Ruhr. The subsequent recovery was interrupted again in 1926. Domestic consumption of iron and steel was about 25% lower than before the war, which comes very close to the reduction in machinery output by 22%. Relative to Britain, the capacity losses were never compensated before the war: still in 1939, Germany’s steel output relative to 1913 was almost exactly the same as Britain’s; no catching-up to compensate for the territorial losses of 1921 had taken place. Cutting through the backward and forward linkages of German heavy industry had been a side effect of the territorial changes of 1921, and was clearly successful from the viewpoint of weakening Germany’s heavy industry base. Given that the industry regions ceded in 1921 disappeared behind high tariff walls, the subsequent slump in German machine building cannot come a surprise. Germany had lost its tariff sovereignty in the Treaty of Versailles and regained it only in 1925. During 1924/25, customs treaties were concluded with most signatory powers of the Treaty, and led to widespread reductions of tariffs and trade barriers that had impeded German machinery exports. By 1926, Germany was about to resolve its tariff conflict with France, but was still amidst a tariff war with Poland up to 1925/6. VDMA [1926b, p. 46f.] provides a detailed survey of the customs treaties concluded in that year. After 1926, exports of German machinery indeed recovered quickly. Given the severe restrictions of German capital goods exports in the preceding years, the subsequent fast recovery of German exports, documented by Balderston [1993, p. 87], is not surprising. Still, Germany’s overall export performance in 1929 compared to 1913 is below the European average, and also lower than that of Britain. Again, there seems little reason to doubt the veracity of the machine output data.

The VDMA data are also consistent with the official statistics on aggregate investment since 1924. Based on work of Keiser and Benning [1931], Germany's Statistical Bureau published aggregate investment data that were based on a personal method, inferring investment from the analysis of company balance sheets, annual reports, and estimates of business associations and cartels. Gehrig [1961] employed a perpetual inventory approach to measuring aggregate investment during the inter-war years. His results build on the output of investment goods shown in Table 3. As these confirm the official investment data very well, both estimates support one another.

Drawing the arguments of this section together, there seems to be good reason to trust in the official figures on machinery output, which fit other available data as well as complementary evidence on the intensity of the 1925 business slump. Put differently, there is little evidence to support Hoffmann's estimates, according to which activity in that sector would have had to be by almost 50 % higher than it plausibly was.

IV. Industrial Production without Spurious Growth: the Adjusted Data

Among the other main sectors of metal-processing, the various available series on shipbuilding and on the output of motor vehicles largely follow similar patterns. In the following, we employ Hoffmann's series, which he discards in favor of his problematic wages-cum-employment estimate. The only remaining task is to find a suitable series for electrical industry. Gehrig [1961] has derived such a series from official data[5]. Table 5 summarizes the results from constructing a new index of production for metal-processing industry.

(Table 5 about here)

The starting point of Table 5 (i) is again the estimate of machinery output from Table 3 (viii). Electrical industry (iii), whose value added data are taken from Gehrig [1961], was more dynamic than machine building. We deflate the value added data by the price index for machinery (iv), which also includes electrical motors. No separate price index for electrical products seems available. The combined production index of machinery and electrical industry in (v) is weighed by the value added of each industry in 1913. To construct the index for metal-processing industry (viii), index weights need to be found that combine the series in (v) with motor vehicle production (vi) and shipbuilding (vii). As Hoffmann provides no index weights, those from the index of industrial production of Wagenführ [1933] are used instead, where proper allowance is made for electrical industry.

The revised index is on average 45 index points lower than Hoffmann's index (reported in Table 5 as column (ix)) during the 1920s. The difference jumps to an average difference of 67 index points in the 1930s. Output at the troughs of the recessions of 1926 and 1932 is at 72.6 and 45.5 percent of the 1913 benchmark, respectively. Hoffmann's index would show 104 and 84 index points for the same years. At the peak of 1929 and in the prewar year of 1938, the revised index attains 119.9 and 169 index points. In contrast, Hoffmann's index would instead rise to 170 and 281 index points, respectively. This is apparently not easy to reconcile with the available evidence.

As a next step, we will insert the revised output index of metal-processing industry into Hoffmann's industry aggregate. The aim of this exercise is to provide upper and lower bounds for a future consensus estimate of industrial production. Upon inspection of the various entries, Hoffmann's industrial production index leans towards modern, fast growing industries, whereas the IfK index of production seems more centered on traditional, slow growing industries. Hence we should expect that, once the bias in the metal processing series has been taken out, Hoffmann's revised series can serve as a plausible upper bound, while the IfK index may be a plausible lower bound.

The Hoffmann [1965, p. 390-394] index of industrial production is a chain index based on census employment weights, all multiplied with value added of that respective industry in 1936. In the relevant time bracket, it employs the census weights of 1907 and 1933, spliced to each other in 1925. For that year, there exists an employment census whose results Hoffmann does not use. This 1925 census also provides revised results for the 1907 census, calculated for Germany's smaller 1921 territory[6]. Above, we suggested that the territorial changes after World War I significantly affected Germany's industry structure. Therefore, use of these revised weights is clearly preferable.

In contrast, the IfK index of industrial production for the inter-war years is only available on a 1928 basis. As there is no hope of finding the true value added data of all industries for all years, comparison between the IfK index and the Hoffmann index introduces inevitable index number problems. To ensure proper comparison, Table 6 provides a whole array of recalculations of Hoffmann's index at various different base years. These include my reconstruction of Hoffmann's original series at original index weights (ii), a proposed provisional consensus estimate (ix) and original the IfK index (x).

(Table 6 about here)

Table 6 reports four different weighing schemes for Hoffmann's industrial production index, along with four versions of my revision. Given any weighing scheme, the difference between Hoffmann's series and my revision is up to ten index points in the 1920s, which rise to 17 index points in the late 1930s. At Hoffmann's uncorrected index weights, the revised index (ii) peaks at 112.7 index points in 1929, as opposed to 121 in the original series (i). For 1938, the index is now at 151 instead of 168 points. Taking the 1907 weights on postwar territory into account, the original series (iii) is about four to five index points lower than the original (i). The revised series (iv) now peaks in 1928 instead of in 1929 and is flatter in the 1930s: relative to the pre-depression peak, the original series shows output to increase to 1938 by almost 40 %. Now, the cumulative increase is hardly more than 30 %. I regard the revised series (iv) as a plausible upper bound for industrial activity in inter-war Germany relative to 1913.

Two more revisions in Table 6 recalculate both Hoffmann's index and the revision in terms of 1933 and 1925 census employment weights, respectively. For the 1920s, results for the revision, shown in cols. (vi) and (viii), are almost undistinguishable from original the IfK index in col. (x). Only from 1935/6 on does the revised Hoffmann series grows faster than the official one, however without ever attaining anything close to the original levels. I therefore regard the IfK series as a plausible lower bound of German industrial output.

As the data in Table 6 show, two thirds of the discrepancy between Hoffmann's series of industrial production and the official figures are probably spurious. About half the difference results from replacing Hoffmann's metal processing series with the revised series from Table 5. To this extent, spurious output growth in Hoffmann's index emerges from the assumption of constant factor shares in metal-processing. The remaining difference results from adjusting the index weights for 1907 to Germany's post-1921 territory. Once this is done, a plausible upper bound emerges; the discrepancy between it (iv) and the IfK series (x) is about 5 index points in 1928 and 13 index points in 1938.

Rebasing the index to 1933 (vi) or 1925 (viii) almost entirely squeezes out the remaining difference with the IfK series (x) for the 1920s. This remarkable fact shows that Hoffmann's and Wagenfuehr's indices essentially paint the same aggregate picture, provided the proper corrections are made and the indices are expressed on the same basis. Moreover, it emerges that the discrepancies with the upper bound estimate (iv) depend entirely on whether the 1925 index value is evaluated at 1907 weights, as in (iv), or at 1925 weights, as in (viii).

This gives rise to a further possible adjustment. Viewed from 1925 at 1907 weights, the 1913 index at 1907 weights in (iv) is obviously a Laspeyres index. Viewed from 1913 at 1907 weights, however, the 1925 index at 1925 in (viii) weights would be a Paasche index. Hence, the Fisher index, which is the square root of their product, is a good compromise. The result of a Fisher index for 1925 is given in col. (ix). It is obtained by taking the square root of the product of the 1925 index values in (iv) and (viii). The rest of the time series in this column is then a Laspeyres index on the 1907/1925 basis found by the Fisher index for 1913 and 1925. For the 1920s, this appears to be the best estimate; I suggest it as a candidate for a future compromise index.

For the 1930s, the discrepancy between the revised Hoffmann series and the official index is growing. This seems to be due to textiles and chemical products. Here, Hoffmann's index is heavily based on synthetic fibers and organic chemistry, whose output was booming under the import-substitution and autarky policies of Nazi Germany, whereas the official index seems to be rather on the conservative side, given its concentration on non-organic chemistry and on wool and cotton processing. The truth may therefore be somewhere in between; however this question is an open one and must be left for future research.

V. National Output without Spurious Growth: the Aggregate Evidence

The implications of correcting the index of industrial production can be carried further. This section will insert the revised industrial output series from Table 6 above into Hoffmann's aggregate output account. Previous research by Ritschl [1990], Spoerer [1997], and Spoerer [1998] has highlighted the discrepancies between Hoffmann's output and expenditure account on the one hand and the official tax-based income estimate on the other. Ritschl and Spoerer [1997] and Ritschl [2002] provided a detailed reconstruction of the expenditure account, and showed it is consistent with the official income series. Working with a provisional dataset, Ritschl [1998] examined the discrepancies between Hoffmann's expenditure account and the official income series. These differences largely disappear once the former is corrected by archival data not accessible to Hoffmann's project group at the time.

The following paragraphs do the same for the product account. I will retain most of Hoffmann's original estimate, and correct only for the industry entry. This exercise is necessarily provisional, as other entries in Hoffmann's estimates of value added would also have to be double-checked. Evidence on mining, agriculture, and construction in Ritschl [2004] suggests that adjustments are necessary in these sectors as well. Still, the effect of replacing the industry estimate in Hoffmann‘s product account with a revised version is large, as shown in Table 7.

(Table 7 about here)

Table 7 shows the product account data from Hoffmann [1965] (i) along with a revised estimate (iii) and a deflated income account (v). The revision in (iii) consists in replacing the manufacturing series in Hoffmann with the revision from Table 6 (ix) above. The income account (v) comes from a slight revision of the official data (and of earlier work by Hoffmann and Müller [1959]) in Ritschl [2002, Table B.1]. I deflate this series with the implicit deflator of national product that obtains from calculating the nominal GNP series in Ritschl [2002, Table B.5] into the estimate of aggregate expenditure at 1913 prices, ibid, Table B.9. Very similar GNP/NNP series and essentially the same deflator appear in Ritschl and Spoerer [1997].

Results in Table 7 can be read in two ways. One is to compare levels of (iii) and (v) in 1913 currency. The starting level of the output estimate in 1913 is over 6% higher than that of the income estimate. Roughly the same holds for 1928 and 1936. Evidently, there is a remaining level problem that is not resolved yet. This appears to confirm a conjecture of Fremdling [1988; 1995].

A second way to read the evidence in Table 7 is in index number comparisons. Evidently, the revised product account in (iv) is very much in line with the expenditure/income account in (vi). This appears to solve the Hoffmann puzzle: Once we dispense with his assumption of constant factor shares in metal-processing industry and insert the available industry data, the big differences between his national product data and the official accounts essentially disappear. Evidently, the fit is not perfect: the slump of 1926 is much deeper in the revised product account than in the income series, while the Great Depression is somewhat less pronounced. But output growth from 1913 to 1938 as a whole is even slightly lower than the income account would predict. Apparently, there is no spurious growth in Hoffmann's output data once the necessary corrections are made.

VI. Conclusions

Revisiting Germany's output data from the interwar period suggests that large parts of its output growth are spurious. The hitherto widely accepted data of Hoffmann [1965] show output in metal processing industry, a key sector of the German economy, to have grown almost threefold between 1913 and 1938. This paper has examined a wide array of evidence on the subsectors of that industry. I find that its output grew slightly more than half that magnitude. Hoffmann worked from employment and wages to provide an input estimate, and assumed constant factor shares. This paper has worked from output and value added data, which were readily available but which Hoffmann did not use. My own findings are in line with the indices produced by Berlin's *Institut fuer Konjunkturforschung* at the time.

The results for metal industry have their impact on the index of industrial production as a whole. Adjusting for the bias in metal working industry, industrial output in Germany increased markedly slower than Hofmann's original data would predict. Presenting various different estimates with different index weights, we have provided what we believe are plausible upper and lower bounds for industrial output in inter-war Germany. Evaluated at the same index basis as the official data, the revised Hoffmann index is almost indistinguishable from the IfK index. This confirms earlier research that has argued for sluggish recovery from World War I and a noticeable increase of the labor share in national income. Not just the Weimar business cycle but also the 1930s come out less dynamic than hitherto accepted. The lower and upper bounds provided in this paper suggest that between 1913 and 1938, Germany's industrial production grew by 30% to 40%, markedly less than the almost 70% which Hoffmann obtained.

The results carry over to aggregate output. Measured on the basis of net national product (NNP), the trend differences between Hoffmann's product account and the official income account disappear once the revised manufacturing series is applied. The revised product account even comes out slightly less dynamic than the income account. Evidently, the faster growth in Hoffmann's output data in both manufacturing and the aggregate economy is spurious.

The results of this paper are still tentative. Future research should build on the revised census data for 1936 being prepared in ongoing research by Fremdling and Staeglin [2003]. From this adjusted benchmark, a new index of industrial production for Germany can be constructed. On this basis, both international comparisons (as in Broadberry [1997] and Broadberry and Fremdling [1990]) and intertemporal comparisons (as in recent work by

Burhop and Wolff [2002] for the aggregate economy will become possible, and will be free of spurious growth.

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[1] The institute was established in 1927 in an effort to produce business cycle indicators and to build up monthly industrial statistics as in the United States, see Tooze [1999]. It was separated from the Reichsamt in 1936 and renamed Deutsches Institut für Wirtschaftsforschung (DIW). Under this name it still exists today. See Krengel [1986] for a historical account by a member.

[2] See,e.g. Statistisches Handbuch von Deutschland (1949) as a standard reference.

[3] For a description of the adjustment, see *Wirtschaft und Statistik* (1927, Nr. 16, p. 695). Balderston, p. 445, puts the new threshold at six, not five employees.

[4] Recalculating the data for 1928 from the sources, I find total employment in 1000s to be 1576, not 1676, and have inserted the corrected data in Table 4.

[5] Being interested in the production of capital goods in the German economy, Gehrig (1961) provides data on the part of output that goes into investment purposes. The data shown in Table 6 above are reconverted to the full output of the respective industries using the proportions provided by Gehrig.

[6] See Statistisches Reichsamt (ed.), *Wirtschaft und Statistik* 7 (1927), p. 162f.

Legends to the Figures:

(Figure 1)

Sources: Wagenführ [1933], Hoffmann [1965].

(Figure 2), (Figure 3)

Sources: Germany: Wagenführ [1933]. Britain: Mitchell [1990], output of steel ingots.

Figure 1: Industrial Production in Germany, 1913-1938

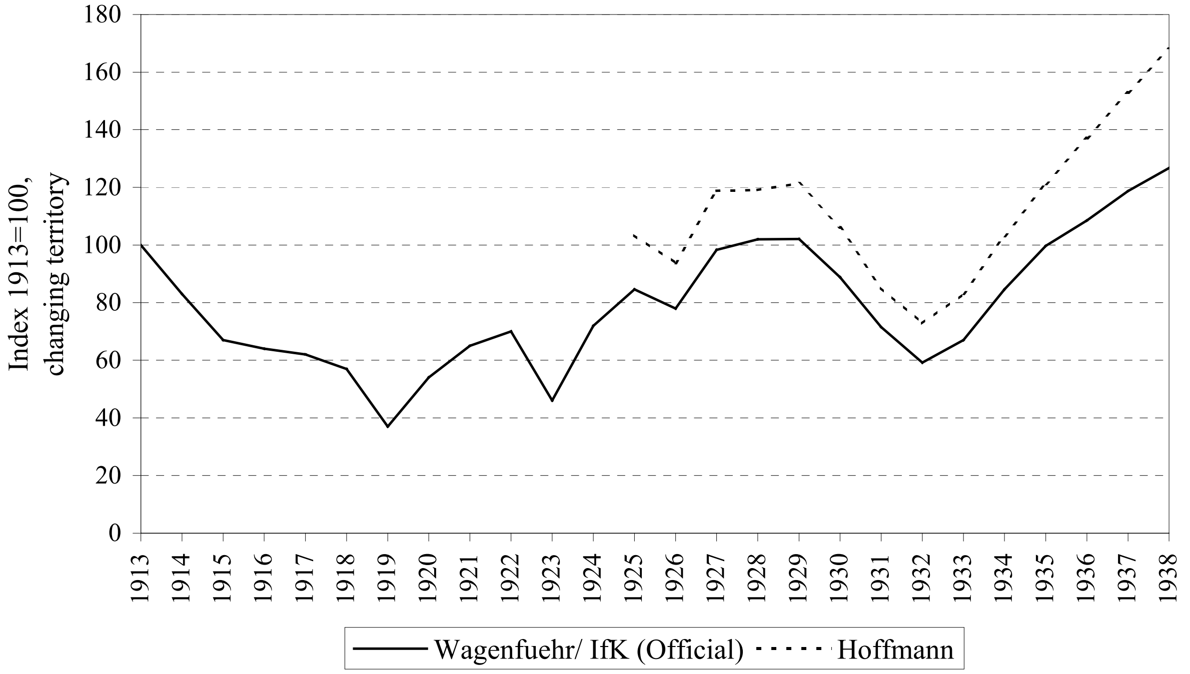
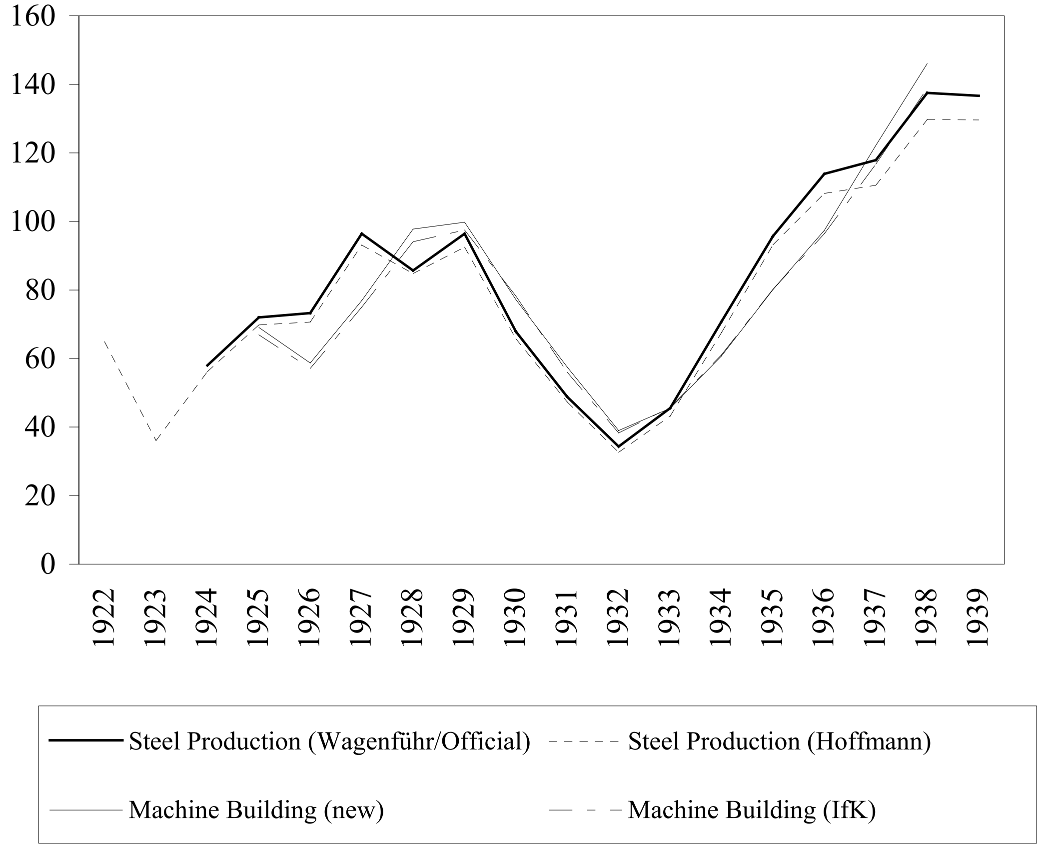


Figure 2: Steel Output in Germany
vs. Machine Production (1913=100)



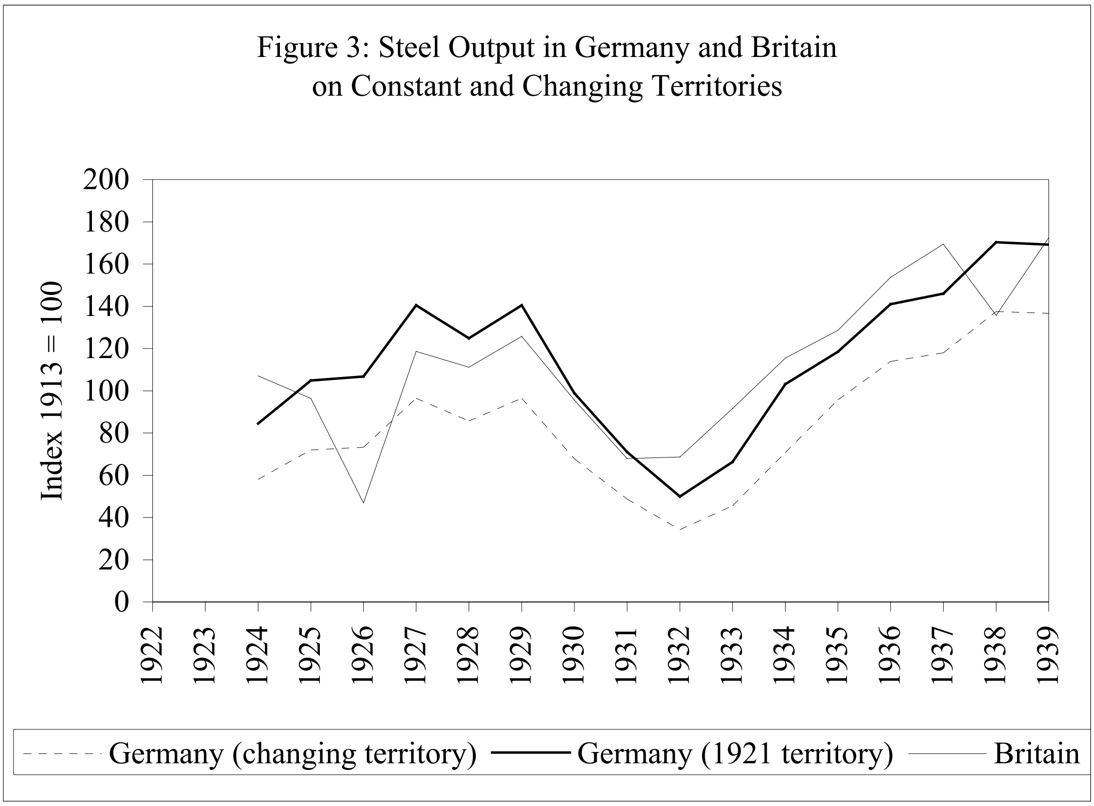


Figure 3: Steel Output in Germany and Britain
on Constant and Changing Territories
Index 1913 = 100
0
20
40
60
80
100
120
140
160
180
200
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
Germany (changing territory)
Germany (1921 territory)
Britain

Table 1: Inferring Output from Employment in Metal-Working Industry (Balderston)

	Hoffmann		Reconstruction				Hoffmann
	Employment in		Employment		Wages	Output	
	Metal making	Metal processing	Share of Metal Processing in Total	Metal processing			
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
1913	443	1887					
1913	*2330*		*0.8099*	*1887*	100	100	*100.0*
1925	2858		0.8099	2315	107.2	131.5	*131.4*
1926	2271		0.8099	1839	106.6	103.9	*103.9*
1927	2692		0.8099	2180	123.5	142.7	*142.6*
1928	2812		0.8099	2277	126.5	152.7	*163.5*
1929	2681		0.8099	2171	138.2	159.0	*170.3*

Sources and Methods:

(i, ii) Hoffmann [1965, p. 196]
(iv-vi) Balderston, [1993, Table 3A]
(vii) Hoffmann [1965, p. 358]

Table 2: Inferring Output from Employment in Machine Building (Balderston)

	Employment	Output per Worker	Total Output	Unit Export Value
	1000s	(tons)	1913=100	1925=100
	(i)	(ii)	(iii)	(iv)
1913	1220	1.25	100	
1925	1572	1.06	109.3	100
1926	1229		94.8	101.8
1927	1502		121.6	105.3
1928	1676		138.9	108.8
1929	1520		140.2	112.6

Sources and Methods:

Balderston, [1993, Table 4A]

Table 3: Recalculating Output in Machine Building

	Sales			Prices	Output				
	VDMA		Gehrig		VDMA		Gehrig	**new**	IfK
	mill. M/RM			(Index 1913 = 100)					
	current	constant	current						
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)
1913	2800	2800	2800	100.0	100.0	100.0	100.0	**100.0**	*100.0*
1925	2900	1933	2509	138.0	75.1	69.0	64.9	**69.0**	*66.9*
1926	2500		2159	139.7	63.9		55.2	**58.7**	*57.1*
1927	3400		2825	139.5	87.0		72.3	**76.9**	*75.0*
1928	4000		3728	144.8	98.7		91.9	**97.8**	*94.1*
1929			3883	147.8			93.8	**99.8**	*97.5*
1930			3042	149.7			72.6	**77.2**	*78.2*
1931			2209	146.0			54.0	**57.5**	*56.0*
1932			1364	132.9			36.7	**39.0**	*38.3*
1933			1547	129.2			42.8	**45.5**	*45.7*
1934			2053	128.4			57.1	**60.7**	*61.1*
1935			2697	127.8			75.4	**80.1**	*80.2*
1936			3286	128.1			91.6	**97.4**	*96.4*
1937			4127	128.2			115.0	**122.2**	*116.7*
1938			4932	128.2			137.4	**146.1**	*138.9*

Sources and Methods:

(i) VDMA [1930, pp. 57,59], Gross Output at Current Prices

(ii) VDMA [1930, p. 57], Gross Output at 1913 Prices

(iii) Gehrig [1961, p. 38]

(iv) Statistisches Jahrbuch für das Deutsche Reich, various issues, index of machinery prices.
1929 to 1938: *Statistisches Handbuch von Deutschland* , p. 460/Table 3.

(v) = (i)/(iv), Index 1913 = 100

(vi) = (ii)/(iv), Index 1913 = 100

(vii) = (iii)/(iv), Index 1913=100.

(viii) = (vii), spliced to the level of (vi) in 1925.

(ix) IfK (1935) and *IfK Halbjahresberichte zur Wirtschaftslage* , various issues
rebased from 1928=100

Table 4: Estimates of Factory-Floor Employment in Machine Building and Metal Processing

	Machine Building			Metal processing			
	VDMA estimates		Census data	Factory inspector reports		Balderston	
	1000s	Index 1913=100	1000s	1000s	Index 1913=100	1000s	Index 1913=100
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
1913	460	100		1173.5	100	1220	100
1924	442	96.1		1411.5	120.3		
1925	452	98.3	*656.5**			1572	128.9
1926	440	95.7		1008.6	85.9	1229	100.7
1927	536	116.5		1263.1	107.6	1502	123.1
1928	549	119.3	444.2	1316.1	112.2	1576	129.2

Sources and Methods:

(i) VDMA [1927, p. 20; 1930, p. 13]

(iii) *Wirtschaft und Statistik* Sonderheft 10 (1931), p. 83.

* includes unemployed, VDMA [1930, p. 52]

(iv) *Statistisches Jahrbuch fuer das Deutsche Reich* , various issues.

(vi) Balderston [1993, Table 4A]

Table 5: Recalculating Output in German Metal-Processing Industry

	Machines	Electrical Industry			M & E	Motor vecs.	Shipbuilding	Total	
		Sales	Prices	Output	Weights 1928				
					0.793	0.086	0.120	**new**	*Hoffmann*
	Index 1913=100	mill. M/RM	Index 1913 = 100						
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)
1913	100.0	1300	100.0	100.0	100.0	100.0	100.0	**100.0**	*100.0*
1925	69.0	2100	138.0	117.1	84.3	329.4	62.1	**84.4**	*131.4*
1926	58.7	1783	139.7	98.2	71.2	275.7	59.1	**72.6**	*103.9*
1927	76.9	2301	139.5	126.9	92.7	467.0	64.1	**94.0**	*142.6*
1928	97.8	2954	144.8	156.9	116.5	558.2	73.0	**116.1**	*163.5*
1929	99.8	3200	147.8	166.6	120.9	559.4	74.5	**119.9**	*170.3*
1930	77.2	2439	149.7	125.3	92.4	403.0	54.2	**90.7**	*156.9*
1931	57.5	1890	146.0	99.6	70.8	319.0	25.5	**66.6**	*120.3*
1932	39.0	1224	132.9	70.9	49.1	236.4	12.7	**45.5**	*84.2*
1933	45.5	1260	129.2	75.0	54.8	408.9	11.3	**52.8**	*91.6*
1934	60.7	1725	128.4	103.4	74.2	603.7	26.7	**74.6**	*125.5*
1935	80.1	2046	127.8	123.1	93.8	815.5	61.5	**100.5**	*163.9*
1936	97.4	2268	128.1	136.2	109.7	975.0	79.3	**119.4**	*202.6*
1937	122.2	2500	128.2	150.0	131.0	1152.0	89.4	**141.4**	*239.7*
1938	146.1	3200	128.2	192.0	160.6	1408.0	88.2	**169.2**	*281.1*

Sources and Methods:

(i)	Real output in machine building, see Table 3, (viii).
(ii)	Gross sales of electrical and optical industry at current prices, Gehrig [1961, pp. 38, 41].
	Index of machinery prices, *Statistisches Jahrbuch für das Deutsche Reich* , various issues.
(iii)	1929 to 1938: *Statistisches Handbuch von Deutschland* , p. 460/Table 3.
(iv)	Real output in electrical industry, (iv)= (ii)/(iii), index 1913 = 100.
(v)	Combined real output in machine building and electrical industry,
	weighed by gross output in 1913.
(vi)	Output of motor vehicles, Hoffmann [1965, p. 358].
(vii)	Shipbuilding production, Hoffmann [1965, p. 358].
(viii)	Total output of metal processing industry;
	(viii) = (v), (vi) and (vii), Index 1928, rebased to Index 1913=100.
	Index weights for (vii) from IfK [1935, p. 99], adjusted for electrical industry.
(ix)	Hoffmann index of metal-working output, Hoffmann [1965, p. 358].

Table 6: Recalculating the Index of Industrial Production

	Chain index with weights 1907/1933					Index weights 1933		Index weights 1925		1907/1925	1928
	1907 weights uncorrected			1907 weights corrected							
	Hoffmann									**Compromise estimate**	
	Original	Reconstructed	Revised	Hoffmann	Revised	Hoffmann	Revised	Hoffmann	Revised	Revised	*Official*
					Upper bound				**Lower bound**		
	(i)	(ia)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)
1913	100	100	100	100	**100**	100	100	100	**100**	**100**	***100***
1925	103	103.8	93.9	100.2	**90.6**	93.8	87.1	96.0	**87.5**	**89.0**	***83.6***
1926	94	94.1	86.3	90.9	**81.9**	85.1	80.0	85.2	**79.2**	**80.5**	***80.6***
1927	119	119.8	108.8	115.7	**105.6**	108.3	101.0	111.2	**102.0**	**103.8**	***103.0***
1928	119	120.5	111.7	116.3	**107.5**	108.9	103.7	110.9	**103.9**	**105.7**	***102.0***
1929	121	121.6	112.7	117.4	**106.5**	109.9	104.6	110.0	**102.9**	**104.7**	***102.9***
1930	106	106.4	94.3	102.7	**88.7**	96.2	87.4	96.7	**85.7**	**87.2**	***90.8***
1931	85	85.3	74.9	82.4	**70.4**	77.1	69.5	77.4	**68.0**	**69.2**	***74.5***
1932	73	74.2	65.0	71.6	**61.6**	67.1	60.3	67.6	**59.5**	**60.6**	***59.9***
1933	83	84.2	74.6	81.3	**71.5**	76.1	69.2	77.4	**69.1**	**70.3**	***66.8***
1934	103	104.1	92.7	100.5	**88.0**	94.1	86.0	94.9	**85.0**	**86.5**	***85.0***
1935	121	121.8	109.3	117.6	**102.9**	110.1	101.4	110.2	**99.4**	**101.1**	***97.7***
1936	137	137.4	122.3	132.7	**114.2**	124.2	113.4	123.8	**110.3**	**112.2**	***108.8***
1937	153	153.2	136.4	147.9	**127.0**	138.5	126.5	137.9	**122.7**	**124.8**	***119.0***
1938	168	168.6	150.9	162.8	**140.4**	152.4	140.0	151.8	**135.6**	**138.0**	***127.0***

Sources and Methods: see Text

Table 7: A Provisional Revision of Net National Output, 1913 and 1925-38

	NNP (Product account)				NNP (Income/expenditure account)	
	Hoffmann		Revised		Official	
	mill. M/RM	1913=100	mill. M/RM	1913=100	mill. M/RM	1913=100
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
1913	48480	100	48480	**100**	45493	***100***
1925	45515	93.88	32656	**67.36**	40626	***89.30***
1926	43688	90.12	41070	**84.72**	41481	***91.18***
1927	51806	106.86	48814	**100.69**	45445	***99.90***
1928	52969	109.26	50296	**103.75**	47065	***103.46***
1929	53596	110.55	50279	**103.71**	46039	***101.20***
1930	50326	103.81	46568	**96.06**	42199	***92.76***
1931	45223	93.28	42053	**86.74**	36240	***79.66***
1932	41001	84.57	38569	**79.56**	32440	***71.31***
1933	45068	92.96	42513	**87.69**	35095	***77.14***
1934	49395	101.89	46092	**95.07**	40052	***88.04***
1935	53856	111.09	49855	**102.84**	45259	***99.48***
1936	59511	122.75	54557	**112.53**	50805	***111.68***
1937	63098	130.15	57503	**118.61**	56639	***124.50***
1938	67967	140.20	61970	**127.83**	61562	***135.32***

Sources and Methods:

(i) Hoffmann [1965, p. 455]

(iii) Corrected by Table VI, (ix), using Hoffmann estimate for value added in 1913 (19902 mill M.)

(v) Ritschl [2002], Appendix, Series B.1.8. Implicit deflator for national product ibid., B.5.1/B.9.1.