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The machine-building industry and Austria's great depression after 1873[1]

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On the eve of the First World War, Austria-Hungary ranked among the leading machinery producers of the world, surpassed only by the United States, Britain, and Germany.[2] Yet despite the interest in Habsburg economic history,[3] little attention has focused on this country's capital goods sector.[4] However, industrialization may be viewed as a process of increasing utilization of fixed capital over time.[5] The machine-building industry is, then, a key sector because its 'output constitutes replacement of or additions to the economy's stock of physical capital'.[6] Indeed, evidence presented recently suggests not only a close long-run association between machinery investment and productivity growth at the macro level, but also the likely direction of causality: to a large extent, the argument runs, output per worker rose in the past *because* of high rates of investment in machinery.[7] Viewed in this light, rising expenditure on capital goods appears not as a mere concomitant of economic expansion but as a strategic factor accounting for growth.

In this article new estimates of Austrian and Hungarian machinery output are presented. It will be argued that the evidence from the capital goods sector supports the traditional notion of a great depression in Austria. The findings presented here cast doubt on the revisionist view, first advanced in 1974, that the Austrian economy grew without major interruptions in the late nineteenth century.[8]

[1] I thank Theo Balderston, Alan Milward, Patrick O'Brien, and John Komlos for their helpful suggestions and critical comments on my doctoral thesis, on which much of this article draws. The useful comments by anonymous referees on an earlier version are gratefully acknowledged.

[2] VDMA, *Denkschrift über die Maschinenindustrie*, pp. 22, 26. The data reproduced in this source refer only to Austria proper and correspond to figures provided in other sources. Adding output and employment in Hungarian machine building yields combined totals that are, respectively, well above the level of Russia's machinery output but still slightly below Russian levels of employment in this sector.

[3] Good, *Economic rise*; *idem*, 'Austria-Hungary'; Komlos, *Customs union*; *idem*, *Stature, nutrition, and economic development*; Rudolph, *Banking and industrialization*.

[4] An exception is Klíma, 'Machine-building industry'. But studies have not been produced for the Habsburg empire comparable to Saul, 'Market and development'; *idem*, 'Machine-tool industry'; Floud, *British machine-tool industry*; Barth, *Entwicklungslinien*; and Schröter and Becker, *Maschinenbauindustrie*.

[5] Reitschuler, *Stellung der Maschinenindustrie*, p. 31.

[6] Rosenberg, 'Capital goods', p. 143. See appendix for a definition of the sector.

[7] De Long, 'Productivity growth'.

[8] Good, 'Stagnation and "take-off" '.

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I

Austrian machinery output was estimated in a three-stage process. As a first step, the gross value of production was approximated on the basis of wage sum data given in the Austrian workers' insurance statistics—though only for 1889 to 1911.[9] Von Fellner estimated output of Austrian and Hungarian machine building for 1911/3 within the framework of his national income calculations.[10] His estimates for Austria are corroborated by the results of another contemporary study of the industry.[11] He approximated the 'raw value of production' by applying wage sum/gross output ratios derived from Hungarian data to Austrian figures on wage sums in machine building. This concept has been used here as well. For 1897 to 1911, gross output of individual machine-building branches was estimated using von Fellner's (1911) percentage shares of wages in gross output and then aggregated across these branches.[12] For 1889 to 1896, the statistics provide only the *total* wage bill in machine building. In these cases, the implied 1897 weighted average ratio was used. Thus a complete series of gross production in Austrian machine building was obtained for 1889 to 1911.[13] Gross output in current prices was then converted into constant (1913) prices. Because of the almost complete lack of machinery output prices for Austria-Hungary,[14] a version of Hoffmann's index of German steam engine prices was used after adjustments had been made to account for Austrian rather than German iron and steel input prices.[15]

As a second step in estimating output, an annual series for iron and steel consumption in Austrian machine building was compiled. This series is composed of 12 subseries, spanning the period 1870 to 1913[16] and

[9] Ministerium des Innern, *Unfallstatistik, 1889-1896, 1897-1901, 1902-1906, 1907-1911*. Included are Gruppe VIa, nos. 166-84 (machinery, tools, apparatus) which correspond to the contemporary definition of *machine building* used in Bibliothek der Kammer der gewerblichen Wirtschaft für Wien, Vienna, Sign. IV.6316: Handelspolitische Zentralstelle, *Gutachten zum autonomen Zolltarif: Die Entwicklung der österreichischen Maschinenindustrie seit 1905 bis 1913*, typescript, no place, no year (hereafter HKB Wien, *Gutachten*), pp. 6-8.

[10] von Fellner, 'Volkseinkommen', pp. 558-72.

[11] According to HKB Wien, *Gutachten*, p. 8, Austrian machinery output in 1911 was approximately 480 million crowns; this compares with 504 million crowns estimated here (app., tab. A.1) and in von Fellner's calculations.

[12] Wage-sum/gross output ratios are available for agricultural machine building (25.0%), boiler making and machine repair shops (17.5%), general machine building (20.5%), the production of sewing machines (33.8%) and soda-water apparatus (17.6%), and *other* branches of the machine-building industry (22.1%): von Fellner, 'Volkseinkommen', tab. VI, p. 621.

[13] The assumption of constant wage bill/output ratios for either the industry as a whole or its individual branches is a simplification necessitated by the lack of more detailed data. The ratios varied not only between different branches of machine building, but within these between different companies and also over the business cycle: HKB Wien, *Gutachten*, pp. 3-8. But the overall ratio is unlikely to have displayed any significant upward or downward trend over time. Hoffman, for example, used labour incomes in the German metal-working industry as a proxy for output. His evidence shows that the shares of wages, depreciation, and profits in (net) output remained fairly constant over the long run: Hoffmann, *Wachstum*, pp. 357-9.

[14] Tinbergen, Cairncross, and Feinstein separately faced similar difficulties in their attempts to construct price indices for British engineering. See Tinbergen, 'Business cycles', pp. 12-5, tab. I A; Cairncross, *Home and foreign investment*, pp. 158-67; Feinstein, *National income*, p. 188, tab. 63.

[15] See app.

[16] Ibid.

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consisting of the following: Austrian iron and steel production: 1. cast iron production; 2. steel production; 3. wrought iron production; *plus* Austrian net imports of iron and steel: 4. net imports of cast iron; 5. net imports of bar iron and steel; 6. net imports of sheet metal and plate; 7. net imports of smelted iron and ingots; *minus* Austrian non-machine-building iron and steel consumption: 8. rail production; 9. production of railway materials such as iron sleepers and rail fixings; 10. production of structural steel for construction purposes; 11. iron and steel consumption in the metal goods industry;[17] 12. iron and steel consumption in the production of transport equipment.[18]

In a third step, the iron and steel input series was divided by the value of gross production of machines (as derived from wage bill data) in constant (1913) prices. This procedure yielded a series of annual input/output ratios for 1889 to 1911. While displaying annual fluctuations, this series shows a downward trend over time. Between the five-year averages centred around 1891 (1889/93) and around 1909 (1907/11), the ratio declined by an average rate of 0.97 per cent per annum. This rate was used to extrapolate the input/output ratio backwards (for 1870 to 1888) and forwards (for 1912 and 1913). Finally, the annual input/output ratios so obtained facilitated the estimation of machinery output for 1870 to 1888 and 1912 to 1913 on the basis of the previously derived iron and steel input series. The production of Hungary's machine-building industry was approximated in essentially identical fashion, though as a consequence of the lack of data the estimation had to rely on a thinner statistical basis than that for Austria (see appendix).

II

The economic development of Austria-Hungary's machine-building industry was a reflection of the course which the Habsburg economy took in the late nineteenth century. Periods of expansion and phases of contraction in mechanical engineering generally coincided with those in the industrial sector at large. But just as overall industrial growth rates in Austria and Hungary were out of phase with one another between 1870 and 1913, so were the rates of expansion in the machine-building industry. In both parts of the empire, however, the growth rates of machinery output over individual business cycles as well as over the full period under review differed markedly from those observed in other branches and in the economy as a whole. Though machine building was a sector particularly exposed to the impact of variations in the business cycle, it was one of the most rapidly expanding branches of industry. In the Habsburg empire, the labour force in mechanical engineering rose from about 33,000

[17] This category refers to the production of wire and wire products; cables and chains; nails, needles, and pins; screws and rivets; knives, sickles, and scythes; enamel wares; locksmith's items; iron and steel furniture; containers; and a multitude of other goods which are not machines.

[18] Transport equipment comprises bicycles, boats and ships, coaches and carts, motor cars, and railway rolling stock.

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workers in 1870, to 48,000 in 1890 and to 109,000 in 1911.[19] By that time, the machine-building sector accounted for 6.5 per cent of total manufacturing output in Austria-Hungary.[20]

The new output estimates indicate that Austria's machine-building industry took a course distinctly different from that implied in earlier research by Rudolph.[21] Between 1870 and 1913, production expanded at a substantially lower rate. The temporal pattern of output growth shows, contrary to the view proposed recently, that the capital goods sector in the western part of the Habsburg empire was subject to a severe downturn and prolonged depression after the stockmarket crash of 1873.[22] Not until 1888 was the contraction of the 1870s and the subsequent stagnation of the 1880s finally overcome as output again reached its pre-crash peak (see appendix, table A.1). This finding amounts to fresh evidence in support of the controversial notion of a great depression which has featured so prominently in Austrian historiography.

Table 1. *Compound rates of growth (% p.a.)*

Business cycle	*Austria*		*Hungary*	
	machinery	*industry*[a]	*machinery*	*industry*[a]
1872-1912	4.57	2.36	7.14	3.08
1872-94	2.57	2.07	7.93	3.47
1894-1912	7.07	2.76	5.92	2.51
1872-82	−1.75	1.86	5.33	3.08
1882-94	6.31	2.32	10.83	3.82
1894-1908	6.76	3.04	4.49	1.51
1908-12	8.16	1.88	8.34	3.96

Notes: Peak-to-peak measurement. The years given refer to peaks in Austrian machinery output. Since the peaks in the four series may not correspond exactly with one another, the periods of measurement are not always identical.
a manufacturing, mining, construction
Sources: app. , tab. A.1; Komlos, *Customs union*, app. E, tab. E.4

In the 1960s and early 1970s, März and Matis, working separately, formulated the traditional view of the economic development which had taken place in Austria in the latter half of the nineteenth century.[23] Proceeding in a largely non-quantitative way, both authors argue that economic growth in Austria conformed 'to the long-wave pattern that

[19] These totals were divided between Austria and Hungary as follows: 1870: Austria 28,489; Hungary 4,800. 1890: Austria 35,710; Hungary 12,183. 1911: Austria 80,981; Hungary 28,025. (The figure for Hungary is an estimate based on the assumption that the average rate of change per annum of output per worker (2.86%) between 1890 and 1912 applied also to the period before 1890.) See tab. A.2 and Ministerium des Innern, *Unfallstatistik, 1889-96, 1907-11*, Gruppe VIa, nos. 166-84; Matlekovits, *Königreich Ungarn*, II, pp. 323-4; Munkás-biztosítási Hivatal, *Jelentése az országos munkásbetegsegélyzö és baleset-biztosító pénztár müködéseröl 1911*, VIII, nos. 199-214, 219, 254-5.

[20] App., tab. A.1; von Fellner, 'Volkseinkommen', pp. 556, 572. For this comparison, gross output in machine building was converted into value-added; see below n. 34.

[21] Rudolph, 'Pattern of Austrian industrial growth', tab. 2; *idem*, *Banking and industrialization*, tab. A.3, p. 207.

[22] *Idem*, *Banking and industrialization*, pp. 28-9; Good, *Economic rise*, p. 165.

[23] März, 'Genesis der Schumpeterschen Theorie'; *idem*, *Industrie- und Bankpolitik*; Matis, *Österreichs Wirtschaft*.

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Kondratieff and others sketched out for the late nineteenth century'.[24] A long upswing from 1848 to 1873 was dominated by the rapid construction of railways. The 1873 crash set off a downswing, the great depression, which was characterized by deflation and low rates of growth of real output. A new upswing began in 1896 and lasted, in the main, until the outbreak of the First World War; its primary driving forces were the rise of new industries and the increase in demand associated with Austria-Hungary's re-armament programme.[25] This periodization of Austrian economic development, and especially the view that the period between 1873 and 1896 is adequately understood as one of depression, was questioned in 1974 by Good.[26] He estimated rates of growth of financial intermediary assets in Austria and translated them into GNP growth rates by using a finance-income ratio originally calculated for several other countries. Good concluded that real per caput output in Austria grew at approximately the same rate between 1873 and 1896 as between 1896 and 1913, and so ruled out a break in secular trend in 1896. The great depression in Austria, as in Britain, was essentially a myth.[27] This assessment was challenged by Komlos on both empirical and theoretical grounds. Relying on his own estimates of industrial output, he maintained that Austria's economy grew at a markedly slower rate between the early 1870s and the mid-1890s than during the following two decades; this growth difference, he argued, was largely a result of an outflow of capital from Austria to Hungary after 1873 which was eventually reversed in the early 1890s.[28] The debate was resumed again in Good's 1984 synthesis of Habsburg economic history.[29] Though Good rejected the traditional interpretation, his new estimates of real per caput regional product in the Habsburg empire seem to provide evidence in its favour. According to these revised calculations, Austrian per caput output grew at a markedly higher rate between 1890 and 1910 than during the preceding 20-year period.[30]

The experience of Austria's machine-building industry in the 1870s and 1880s clearly diverged from its course in the following two decades, when output growth was markedly faster.[31] This result has major implications for the understanding of the timing and pace of Austrian economic development. If the domestic machine-building industry produces primarily for the domestic market and if it holds a dominant share in this market (with both conditions applied in the case of Austria as well as of

[24] Good, *Economic rise*, p. 163.

[25] März, 'Wirtschaftliche Entwicklung', p. 368; Matis, *Österreichs Wirtschaft*, p. 19.

[26] Good, 'Stagnation and "take-off" '.

[27] Ibid.; Saul, *Myth*.

[28] Komlos, 'Depression in Austria'; *idem*, *Customs union*, pp. 218-9, 243-51. Cf. Good, 'Great depression'.

[29] Good, *Economic rise*, pp. 162-85; Komlos, review of Good, *Economic rise*.

[30] Good, 'Economic lag', tab. 2, p. 877. This increase in output growth per caput was achieved in a period of accelerating population growth: Fischer, 'Wirtschaft und Gesellschaft', tab. 3, p. 14.

[31] Due to a lack of adequate data, the new output estimates do not stretch further back than 1870 and, consequently, do not permit any inference about the early 1870s as a break in the secular trend of machinery production. Thus no conclusions can be drawn on the validity of the long-wave concept as such.

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Hungary[32]), then changes in the rate of growth of machinery production are likely to reflect changes in investment demand for plant and equipment effective in the economy. Good's thesis, which postulates steady and uninterrupted growth in the Austrian economy from 1870 to 1913, implies that no significant differences in the rate of machinery investment existed between the subperiods in question.[33] The pattern of output growth in the machine-building sector is clearly not compatible with this view. However, apart from this industry's function as a provider of capital goods to the rest of the economy, there is a further important reason why the machine-building sector should be examined: it was a sector of considerable size and as such directly influenced the volume of total industrial output. This held especially for Austria. The effects on manufacturing output of expansion and contraction in machine building are illustrated in table 2. Incorporating value-added in machine building into Komlos's manufacturing series for Austria widens markedly the already significant gap in growth rates between the two periods 1872-95 and 1895-1912. Moreover, it further accentuates the pattern of a depression composed of two distinct business cycles with a particularly severe recession during the first cycle (1872-84).[34]

Table 2. *Growth of manufacturing (% p.a.)*

Business cycle	*Austria*		*Hungary*	
	A	*B*	*A*	*B*
1872-1912	2.72	2.39	4.39	4.04
1872-95	2.31	2.18	4.92	4.48
1895-1912	3.27	2.68	3.71	3.47
1872-84	1.77	1.90	6.06	5.80
1884-95	2.91	2.51	4.13	3.58

Notes: Peak-to-peak measurement. Since the peaks in the four series may not correspond exactly with one another, the periods of measurement are not always identical.
A = including machine building
B = excluding machine building
Sources: app., tab. A.1; Komlos, *Customs union*, app. E, tabs. E.5 and E.6

[32] For the Habsburg empire as a whole, machinery imports from abroad never exceeded a share of 21% in total machinery consumption between 1870 and 1913 and averaged 14% over the period. If internal trade between the two parts of the empire (data on which are available only from 1883) is taken into account as well, then Austria's degree of import penetration averaged 17% and that of Hungary 35%. Most of Hungary's machinery imports came from Austria. Total Austrian machinery exports, including those to Hungary, accounted on average for 16% of domestic machinery production; the Hungarian export share was slightly below this level (11%). See app., tab. A.1, and Schulze, *Machine-building industry*, app. D, tabs. D.1 to D.3.

[33] This holds to the extent that similar rates of growth of an economy's output require roughly similar rates of investment, i.e. no abrupt changes in the structure of the economy take place which alter the output/investment ratio.

[34] A proportion of 53% was used to convert gross output (app., tab. A.1) into value-added in machine building: von Fellner, 'Volkseinkommen', pp. 570-1. However, for a more complete and accurate assessment of the relative contribution of the machine-building industry to total industrial growth, the output of all those branches of industry not included in Komlos's manufacturing index would also need to be estimated.

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III

The poor growth record of Austrian machine building between 1873 and the late 1880s can be explained by two factors: first, the disappearance of some of those forces that stimulated the industry's rapid expansion in the preceding upswing of 1867 to 1872; secondly, and more importantly, the impact of the stockmarket crash and the subsequent outflow of Austrian capital which hampered industrial investment.

The initial upswing unfolded in the climate of political and institutional stability following the 1867 Constitutional Settlement between Austria and Hungary. The economic upsurge was fuelled primarily by an expansion in the money supply and the Hungarian 'miracle harvest' of 1867/8.[35] New paper money was issued by the government to finance the Prussian and Italian wars. The record harvests came at a time of poor harvests elsewhere in Europe. Agricultural incomes rose as prices for both grain and land began to climb and, as a result, demand for consumer goods grew. The sharp growth in intensity of freight traffic associated with buoyant cereal exports initiated an unprecedented expansion of the railway network.[36] Austria's railway network grew from about 5,300 kilometres in 1869 to more than 10,300 kilometres in 1875. Never before and never thereafter was more track laid in one year than in each of the years 1871 and 1872.[37] Hungary's railway system was enlarged at the same rate.[38] With rising demand for rails, engines, and rolling stock, the railways provided a major stimulus for the producer goods and capital goods industries.[39] But in response to generally rising incomes, economic expansion between 1867 and 1873 was also associated with rapid growth in the production of consumer goods such as sugar, beer, and textiles.[40] Demand for machinery rose as new productive capacity was installed in a rapidly advancing industrial sector.[41]

The impact of railway construction on the machine-building industry is well illustrated by the case of Vienna's locomotive industry—around 1870 probably the most important single branch of Austrian machine-building. In 1870, prior to the peak of the railway boom, the value of locomotive and tender production of Austria's producers of locomotives (numbering three at that time) accounted for approximately 15 per cent

[35] Matis, *Österreichs Wirtschaft*, pp. 153-61.
[36] Ibid., p. 158.
[37] Annual issues of *Statistisches Jahrbuch* and *Statistisches Handbuch*.
[38] Matlekovits, *Königreich Ungarn*, II, pp. 661-3.
[39] Matis, *Österreichs Wirtschaft*, pp. 186-91. Between 1867 and 1873, pig iron output rose by almost 10% per annum and that of steel by more than 40%: *Statistisches Jahrbuch 1874*; Kupelwieser, 'Erzeugung von Flusseisen und Stahl', pp. 656-7.
[40] Komlos, *Customs union*, app. E, tab. E.6.
[41] Handelskammer Wien, *Bericht 1872-1874*, p. 134. Between 1866 and 1873, 463 industrial establishments with a total share capital of 956 million crowns were either newly founded or converted into joint-stock enterprises (eventually, two-thirds of these went into liquidation or bankruptcy in the stock market crash of 1873). This compares with only 21 new industrial joint-stock companies set up between 1851 and 1865 (92 million crowns) and 77 new formations between 1874 and 1890 (198 million crowns): Somary, *Aktiengesellschaften*, tab. II, p. 39.

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of the country's total machine-building output.[42] Up to 1873 the output of railway engines rose rapidly. But once pre-1873 orders from domestic and foreign customers were completed in 1874 or 1875, factories began to run out of work. Neither the few state owned nor the privately run railway companies required new machinery, and deliveries to foreign markets took place over a short period, allowing for only partial substitution for domestic demand.[43] The collapse of the private railways shortly after the 1873 crash led to a contraction in new railway construction, while in Hungary expansion of the network also slowed markedly.[44] Austrian production of locomotives fell from an annual average of 334 in 1870-4 to 118 in 1875-80. The example of the Aktiengesellschaft der Locomotivfabrik, vormals G. Sigl (Wiener Neustadt) is representative. The number of people employed in the workshops of this company—the biggest and most important producer of railway engines—rose from 2,460 in 1872 to its peak of 2,826 in 1874, but as a consequence of the subsequent contraction only 650 workers had kept their jobs by mid-1876 and some of these were being employed part-time.[45] However, for most of the 1870s and 1880s conditions of insufficient demand and low employment were not confined to one establishment.[46] Though turnover and employment improved during the early 1880s in response to a new railway programme of the government, the peak levels of employment in Vienna's locomotive industry attained in the early 1870s, for instance, were never reached again. Throughout the late nineteenth century, railway construction in Austria was carried out sporadically. Yet as the relative importance of railway related machine building within the mechanical engineering sector declined subsequently, the cyclical nature of demand for machinery changed. In the early 1870s locomotive engineering was at the centre of Austrian machine building. Hence a downturn in this branch had an immediate effect on overall machine-building output.

The consumer goods industries whose expansion in the previous upswing provided a stimulus for machinery production were now also in crisis. While the dominant Bohemian sugar industry recovered relatively fast, with pre-crash levels of production realized again in 1878/9,[47] other light industries remained in difficulties. The output of beer dropped by almost 17 per cent between 1873 and 1880 and did not catch up the difference until 1887, while little relief was to be expected from the woollen textiles industry.[48] Initially, the recovery of the sugar industry provided at least some measure of stability of demand for equipment, but the world sugar crisis of the mid-1880s brought a collapse in new

[42] App., tab. A.1; Handelsministerium, 'Statistik der österreichischen Industrie 1870', *Nachrichten über Industrie, Handel und Verkehr*, 3 (1874), no. 2, pp. 116, 145.

[43] Handelskammer Wien, *Bericht 1875*, p. 41; Schulze, *Machine-building industry*, app. D, tab. D.9.

[44] See Bachinger, 'Verkehrswesen', pp. 292-303, for a brief discussion of the disintegration of the private railway companies after 1873 which eventually led to the re-establishment of state-owned railway lines in Austria.

[45] Handelskammer Wien, *Bericht 1875*, p. 42.

[46] Schulze, *Machine-building industry*, tab. II.2, p. 23; Mathis, *Big Business in Österreich*, pp. 144, 284.

[47] Brousek, *Großindustrie Böhmens*, pp. 90-1.

[48] Komlos, *Customs union*, app. E, tab. E.6.

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orders. As Austrian sugar output declined by almost 40 per cent between 1885 and 1886, demand for plant contracted and caused a rapid fall in production of those machine-building branches that worked largely for the sugar industry.[49]

The rapid growth in machinery output in the pre-1873 upswing implied an enlarged stock of capital goods in the economy subsequently. As aggregate demand contracted after 1873, with sales and output of industrial goods falling and only gradually returning to pre-crash levels, capacity utilization in most branches of industry declined. Machinery purchases during the mid-1870s to late 1880s were thus largely confined to replacements. At a time when railway construction and the associated demand for locomotives ceased to be a driving force behind the expansion of machine building, the industrial sector could not fill the gap. Low rates of manufacturing growth meant that there was little net investment in capital goods and, consequently, demand for steam engines and plant equipment recovered only slowly.[50] The state of the Austrian machinery market in the 1880s is fully reflected in the experience of individual machine-building firms. Company growth and the related rise of capital requirements were severely limited. In response to slow output growth and insufficient capacity utilization, investment in new production equipment remained low throughout the decade. The average value of fixed assets and plant equipment actually fell between 1880 and 1890 because of low or even negative rates of net investment. It was not until the late 1890s that Austrian machine-building companies substantially expanded their production capacity to meet a rising demand for their output.[51] The question which arises is why the initial cyclical downswing of the Austrian economy in 1872 was translated into prolonged stagnation and sluggish recovery thereafter, rather than leading to a renewed and vigorous cyclical upswing. Komlos argued that the stockmarket crash of 1873 led to a loss of confidence of Austrian capitalists in their domestic economy, especially in its industrial sector, and that a result was that industrial investments in Austria declined until well into the 1880s when, eventually, the prices of industrial stocks began to rise again.[52] In the late 1870s, the Austrian and Hungarian governments began to issue state securities, just at a time when, in the aftermath of the Vienna stockmarket crash, there was demand for relatively safe assets on the part of Austrian investors. However, the total of new Hungarian debt issued up to the early 1890s was significantly larger than its Austrian equivalent. Yet while only a few of the Austrian bonds were held in Hungary, more than 60 per cent of the Hungarian issues prior to 1893 were acquired by Austrian investors. In sum, the period between the late 1870s and the early 1890s

[49] Ibid.; Handelskammer Wien, *Bericht 1884*, pp. 81-2; *Bericht 1885*, pp. 80-1; *Bericht 1886*, pp. 82-3; Handelskammer Brünn, *Bericht 1884*, p. 17.

[50] Handelskammer Wien, *Bericht 1885*, pp. 75-82.

[51] Schulze, *Machine-building industry*, pp. 94-8.

[52] Between March and October 1873 industrial, bank, and construction stocks lost 60% of their value, while the values of other securities fell by 7%: Komlos, *Customs union*, p. 169. See also März, *Industrie- und Bankpolitik*, pp. 215, 218-25, 256.

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was characterized by an outflow of capital from Austria to Hungary.[53] It was this recourse to Austrian capital that facilitated the first widespread wave of industrialization in Hungary from the late 1870s. The Hungarian government was able to finance its regular expenditure, its industrial promotion programmes, and its investment in social overhead capital without crowding out private domestic investors, as a large part of the deficit was financed on the Austrian capital market. The growth of disposable incomes, and thus of consumer demand, was not impeded since the government did not have to resort to excessive taxation in order to accomplish its fiscal targets. As a result, the symptoms of depression were virtually absent in Hungary. In Austria, on the other hand, 'the diminished stock of venture capital had a negative impact on industrial production until the 1890s. By attracting large amounts of Austrian capital, the Hungarian economy was therefore influential in prolonging the depression in Austria.'[54]

The new estimates of machinery production provide the link between the flow-of-funds argument and the pattern of output growth in the industrial sector as a whole. If the outflow of capital from Austria into Hungary had a negative impact on industrial investment in the western part of the empire, and a positive one in the eastern part, one would expect (*ceteris paribus*) to see significant differences in the performance of the machine-building industries of the two countries, since in both halves of the empire the bulk of machinery investment was met out of domestic production.[55] While Austria's production of machines declined after 1872 and reached its pre-crash peak again only in 1888, mechanical engineering in Hungary was an integral part of the country's industrial expansion from the late 1870s to the mid-1890s.[56]

However, when the Austrian public began to purchase safe bonds on a large scale in the late 1870s, the cyclical downswing of 1872 had already turned into a severe recession with only sluggish recovery from the 1876 trough. What may have started out as the downswing phase of a minor business cycle with little immediate effect on long-term investment was transformed under the impact of the stockmarket crash which led to a dramatic and lasting deterioration in business confidence and longer-term expectations. Investment in plant and equipment contracted sharply and remained low up to at least the mid-1880s, thus curtailing the recovery of the machine-building sector. It was the shock of the crash, superimposed on the downswing, and the subsequent withdrawal of capital that undermined the operation of the cyclical response mechanism which otherwise would have brought about a revival in long-term investment.[57]

[53] Komlos, *Customs union*, pp. 162-94.

[54] Ibid., p. 218; see also pp. 188-94. Cf. Good, *Economic rise*, p. 173, which rejects the argument of an asymmetric impact of bond purchases on the Austrian and Hungarian economies.

[55] See above, n. 32.

[56] See Schulze, *Machine-building industry*, ch. III, for a full discussion.

[57] Gordon, 'Investment behaviour and business cycles', pp. 412-5. Given the change in expectations during the early and mid-1870s, which implied a very low propensity to invest in industry, and the

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IV

Full recovery in Austrian machine building was finally achieved by the late 1880s in the wake of accelerating growth in the industrial economy. Domestic demand for machinery was rising as manufacturers began to exceed the limitations of mere replacement investment by installing new capacity.[58] Good harvests in Russia, Hungary, and Romania—the primary export markets for Austrian agricultural machinery—provided a further stimulus.[59] Though interrupted by two recessions in 1901/2 and 1909/10, the ensuing long-run upswing in Austria's mechanical engineering industry lasted until the eve of the First World War.[60]

The beginning of this upturn in about 1890 coincided with the reversal of capital flows between Austria and Hungary. While Austria's investors had accumulated a rising stake in Hungary's national debt, from less than 15 per cent in 1878 to more than 60 per cent in 1893 when they held Hungarian bonds with a nominal value of almost 2.7 billion crowns, they withdrew about 1.3 billion crowns in the years to 1896, and a

timing of the capital outflow, which gathered pace only during the late 1870s, it seems likely that the flow of funds from Austria to Hungary had a more profound effect during the second rather than the first business cycle after 1873. During the latter any outflow (after 1878) was probably inconsequential with regard to industrial production as Austrians may not have contemplated large-scale industrial investment in any case.

[58] Handelskammer Wien, *Bericht 1888*, p. 78.

[59] Ibid., pp. 85-7.

[60] After 1908, the expansion of machinery output deviated most markedly from that of aggregate industrial production. To some extent this was an outcome of favourable export demand for Austrian machines. However, the growth of machinery imports in 1912 was almost as fast as that of output, suggesting a sharp upsurge in domestic demand. The timing of investment decisions and the impact of minor cyclical variations in aggregate output seem to account for this. Between 1895 and 1900, the ratio of machinery to manufacturing output rose rapidly and moved above its trend level. In the trough of the brief economy-wide recession around 1903, this ratio fell substantially as machinery users temporarily refrained from further net investment, thus adjusting the level of the capital stock to that of demand. Hence, there may have been some over-shooting in machinery investment, stimulated by low real interest rates, which was subsequently corrected for. Between 1904 and the business cycle peak in 1908, a period of particularly rapid industrial growth, the ratio fluctuated closely around its trend. During the comparatively mild downturn that followed in 1909/10, the lull in aggregate demand was responded to by an immediate cutback in investment, probably to avoid any build-up of excess capacity. Yet this downturn was not as pronounced as anticipated by industrialists and the ratio of machinery to manufacturing output stagnated at a level below its trend. Consequently, at least part of the sharp increase in Austrian machinery production in the upswing of 1911 and especially 1912 can be interpreted as an outcome of industrialists' attempts to increase the existing capital stock which had not been brought up to the required level in the two preceding years. In addition, it seems quite likely that by this time those parts of the capital stock that had been installed during the investment wave of the early 1890s were beginning to be replaced again, initiating a re-investment cycle. However, coinciding with a massive increase in military expenditure, especially on the navy, the rapid growth in machinery output may also have been related to Austria-Hungary's extensive rearmament programme before the First World War. But the available data do not permit an approximation of that proportion of expenditure on equipment that was directed to the mechanical engineering industry as distinct from the armaments or shipbuilding sectors. Yet even if government orders for steam engines, for example, were insignificant, the increase in military expenditure may have exercised considerable indirect demand effects through facilitating an expansion in the productive apparatus of armaments and shipbuilding firms, especially after 1910: cf. März, *Bankpolitik*, pp. 27, 30-1; Paulinyi, 'Industriepolitik', pp. 139-41; Wagner, 'K.(U.)K. Armee', tab. 4, pp. 590-1.

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further 350 million crowns until 1905,[61] and began to turn to Austrian industrial equity again.[62]

Expansion in Austria's machine-building industry was sustained by a general rise in demand for capital goods from a growing domestic industrial sector. Investment in machinery was aided by the trend fall in the level of interest rates, especially after the mid-1880s (table 3). Thus, at a time of absolutely and relatively declining machinery prices,[63] the real cost of borrowing fell and, subsequently, investment in physical capital became increasingly attractive once capacity utilization throughout the economy had recovered from the trough of the depression. However, the marked acceleration in Austrian machinery production observed for the post-1888 period was also related to the emergence of new, additional sources of growth, namely the development and application of new technologies such as electricity generation and the internal combustion engine, an increase in the mechanization of agriculture, and a favourable development of machinery trade between the mid-1880s and the turn of the century.

Mechanical engineering benefited directly from the rapid growth in electricity generation and usage which set in during the 1880s. Austria's first central power stations were built in this period.[64] Demand for water turbines and steam engines, as sources of moving power for generators, rose in response to the growing number of privately and publicly owned power plants which supplied electricity for communications, industry, and private households.[65] Between 1907 and 1913, the number of power plants in Austria rose from 446 to 854; their electricity output increased by more than 18 per cent per annum. About 57 per cent of generating energy was provided by steam engines, 38 per cent by water power, and the remaining 5 per cent by internal combustion engines.[66] Output data

[61] Three factors, in particular, seem to account for the permanent repatriation of Austrian funds. First, whatever its initial causes, the yield differential between Hungarian bonds with higher returns and Austrian bonds practically disappeared in the early 1890s. Secondly, Austrian government issues increased markedly after 1892, competing directly with Hungarian securities for investors' attention. Finally, the effects of the 1873 stock market crash on the preferences of Austrian investors were wearing off as the improved industrial performance during the previous cycle of the 1880s had signalled that stagnation was not a permanent characteristic of the economy: Komlos, *Customs union*, tab. 4.28, p. 164; pp. 177-80.

[62] Between 1874 and 1890, 77 new industrial joint-stock companies were founded with an initial share capital of 198 million crowns; 19 of these went into liquidation or bankruptcy. During the period 1891 to 1900, the number of new incorporations increased to 143 and the capital raised increased to 277 million crowns. Hence, on an annual basis, 11.7 million crowns were raised on the stock market for new industrial company foundations between 1874 and 1890; this compares with an average of almost 28 million crowns between 1891 and 1900 (Somary, *Aktiengesellschaften*, tab. II, p. 39). Though based on only a relatively small sample of all industrial corporations, Mosser's calculations show a marked rise in the fixed capital investment ratio in industrial joint-stock companies after 1896. Between 1896 and 1913, net investment as a percentage of fixed assets was on average more than twice as high as it had been between 1881 and 1896: Mosser, *Industrieaktiengesellschaft*, tab. 55, p. 260.

[63] The ratio of the machinery price index to the consumer price index fell from 2.08 in 1870 to 1.00 in 1913: see app. for sources on machinery price index and Mühlpeck et al., 'Index der Verbraucherpreise' (Generalindex), pp. 676-9.

[64] Matis and Bachinger, 'Industrielle Entwicklung', p. 185.

[65] Handelskammer Brünn, *Bericht 1890*, p. 54.

[66] Handelsmuseum, *Materialien zur Produktionsstatistik*, p. 12.

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Table 3. *Austrian long-term interest rates*[a] *(%)*

	Nominal interest[b]	*Real interest*[c]
1870/4	6.70	3.80
1875/9	6.43	8.08
1880/4	5.43	6.17
1885/9	5.05	5.94
1890/4	4.45	5.30
1895/9	4.15	3.77
1900/4	4.22	3.86
1905/9	4.23	2.05
1910/3	4.56	2.08

a period averages
b yield of 4.2% silver bonds
c nominal interest minus consumer price inflation

Sources: Finanzministerium, *Tabellen zur Währungsstatistik*, tab. 207, p. 127; Bunzl, *Wiener Rentenmarkt*, tab. II; Mühlpeck et al., 'Index der Verbraucherpreise', (Generalindex), pp. 676-9

for Brno in Moravia, the country's leading region in steam technology,[67] show that in the two decades around the turn of the century, electric power generating plants had become the second most important industrial customer of steam engine and steam turbine manufacturers; only the textile industries maintained larger orders.[68]

The appearance of the internal combustion engine opened hitherto largely untapped sources of demand for power machines. Small workshops and factories, in particular, which by the turn of the century still employed the majority of workers in Austrian industry, made increasing use of gas, petrol, and—somewhat later—diesel engines.[69] For these establishments, the internal combustion engine offered a credible alternative to costly steam power, since it was more efficient when operating intermittently or at less than full load, conditions frequently found in small industry.[70]

A shift towards more capital intensive modes of production in agriculture also provided a major and lasting stimulus to the growth of the machine-building sector. The large share of people employed in farming and the low initial degree of mechanization in Austrian agriculture implied ample scope for potential improvement during the late nineteenth century. In 1890, more than 62 per cent of the total labour force were still employed in agriculture and forestry. By 1910 this share had fallen to 53 per cent.[71] Yet in 1902, only one-third of all agricultural operations in Cisleithania used machinery; the three most widespread implements, namely chaff-cutters, cleaning and sorting machinery, and threshing

[67] Statistische Zentralkommission, 'Betriebszählung 1902', *Österreichische Statistik*, 75, 1.Heft, 2.Abtlg. (1907), tab. II, pp. 18-9; 3.Heft (1905), tab. I, pp. 4-5; 9.Heft (1906), tab. I, p. 11; 10.Heft (1905), tab. I, p. 8.

[68] Handelskammer Brünn, *Bericht 1900*, pp. 126-7; *Bericht 1910*, pp. 81-9.

[69] Good, *Economic rise*, p. 194; Handelskammer Wien, *Bericht 1889*, pp. 87-9; *Bericht 1897*, pp. 95-6; *Bericht 1904*, pp. 102-4; *Bericht 1911*, p. 83.

[70] Landes, *Unbound Prometheus*, p. 280.

[71] Sandgruber, *Österreichische Agrarstatistik*, tab. 51, p. 114.

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machines, were employed respectively in only 28, 13, and 11 per cent of all operations.[72] The temporal coincidence of rapidly growing imports and expanding production indicates that there was a genuine rise in domestic demand for farm equipment after the turn of the century.[73] The sector invested heavily in labour-saving technology and equipment which allowed more intensive cultivation of the soil. As Sandgruber points out, productivity growth in Austrian agriculture was indeed particularly fast after 1900 when compared with the previous decades.[74] However, growth in Austrian output of agricultural machines was a function not only of rising domestic demand, but also of increases in machinery requirements elsewhere, as Austrian exports of farming implements and machines (especially to Russia and the Balkans) rose rapidly after the mid-1890s.[75]

Finally, the development of Austria-Hungary's foreign trade in machinery as a whole from the late 1880s to the early 1900s should be considered. The growth of imports was slower than that of domestic output and, despite considerable export growth, the degree of import penetration was temporarily falling. This, however, was less an outcome of increased tariff protection[76] than of changing economic circumstances in those countries which exported machinery to the Habsburg empire. As growth in the German economy accelerated again in the second half of the 1880s, some of the external pressure on Austrian producers was reduced, since much of the surplus output previously sold as exports to the empire was now supplied to an expanding German market where demand for capital goods was rising again.[77] Domestic manufacturers were, therefore, left with a larger share of a growing machinery market. Austrian machine-building firms were thus in a better position to exploit any increases in domestic demand than was the case during the 1880s.

V

Gross concluded that 'long-run industrial growth in nineteenth-century Austria was not sufficiently rapid to make her economy relatively less backward at the end of the period than it had been in the middle of the century'.[78] Though drawing only on growth rates and thus ignoring the qualitative changes in the composition of total industrial output, this statement refers to some of the core elements of the debate about the path of the Habsburg empire's industrialization. The data that are now available suggest that sustained growth of the Habsburg economy was the outcome of a long-term acceleration from the eighteenth century,

[72] Ibid., tabs. 52, 53, pp. 116-7.
[73] Schulze, *Machine-building industry*, pp. 135-7; app. A, tab. A.11; app. D, tab. D.10.
[74] Sandgruber, *Österreichische Agrarstatistik*, pp. 113-4.
[75] Schulze, *Machine-building industry*, pp. 135-40; app. D, tab. D.10.
[76] In fact, the average rate of effective production accorded to value-added in Austrian machine building was negative because of high tariffs on imports of iron and steel inputs and relatively low tariffs on imports of machinery: Schulze, *Machine-building industry*, pp. 153-9.
[77] Ibid., pp. 126-9.
[78] Gross, 'Industrialization in Austria', p. 96.

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and not of a nineteenth-century Gerschenkronian great spurt or Rostovian take-off.[79] However, by the early 1870s Austria, and the Habsburg empire as a whole, lagged well behind the more advanced countries of western Europe. But between 1870 and 1910, real per caput product in both parts of the Habsburg empire grew faster than in most west European countries and the wide gap in per caput output levels when compared with those in Great Britain, France, and Belgium, for instance, narrowed.[80] 'By 1914', Good remarks, 'the Empire's position relative to Western Europe was no better and may have been somewhat worse than a century before, and it had lost out to Germany for political dominance of Central Europe. But in its final four decades the Empire began to "catch-up".'[81] Most of this 'catching-up', it should be stressed, took place in the last two decades before the First World War, i.e. during the period which the traditionalists in Austrian historiography view as marked by a renewed long-run upswing after the end of the great depression. Real per caput output in Austria rose by less than 1.3 per cent per annum between 1870 and 1890, but by more than 1.6 per cent between 1890 and 1910.[82] This acceleration matches the changes in machine-building growth and the sector's rising contribution to total industrial output. The evidence from other countries suggests that the rise in aggregate productivity may have been causally linked to changes in machinery investment. In a study covering six major industrial countries during the century from 1870, De Long detected a strong association of machinery investment and per caput income growth.[83] Moreover, his regression results indicate that machinery investment was more strongly associated with growth in GDP per caput than investment in general (including non-residential construction investment). The problem is, of course, to determine whether causation runs from machinery investment to economic growth or from growth to machinery investment. If faster growth causes higher investment because of rising profit expectations, then investment should respond equally to increases in output resulting from improved productivity (higher per caput incomes) and to those caused by population growth. However, De Long's results show a strong association between growth in output per caput and machinery investment, and a weaker and imprecisely estimated association between population growth and machinery investment. In short, intensive growth which raises productivity and income levels is particularly strongly associated with investment in machinery.[84] Viewed in this light, the temporal coincidence of changes in per caput output and those in machinery production suggests that the rise in productivity in the Habsburg empire was an outcome of increased machinery investment.

[79] Good, 'Austria-Hungary', pp. 221-5; Komlos, *Customs union*, pp. 90-111; *idem*, *Stature, nutrition and economic development*, pp. 167-83.

[80] *Good*, 'Economic lag', tab. 6, p. 886.

[81] *Idem*, 'Austria-Hungary', p. 229.

[82] *Idem*, 'Economic lag', tab. 2, p. 877. Hungary's income per caput rose by 2% per annum between 1870 and 1910; note that in each of the four decades during this period both income per caput and machinery output rose at faster rates in Hungary than in the western part of the empire.

[83] De Long, 'Productivity growth'.

[84] Ibid., p. 317.

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VI

The conclusion that a dynamically growing machine-building industry was at the core of industrial expansion in late nineteenth-century Austria-Hungary does not amount to a corroboration of Gerschenkron's hypothesis that the capital goods sector was likely to dominate over the consumer goods industries in the process of industrialization of follower countries, such as the Habsburg empire.[85] Industrialization in Austria started much earlier and rested to a large degree on advances in the textile industries. In Hungary, the first widespread wave of industrialization in the 1870s and 1880s was dominated by the rise of the flour-milling industry. What has been observed here is that the machine-building industry became an increasingly important source of economic growth *after* initial industrialization. This finding could be interpreted as evidence in support of Hoffmann's hypothesis that in the course of the process of industrialization the consumer goods industries lose their dominant position in favour of the capital goods sector, including iron and steel, metals, and engineering.[86] However, any inference about trend shifts from the consumer goods sector to the capital goods sector would require a more complete coverage of industrial sectors and an analysis of the input-output relationships necessary to allocate outputs between them.[87] Nevertheless, among those manufacturing branches for which comparable output estimates are available, the machine-building industry belonged to the most rapidly advancing sectors in both Austria and Hungary.

Rising aggregate productivity was, to a considerable extent, facilitated by investment in *domestically* produced machinery, especially in the western part of the empire. Yet the pattern of growth and stagnation in the machinery sector lends strong support to the view that Austrian economic growth between 1870 and 1913 was not a process of smooth, uninterrupted expansion. Rather it unfolded in two major phases: first, a period of sluggish growth up to the late 1880s/early 1890s and, thereafter, a phase characterized by an acceleration in economic activity. The 1873 stockmarket crash had a lasting impact on the preferences of Austrian investors and, ultimately, led to the withdrawal of capital from Austria. Industrial investment declined and demand for plant and equipment contracted sharply. In Hungary, on the other hand, the inflow of Austrian funds allowed a substantial rise in investment, which stimulated the growth of the country's machine-building industry. The repatriation of Austrian capital in the early 1890s, in turn, coincided with an upturn in investment activity there and an acceleration in the growth of Austrian machinery production. In short, *Austria's* depression after 1873 was not a myth but an integral part of the country's growth experience.

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[85] Gerschenkron, *Economic backwardness*.

[86] Hoffmann, *Growth of industrial economies*, pp. 31-41, 145-59. The empirical basis of Hoffmann's concept has been criticized by O'Brien, 'Typology', pp. 310-1.

[87] O'Brien, 'Typology', pp. 310-1.

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APPENDIX: Definition of the sector and estimation of machinery output

Because of the heterogeneity of output there was no uniform usage or definition of the term machine building at the time. Reflecting this heterogeneity, the organizational structure of the German machine-builders' association serves to illustrate the scope of what is referred to here as mechanical engineering or machine building. The association was organized into 13 divisions relating to major product groups: I: machine tools; II: textile machines; III: agricultural machines and implements; IV: locomotives; V: power machines; VI: working machinery; VII: plant equipment and machinery for iron and steel works and rolling mills; VIII: mechanical conveyors and scales; IX: machinery for the paper-making and graphical industries; X: machinery for the food processing and chemical industries; XI: dressing/separation and crushing machines; XII: special machines and machinery parts; XIII: apparatus.[88]

Estimation of machinery output

(1) Results
Please see table opposite

(2) Contemporary output measures and wage bill data
Austria: See main text. *Hungary*: Though fairly comprehensive spot estimates of output are available for 1898 and 1906 (see below, table A.2), wage bill data from the Hungarian accident insurance statistics which could be used for further approximations of output exist only for 1909-12.[89] It was assumed that the input/output ratio in Hungarian machine building moved along a path similar to that in Austrian machine building. A linear trend line was fitted to the series of Austrian input/output ratios (1870-1913). Since the input/output ratios implied in the Hungarian data for 1909-12 are on average 21% above the Austrian trend figures, the trend of the Austrian input/output ratio was adjusted accordingly before being applied to the Hungarian iron and steel input series for an estimation of Hungarian machinery output (1870-1908; 1913).

(3) Iron and steel inputs
Subseries 1-10. Austria and Hungary: a detailed discussion is available of the methods and sources used in the derivation of iron and steel production, net imports of iron and steel, and the production of structural steel (*Träger*) rails, and railway materials such as iron sleepers and rail fixings.[90]

Subseries 11 and 12. Austria: Using the 1889-1911 wage bill data provided in the *Unfallstatistik* and von Fellner's wage sum/gross output ratios, output in the metal goods industry and in transport equipment production had been estimated in a fashion identical to that used for machine building. The value of input materials was then computed as a percentage of output in these industries and in machine building on the basis of the ratios provided in von Fellner.[91] The *quantity* of iron and steel used in each industry was then determined by multiplying its share in the total *value* of input materials by total iron and steel consumption (net of subseries 9-10). For the years lacking value data (1870-88; 1912-3), iron and steel quantities were allocated by using the average five-year shares for 1889-93 and 1907-11, respectively.

[88] VDMA, *Denkschrift über die Maschinenindustrie*, p. 63. This grouping is in accordance with the contemporary description of the sector in Fischer, 'Maschinenindustrie'.

[89] Munkás-biztosítási Hivatal, *Jelentése az országos munkásbetegsegélyzö és baleset-biztosító pénztár müködéseröl 1909-1912*, VIII, nos. 199-214, 219, 254-5.

[90] Schulze, *Machine-building industry*, app. A, pp. 171-8, tabs. A.6-A.8, A.13-A.15.

[91] Ministerium des Innern, *Unfallstatistik 1889-96, 1897-1901, 1902-6, 1907-11*, Gruppe Vb, nos. 109-41, Gruppe VIb, nos. 184a-190; von Fellner, 'Volkseinkommen', pp. 571, 621.

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Table A1. *Estimates of machinery production*

	Iron and steel input ('000 tons)		*Output in 1913 prices (m. crowns)*		*Output in current prices (m. crowns)*	
	Austria	*Hungary*	*Austria*	*Hungary*	*Austria*	*Hungary*
1870	110.50	17.06	61.35	7.89	109.54	14.08
1871	138.75	22.55	77.80	10.51	145.58	19.66
1872	187.59	21.64	106.21	10.17	199.39	19.09
1873	162.58	20.06	92.95	9.50	174.87	17.87
1874	102.09	15.09	58.94	7.21	112.40	13.74
1875	102.36	16.53	59.67	7.96	111.09	14.81
1876	101.03	25.08	58.48	12.18	103.36	21.16
1877	94.01	22.69	55.89	11.11	92.55	18.40
1878	112.97	20.06	67.82	9.90	106.31	15.52
1879	97.92	20.86	59.36	10.39	92.31	16.16
1880	106.90	20.81	64.43	10.45	97.56	15.58
1881	128.59	31.67	79.48	16.05	117.03	23.63
1882	142.59	32.93	89.00	16.83	127.13	24.04
1883	139.65	38.21	88.02	19.71	123.57	27.67
1884	124.94	39.67	79.52	20.64	112.78	29.28
1885	126.62	39.89	81.37	20.94	114.61	29.50
1886	105.85	31.62	68.69	16.76	92.61	22.59
1887	117.84	32.99	77.22	17.64	101.17	23.12
1888	165.10	46.98	109.25	25.36	138.91	32.24
1889	185.71	46.57	112.94	25.37	142.95	32.11
1890	193.71	63.71	126.33	35.04	159.58	44.27
1891	199.91	65.26	138.33	36.23	176.23	46.16
1892	207.18	84.03	146.21	47.11	186.84	60.20
1893	215.00	104.38	163.81	59.09	201.75	72.78
1894	271.42	108.43	185.48	61.99	221.19	73.92
1895	285.70	115.67	191.21	66.79	225.16	78.64
1896	318.64	121.49	203.66	70.86	236.16	82.16
1897	328.62	124.94	220.28	73.61	252.27	84.30
1898	364.20	130.38	245.70	77.60	282.38	89.19
1899	386.73	135.66	270.30	81.59	307.93	92.95
1900	380.74	136.38	292.01	82.88	329.68	93.57
1901	381.18	133.93	284.36	82.25	328.27	94.95
1902	350.13	138.17	260.43	85.77	304.34	100.23
1903	347.77	128.02	279.79	80.33	307.55	88.30
1904	374.46	135.93	307.29	86.22	320.95	90.05
1905	419.10	155.42	326.25	99.68	344.03	105.11
1906	455.72	169.43	376.02	109.88	395.51	115.58
1907	531.10	198.36	431.98	130.10	452.79	136.37
1908	620.70	237.10	463.42	157.29	496.05	168.36
1909	550.25	213.89	454.07	155.07	491.73	167.93
1910	565.59	242.38	450.20	160.49	478.37	170.53
1911	561.08	230.96	493.83	156.32	504.21	159.60
1912	760.36	268.82	634.15	177.73	641.37	179.76
1913	684.12	240.77	576.16	169.43	576.16	169.43

Sources: see remainder of app.

Hungary: Hungary's use of iron and steel in the production of metal goods and in the production of transport equipment was approximated in the same way as Austria's.[92] However, since Hungarian wage bill data are available only for 1909-12, iron and steel quantities were allocated between the machine-building, metal goods, and transport equipment industries using their respective consumption shares in 1909 and 1912 for the years with missing value data (1870-1908 and 1913).

[92] Munkás-biztosítási Hivatal, *Jelentése az országos munkásbetegsegélyzö és baleset-biztosító pénztár müködéseröl 1909-1912*, VII, nos. 141-74, VIII, nos. 215-8, 220-2.

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(4) The price index

Hoffmann observed a close correlation between steam engine prices and iron prices and used the latter to interpolate and extrapolate missing annual values of the steam engine price index.[93] Regressing Hoffmann's index of derived steam engine prices on iron prices and a time trend yielded this result for 1870 to 1913 (44 observations):

CNT	2.5804 (54.05)	R^2	0.994
LIP(–2)	0.5162 (51.82)	DW	2.101
T	–0.0080 (–46.80)	F(2, 41)	3,422.4

where CNT = constant term; LIP(–2) = log of iron prices, lagged two years; T = time trend; R^2 = corrected coefficient of determination; DW = Durbin-Watson test statistic; F = F test statistic; *t*-statistics are given in parentheses. Assuming that Austrian machinery prices were equally responsive to changes in iron prices and subject to a similar downward trend, the estimated coefficients were then employed in an approximation of Austrian machinery prices using an index of Austrian iron and steel prices. A Laspeyres index was constructed as a weighted arithmetic average of price relatives for iron and steel inputs. Four series of price relatives are included:

(a) average price per ton of Austrian cast iron at place of production (1913 = 100; weight: 0.28);
(b) average price per ton of Hungarian cast iron at place of production (1913 = 100; weight: 0.04);
(c) price per ton of imported cast iron *inclusive* of tariff (1913 = 100; weight: 0.23);
(d) wholesale price of bar iron in Vienna (1911/2/3 = 100; weight: 0.45).

According to a study by the German Machine-Builders' Association, cast iron and bar iron—by far the two most important engineering material inputs—had a share of 40-50% and 30-35%, respectively, in the total volume of iron used in machines.[94] These percentages have been used to compute weights with which to combine four input price series. As no continuous price data for other raw materials and semi-finished inputs are available, the weight share of cast iron has been raised to 55%, that of bar iron to 45%. The three prices for cast iron have been weighted according to the average 1870-1913 shares of Austrian cast iron, Hungarian cast iron, and imported cast iron, respectively, in total Austro-Hungarian cast iron consumption. The lack of adequate price data makes it impossible to construct a separate price index for Hungarian machine-building. The price index is, therefore, used for deflating estimated machine-building output in both Austria and Hungary. Hence Hungarian cast iron prices have been included as well. Import prices for cast iron apply to both countries alike because of their common customs border.[95]

(5) Evaluation of the new estimates

Austria: Because of the use of minimum size criteria in the collection of data and as a consequence of changes to these criteria (factory employment; business tax thresholds), the three Austrian industrial surveys of 1870, 1880, and 1885 report only minimum levels of machine-building output and do not present fully compatible sets of information.[96] However, these contemporary estimates may be used as lower bounds against which to measure the new output estimates presented here. For 1870, estimated output is very close to the minimum level of 109 million crowns. The value of production appears not to be overestimated and it is thus possible to assume that no downward bias has been introduced into computed long-run growth of output. For 1880 and 1885 the

[93] Hoffmann, *Wachstum*, pp. 571-4.

[94] VDMA, *Denkschrift über die Maschinenindustrie*, p. 39.

[95] For sources see Schulze, *Machine-building industry*, app. A, tabs. A.6, A.7, A.13; app. C, tabs. C.1, C.3.

[96] See Gross, 'Industrialization in Austria', pp. 167-85; *idem*, 'Austrian industrial statistics, 1880/85 and 1911/13', pp. 39-48; Handelsministerium, 'Statistik der österreichischen Industrie 1870, 1880, 1885', *Nachrichten über Industrie, Handel und Verkehr*, 3 (1874), no. 2, p. 173; 28 (1884), pp. VIII-X, 94-7; 38 (1888/9), pp. VII-VIII, 106-9.

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new estimates are well above the benchmarks. Though the divergence may to some extent be explained by cyclical variations in the actual input/output ratio, it seems more likely that the contemporary approximations indeed reflect only a part of total output in the industry. This impression is confirmed by a recalculation of output using the available *labour force* data published in the surveys. It should be noted that the production and employment figures of the surveys imply exceptionally low levels of output per worker. For example, the 1880 survey would suggest a level of labour productivity which was 25% below the 1870 level in nominal terms and 11% below this when measured in real terms. Apparently, more firms reported their employment levels than the value of output. The number of workers in Austrian machine-building rose from 28,489 in 1870 to 80,981 in 1911. In conjunction with the apparently robust output figures for those years,[97] these labour force data allow the computation of the average rate of change per annum in real output per worker for 1870 to 1911 (2.6%). Though the assumption of a constant rate of change is without doubt a simplification, it can be used in an alternative approximation of output.

Table A2. *A comparison of output estimates* (m. current crowns)

Austria	*Survey direct*	*Survey alternative*	*New*
1870	109.23[a]	–	109.54
1880	59.83	86.87	97.56
1885	86.09	108.51	114.61
Hungary	*Survey*		*New*
1898	61.67[b] to 91.30[c]		89.19
1906	89.00[b] to 125.35[c]		115.58

a corrected for labour force-output mismatch
b machine building proper
c machine building plus railway repair shops

Sources: Handelsministerium, 'Statistik der österreichischen Industrie 1870, 1880, 1885, 1890', *Nachrichten über Industrie, Handel und Verkehr*, 3 (1874), no. 2, pp. 108, 145-6, 149-54, 157-8, 160, 162, 173; 28 (1884), pp. 94-7; 38 (1888/9), pp. 106-9; 54 (1894), pp. 132-3; Kereskedelmügyi Miniszter, 'Gép-gyártás 1898', pp. 93-6; Központi Statisztikai Hivatal, *Gyáripar 1906*, pp. 716-7

Multiplying the implied level of output per worker by the number of workers in 1880 (20,675) and 1885 (24,850) yields alternative figures for total output in machine building. These are very close to the new estimates (table A.2). The small remaining gaps for 1880 and 1885 are plausibly explained by the effects of the minimum size criteria used in the surveys (note that in 1880 a higher tax threshold applied than in 1885). However, deviations of actual from implied output per worker in these years may also have played a role. In sum, the new estimates of output in Austria's machine-building industry are compatible with the available labour force data for 1880 and 1885. The evidence points less to an overestimation of machinery output than to an under-recording of production levels in the contemporary surveys. If anything, the implied rates of growth of output over all business cycles are upwardly biased. Since Austrian iron and steel prices fell more rapidly over the period than German prices and since a similar time trend reflecting productivity advances was assumed, the index of Austrian machinery prices declines more rapidly than Hoffmann's index for Germany, yet not nearly as fast as business equipment prices in the United States.[98] However, it could be argued that as a result of the larger market size the scope for specialization and productivity growth was wider in Germany

[97] See tab. A.2 and n. 11.
[98] Gallman and Howle, 'Fixed reproducible capital', tab. 5, p. 209.

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than in Austria. The growth rates of machinery output presented here thus represent probable upper limits. The growth of the iron and steel input series, in contrast, can be seen as the lower limit of expansion in machine building, given an implicitly constant input/output ratio.

Hungary: The new output estimates are well above what might be regarded as minimum levels of Hungarian machinery output, but there are several factors which suggest a severe downward bias in the official survey figures. First, in 1898, only establishments employing more than 20 people were surveyed and eight years later an even more restrictive definition of factory establishment was used.[99] The available statistics for Hungarian machine building do not record the labour force in factories with fewer than 20 workers, but in Austria, for instance, about 15% of all workers in mechanical engineering in 1902 were employed in those smaller units.[100] Thus, a presumably significant number of smaller producers were not included in the Hungarian surveys and, as a result, their output was not recorded. Secondly, as the two surveys emphasize, many of the railway repair shops not only carried out repair work but were engaged in the production of completely new machinery, but their output is not included in the total for machine building. Thirdly, the survey estimates do not match with the evidence on employment and productivity in the industry. Comprehensive accounts of the total number of workers in mechanical engineering as a distinct branch within the broadly defined engineering sector are available only for 1890 (12,183), 1911 (28,025), and 1912 (33,213).[101] However, for 1906 the number of workers in mechanical engineering can be reconstructed with a fair degree of accuracy. In 1911, 28 companies employed 47.6 per cent of the total labour force in the machine-building industry.[102] Applying this share to the same company sample's level of employment in 1906 yields an estimated total labour force of 22,866 workers (note that no comparable data are available for 1898). This figure matches almost exactly with that derived from a simple calculation based on the average rate of change in total machine-building employment between 1890 and 1911 (22,995 workers). The implied 1906 level of output per worker was, then, 5,030 crowns in nominal terms (4,780 crowns in real terms) according to the new estimates; this compares with 3,870 crowns (3,680 crowns) for the survey estimates. Output per worker according to the survey estimates does not match with the data from machine-building companies such as Ganz-Danubius, Schlick or Weitzer, all of which achieved levels of well above 5,000 crowns in current prices at around this time.[103] In conclusion, the evidence suggests a strong downward bias in the contemporary output estimates.

[99] Kereskedelmügyi Miniszter, 'Gép-gyártás 1898', pp. 4-5; Központi Statisztikai Hivatal, *Gyáripar 1906*, p. 546.

[100] Statistische Zentralkommission, 'Betriebszählung 1902', *Österreichische Statistik*, 75, 1.Heft, 2.Abtlg. (1907), tab. II, pp. 18-9.

[101] Matlekovits, *Königreich Ungarn*, II, pp. 323-4; Munkás-biztosítási Hivatal, *Jelentése az országos munkásbetegsegélyzö és baleset-biztosító pénztár müködéseröl 1911, 1912*, VIII, nos. 199-214, 219, 254-5.

[102] Vasmüvek és Gépgyárak Egyesületének, *Évkönyve 1911*, p. 99; *1912*, pp. 126-7.

[103] *Compass* 1909, pp. 317, 322, 326, 331; Vasmüvek és Gépgyárak Egyesületének, *Évkönyve 1912*, pp. 126-7.

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