Fiscal Policy and Economic Development in XIXth Century Germany

J.A. Perkins
University of New South Wales

In contrast to development economists, economic historians concerned with European industrialization since the 18th century have somewhat neglected the role of taxation in the process of economic development. Exceptions include the preliminary assessment of the impact of taxation between 1715 and 1810 in Britain and France by Mathias and O'Brien and, of particular relevance to this paper, the analysis by Lee of the role of the tax structure in the economic growth of Germany between 1750 and 1850.[1] Both of these studies have hitherto attracted little attention, insofar as subsequent publications are a guide. In the case of the latter article this neglect is somewhat surprising in view of the thesis presented and the form of argumentation adopted to support it.

Concentrating upon supply-side factors, the underlying theme of Lee's paper is that an optimum taxation system would have promoted savings and consequently — or perhaps presumably — investment at the expense of consumption to generate a high level

[1] P. MATHIAS & P. O' BRIEN, ' Taxation in Britain and France, 1715-1810 ', *Journal of European Economic History*, Vol. V, No. 3, 1976, pp. 601-50; W.R. LEE, ' Tax Structure and Economic Growth in Germany (1750-1850) ', *Ibid.*, Vol. IV, No. 1, 1975, pp. 153-78.

of investment-led economic growth. This ignores, of course, the role of the level of effective demand as a determinant of investment, returns from investment and, therefore, of the level of savings. If, on the other hand, savings were to be promoted by taxes on consumption, and these were expected to prevail in the future, then the only gain from deferring consumption would be income from the investment of deferred taxes. Given especially the inflation normally associated with growth, such a prospective income may not have a significant effect on the propensity to save.[2] In addition, the approach ignores the argument, presented in particular by Borchardt, that the means of mobilizing capital rather than the potentially available capital supply was the key factor in the generation of industrial growth in 19th-century Germany.[3] However, even when Lee's premise of the crucial role of savings is accepted his assessment of the role of the German tax structure in this respect is extremely deficient.

Prominent features of the paper are the frequency with which facts are presented in support of propositions when they do not prove the validity of the propositions, and the lack of consideration of alternative explanations of the facts. We are informed, for example, that the higher incidence of indirect taxation in urban areas, at a time when that form of taxation accounted for a large proportion of state revenue, ' may well have retarded the growth of towns by exacerbating their high cost situation '. There then follows the statement that: ' In Bavaria, for example, even as late as 1890s, only 23 per cent of the population lived in urban areas '.[4]

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[2] See S.R. Lewis, Jr., ' Agricultural Taxation in a Developing Economy ', in H.M. Southworth & B.F. Johnston, (eds.), *Agricultural Development and Economic Growth*, (New York, 1967), p. 456.

[3] K. Borchardt, ' Zur Frage des Kapitalmangels in der ersten Hälfte des 19. Jahrhunderts ', *Jahrbücher für Nationalökonomie und Statistik*, Vol. CLXXIII, 1961, pp. 401-21. See also H. Winkel, ' Kapitalquellen und Kapitalverwendung am Vorabend des industriellen Aufschwungs in Deutschland ', *Schmollers Jahrbuch*, Vol. XC, Part I, 1970, pp. 275-301.

[4] Lee, *op. cit.*, p. 171.

No evidence is presented for the actual impact of the differential incidence of indirect taxation between urban and rural areas on the rate of urbanization, and no consideration is given to other, probably more relevant, explanations of the slow pace of urbanization in 19th-century Bavaria. Similarly, the excise is given as a cause of the shift of distilleries from Prussian towns after 1815, whereas the far more important role of the substitution of potatoes for cereals as the raw material of the distilleries is not mentioned.[5] The bulk-to-value ratio of potatoes was far higher than that of grain, the alcohol content diminished rapidly after harvesting and the market demand for potatoes centred on towns was limited. Together these factors necessitated processing within the potato-growing rural areas.

It is perhaps Lee's analysis of the role of the land tax in 19th-century Germany that leaves most to be desired. The early 19th-century reforms of this tax involved, firstly, the abolition of the exceptions accorded to privileged estates and, consequently, the shift of the tax burden from the social status of the person holding land to the land itself. Secondly, outdated assessments of land values and levies on the harvest were replaced by new cadasters or assessments of the net yield of land as the basis of the tax. Finally, the cash form of payment was adopted. Overall, Lee attributes a negative impact on economic development to the land tax. Apart from the relatively high cost of implementation and administration, his principal criticisms are that it probably detracted from the capital available for agricultural improvement and that it may have discouraged the peasantry from production for the market rather than for subsistence.[6]

As regards the suggested influence of the land tax upon the

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[5] *Ibid.* Between 1831 and 1839 the quantity of cereals used in Prussian distilleries declined by an estimated 38 per cent — from 3.14 to 1.93 million bushels — whereas the volume of potatoes increased by 34 per cent — from 20.01 to 26.89 million bushels. ('The Principles of Tariffs Applied', *British and Foreign Review*, Vol. XVI, 1844, p. 434).

[6] Lee, *op. cit.*, p. 160-3.

supply of capital for agricultural improvement, this view is surprising when it would appear that the author accepts that ' rapid and large returns in the agricultural sector are possible with relatively minor changes in techniques '.[7] Certainly in practice the major sources of the growth in productivity in 19th-century German agriculture did not require large inputs of capital; and in the area where capital investment was substantial, such as in farm buildings and land purchases, it was arguably to a large extent wasted in terms of its contribution to production. The argument that the land tax discouraged the shift from subsistence to market production is patently incorrect. Of necessity farmers had to market sufficient produce to pay the land tax, and the only manner in which the fixed burden of the tax could be lessened was to increase returns from the market by improved methods, in order to reduce the ratio of the tax to total market receipts. Moreover, it is not a criticism of the land tax, as the author suggests, that ' despite the reforms of the early 19th century, [land taxes] were seldom optimally designed to promote increased production ', because the ' production of vegetable products only increased by 62 per cent (1816–65), hardly exceeding the growth of population '.[8] Not only would a greater increase have probably depressed returns, and thereby discouraged production for the market, but once again no connection is proven between the two statements.

As the foregoing discussion suggests the principal criticism to be levelled at Lee's approach is the failure to analyse adequately the relationship between the German taxation system and the development of the economy. In this paper it is proposed to investigate the nature of that relationship in respect of one form of taxation, namely that levied on the beet-sugar industry in the 19th century. Here the thesis is advanced that the particular form of taxation adopted in this area was largely responsible for the phe-

[7] *Ibid.*, p. 160.
[8] *Ibid.*, p. 162.

nomenal growth of the German beet-sugar industry from the 1840s, to the position where Germany became the world's largest exporter of sugar by the 1890s. This thesis is not novel, in that it has been advanced by a number of studies of the industry in the past.[9] Nevertheless, it has not so far been investigated for an English-language presentation. Moreover, it is also argued that the subsidy for beet-sugar production created by the taxation system was on balance more than compensated by the "spin-off" benefits of the development of the industry for other economic activities. In other words, the subsidy might be regarded as a means whereby a portion of the social gains generated by the beet-sugar industry was privatised for the benefit of beet-sugar producers.

II

The history of German sugar taxation for most of the 19th century may be viewed as an instance of the persistence of 18th-century *Cameralist* notions of promoting industrial development, especially by means of tariff protection for industries producing import substitutes. In other words, apart from yielding a substantial proportion of state revenue, the sugar taxation system continued in the 19th century to provide support for an industry processing an imported raw material, namely the cane-sugar refining industry. In addition, it also acquired the function of supporting an infant industry producing a complete import substitute, namely the beet-sugar industry, which supplanted the cane product. Arguably therefore, the taxation of sugar provides a link between the 18th-century era of *Cameralism* and that of *Neo-mercantilism*; the latter commencing with the adoption of a general policy of protectionism from 1879. More specifically, the 19th-century

[9] See, for example, T. SCHUCHART, *Die volkswirtschaftliche Bedeutung der technischen Entwicklung der deutschen Zuckerindustrie*, (Leipzig, 1908), esp. pp. 8–9; and more recently J. BAXA & C. BRUHMS, *Zucker im Leben der Völker*, (Berlin, 1967), p. 176.

history of the beet-sugar industry provides a link with German autarchic aspirations in the 20th century that culminated in the Nazi era. Expressed another way, it provides a marked and significant contrast with the dominant theme in the current literature on 19th-century German economic history. This consists of the identification of a hiatus in the historical role of the state, which began with the liberal Prussian Tariff Law of 1818 and progressed through an apparently more or less free-trade era of the *Zollverein.*[10]

Throughout the 19th-century a high level of duty was imposed upon cane-sugar imports in Germany, which was even increased on several occasions up to the 1870s and yielded about a quarter of total revenue from customs duties during the early decades of the century. At the same time a differential levy upon raw and refined cane-sugar, of 40 and 100 *taler* per tonne respectively before 1831, was maintained to support the Prussian refining industry. In 1831 the duties were actually increased to 50 *taler* per tonne on raw and 110 *taler* per tonne on refined, which entailed a slight reduction in the effective level of protection provided for the refining industry. More significantly, the levy upon semi-refined "loaf" or "lump" sugar, which yielded approximately 12 per cent more refined sugar than the raw commodity, was reduced from 100 to 50 *taler* per tonne.[11] Together with a Dutch export bounty, this stimulated a rapid increase of "loaf" sugar imports from Holland, much of which entered directly into consumption. Eventually, in response, the *Zollverein* in 1837 raised the duty on such sugar to the refined level of 110 *taler*, which brought about a marked expansion of the domestic beet-sugar industry producing a semi-refined product for the market pioneered by Dutch imports. Even a reduction of the duty on semi-refined sugar, to 55 *taler*

[10] For a recent example see M. KITCHEN, *The Political Economy of Germany*, 1815-1914, (London, 1978), pp. 30-1.

[11] W. HENNEBERG, 'Produktion und Besteuerung des Rübenzuckers im Deutschen Reiche', *Journal für Landwirtschaft*, Vol. XXXVI, 1882, p. 368; SCHUCHART, *op. cit.*, p. 23.

in 1839, failed to halt this expansion. By 1840/41 the number of beet sugarmills in the *Zollverein* stood at 145 and they processed 241,466 tonnes of beet to produce 14,205 tonnes of raw sugar.[12]

In spite of rapid growth in the late 1830s, the German beet-sugar industry at the beginning of the following decade accounted for a minute proportion of domestic sugar consumption. The majority of the mills established in the 1830s were highly speculative ventures. Compared with those of neighbouring France they involved a minimal investment in a relatively primitive technology. None of the existing refineries was able or prepared to refine raw beet-sugar: being precluded from doing so by customs regulations designed to protect the revenue from imported cane-sugar and being unwilling on account of the inferior nature of the beet product. Consumer prejudice and resistance to beet-sugar was pronounced and lingered until the 1850s.[13] Originally, according to one writer:

> the reason may have been the somewhat unpleasant smell of beet-sugar, which was a consequence of deficiencies in the manufacturing process. Subsequently, the ground was the use of animal bone ash to bleach the sugar, which engendered the rumour disseminated by opponents of the industry that human bones were also used for this purpose.[14]

Primarily, however, the backward state of the industry arose from the apprehension that the state would react to its growth by the imposition of a duty, in order to counter the threat to revenue from imported cane-sugar and to protect the established cane-sugar refining industry.

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[12] E.O. von LIPPMANN, *Die Entwicklung der deutschen Zuckerindustrie von 1850 bis 1900*, (Leipzig, 1900), Preface: SCHUCHART, *op. cit.*, p. 13; K. PFEIFFER, *Geschichte des Zuckerrübenbaues und der Rübenzuckerindustrie in der Rheinprovinz*, (Bonn, 1923), pp. 189.

[13] SCHUCHART, *op. cit.*, p. 37; HELFERICH, 'Die Zölle vom Colonialzucker und die Rübenzucker im Zollverein', *Zeitschrift für die gesamte Staatswissenschaft*, Vol. VII, 1852, pp. 75–6; G. WEBERSINN, 'Die schlesische Zuckerindustrie', *Jahrbuch der schlesischen Friedrich-Wilhelms-Universität zu Breslau*, Vol. VXIII, 1973, pp. 169–70.

[14] PFEIFFER, *op. cit.*, p. 13.

In 1841 the *Zollverein* did in fact respond as the industry feared with the imposition of a levy, although the effects were precisely the opposite of those anticipated. In that year an excise duty was imposed to yield 20 *taler* per tonne of raw beet-sugar, with the choice of the point of production at which the duty was to be levied being decided by the individual member states. Of these only Württemberg opted for a duty on raw sugar. The rest, following Prussia's lead, decided upon a raw material tax of 1 *taler* per tonne of beet entering the mills, which assumed — correctly at the time — that the average extractable sugar content of beet was 5 per cent.[15]

Some writers have suggested, to use the words of one, that the raw material tax was ' deliberately adopted in order to stimulate improvements in cultivation and manufacture '.[16] The facts, however, do not support this contention. Rather the system was applied for reasons of administrative cost and convenience and for lack of a preferable alternative. The only available means of measuring the sucrose content of sugar was the Dutch colour system, under which sugars were simply classified into one of 20 grades according to colour: from white assumed to have the highest sucrose content to dark brown. Apart from being extremely rudimentary and imprecise, where this system was employed as the basis of fiscal levies it encouraged tax evasion by artificially darkening sugar through, for example, applying extra heat when

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[15] Helferich, *op. cit.*, pp. 74–5; HENNEBERG, *op. cit.*, p. 369. At the end of 1841 the *Zollverein* duty on imported semi-refined sugar was raised once again, to 100 *taler* per tonne. According to one writer, this was an instance in which ' a powerful new German industry, [i.e. beet-sugar manufacture] ... had become powerful enough to impose its will upon the *Zollverein* as a whole '. (W.O. HENDERSON, *The Zollverein*, (2nd edition, London, 1939, (p. 132). In view of the miniscule size of the industry, and the extremely small scale of the average unit of production, this opinion is untenable. Any substantial pressure in this regard came from the long established cane-sugar refining industry.

[16] G. MARTINEAU, 'The Statistical Aspect of the Sugar Question', *Journal of the Royal Statistical Society*, Vol. LXIII, 1899, p. 298. See also, *Report on the Sugar Beet Industry at Home and Abroad*, (Ministry of Agriculture and Fisheries, Economic Series No. 27, London, 1931), p. 20.

boiling down the beet-juice.[17] To preclude this and other methods of evading tax, a levy on the product of beet-sugarmills, as one observer described the situation in the French beet-sugar industry, 'brings with it the necessity to maintain legions of tax officials, whose incomes devour a large part of the revenue from the sugar tax'. Such officials were required to ensure that the millers adhered to the comprehensive regulations covering the manufacture and movement of beet-sugar, which entailed an extensive degree of interference in the technology and processes of production.[18]

In contrast to France the raw material tax adopted in Germany merely required the location of a tax official at the entrance to each mill in order to check and record the volume of beet passing. This minimized the administrative costs of a tax levied on an industry conducted in numerous relatively small-scale establishments scattered over the countryside, and it left decision-making in production entirely to the entrepreneur. Moreover, the difficulty for a manufacturer with a tax levied at an early stage of production, of having to tie up a substantial capital in tax, was obviated by the deferment of payments for six months from the entry of the beet into the mill.[19] By this measure a net gain was achieved, in that where the government needed to borrow funds, to cover expenditure before receipt of the tax, it was able to do so at an appreciably lower rate of interest than that charged for capital borrowed by manufacturers in a new industry.

Although the raw — material tax on the beet-sugar industry was levied for other purposes, it did provide an enormous stimulus to the expansion and technological advance of the industry. This stemmed from the fact that beet-sugar millers found themselves

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[17] H. Ebeling, *Wirtschaftliche Probleme bei dem deutsch-englischen Zuckerhandel*, (Karlsruhe, 1914), p. 33; C.S. Griffin, 'The Sugar Industry and Legislation in Europe', *Quarterly Journal of Economics*, Vol. XVII, 1903, p. 21.

[18] J. Wolf, 'Die Zuckersteuer, ihre Stellung im Steuersystem, ihre Erhebungsformen und finanziellen Ergebnisse', *Zeitschrift für die gesamte Staatswissenschaft*, Vol. XXXVIII, 1882, p. 315.

[19] J.F. Due, *Indirect Taxation in Developing Countries*, (Baltimore, 1970), p. 62.

in the position to gain substantial savings on tax outlays, insofar as they were able to extract more sugar from beet than the notional content on which the levy was based. If, for example, a miller in 1842 was able to produce an average of 6 tonnes of sugar per hundred of beet, instead of the 5 on which the levy was based, the excise payment was 16.6 rather than 20 *taler* per tonne. This amounted to a tax premium for the improvement of methods of cultivating and processing beet in order to maximise the sugar yield, which was subsequently maintained by periodic increases in the raw material tax. In 1844 the beet-tax was tripled to 3 *taler* per tonne. It was doubled in 1850 and again in 1852: to 12 *taler*. Later increases were more moderate and further apart: to 15 *taler* in 1858 and to 16 *taler* in 1869. Through these measures the state endeavoured to maintain revenue from sugar, in the face of a rising yield of sugar from beet and a falling income from the duty on cane-sugar imports as these were replaced as a source of domestic consumption by the beet product. Between 1840/41 and 1860/1 the volume of beet processed increased from 241,466 to 1,467,702 tonnes, the output of raw beet-sugar expanded from 14,205 to 126,526 tonnes, and the average raw-sugar yield of beet rose from 5.88 to 8.62 per cent.[20]

The raw material tax on the beet-sugar industry was not introduced and maintained without objection or opposition. Outside the industry many viewed it as an artificial stimulus to the expansion of a comparatively uneconomic industry and, therefore, the source of a maldistribution of economic resources. Within the agricultural sector the tax was criticized on the ground that it was the cause of the concentration of the industry in areas where soil and climatic conditions promoted the growth of beet with

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[20] LIPPMANN, *op. cit.*; SCHUCHART, *op. cit.*, p. 13. By 1857 Germany accounted for an estimated 46 per cent of world beet-sugar production and German production was an estimated 37 per cent greater than that of France. (G.B. HAGELBERG & H.-H. MÜLLER, 'Kapitalgesellschaften für Anbau und Verarbeitung von Zuckerrüben in Deutschland im 19. Jahrundert', *Jahrbuch für Wirtschaftsgeschichte*, 1974, Part IV, p. 116).

a particularly high sugar content. In this respect, the form of taxation largely explains the dominant role in the XIXth century of beet-sugar industry of the Prussian province of Saxony, especially the areas of very fertile soils around Magdeburg and Halle, and the adjoining states of Saxony-Anhalt, Brunswick and Hanover. In 1860/61, for example, Prussian Saxony contained 120 of the 247 sugarmills operating in the *Zollverein* and they processed 53 per cent of the sugar-beet crop. As late as the 1890s, after the extension of cultivation on a considerable scale to other parts of Germany from 1870s, Prussian Saxony and Anhalt were still referred to as 'the El Dorado of sugar-beet cultivation'.[21]

Even within the beet-sugar industry itself the raw material tax was not accepted without criticism. The high degree of geographical concentration of sugar-beet growing exposed the industry to potential disaster from a localized crop failure, or substantial shortfall, through adverse climatic conditions or the ravages of the many pests to which the crop was prone. In addition, the form of the levy had the effect of causing the rate of duty per tonne of raw sugar to vary inversely with the state of the beet harvest. In other words, in poor seasons, when the sugar content of beet and the sugar yield per hectare were low, the rate of duty per tonne on raw sugar was higher than in good seasons. Hence the tax tended to exacerbate the already considerable fluctuations in the fortunes of the industry stemming from natural causes. In the case of Westphalia, for example, an average of 17.08 tonnes of beet were required to produce one tonne of raw sugar in 1876/77, whereas in 1877/78 the amount was only 11.65 tonnes. On one central German farm from 1891 to 1892 the average yield of beet per hectare declined by 16.7 per cent, the average sugar content of beet fell from 16.78 to 13.34 per cent, and the average yield of sugar per hectare declined from 2,718 to 1,801 tonnes.[22] It

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[21] H. VON MENDEL, *Fünfzig Jahre der Landwirtschaft der Provinz Sachsen im Lichte des Landwirtschaftlichen Zentralvereins* (Berlin, 1894), p. 334.

is probable that earlier in the century, when methods of cultivating beet were much less advanced, fluctuations in crop and sugar yields were even more pronounced.

In spite of criticism, the authorities persisted with the raw material tax which brought about the rapid growth of the beet-sugar industry during the 1840s and 1850s. The attempt was made to compensate the cane-sugar refining industry for the gradual loss of the domestic market by legislative means. In particular, facilities for the rebate of duty on exports were confined to the cane product and a disguised export premium or bounty of increasing value over time was allowed to emerge. This occurred through the authorities deliberately fixing the rebate at a higher level than the duty actually paid on the raw sugar component of refined sugar exports. By 1861, for example, the duty on raw cane-sugar imports was 165 *taler* per tonne and the drawback of duty for refined cane-sugar exports was 200 *taler* per tonne, which assumed an 82.5 per cent yield of refined from raw sugar. However, the actual average yield in that year was 87 per cent, so that the average duty paid on the raw sugar was only 189.80 *taler* and the average export bounty was 10.20 *taler* per tonne.[23]

In addition to being an attempt to provide alternative export markets for the cane-sugar refineries, the restriction of the rebate of duty to their exports was a consequence of the problems foreseen by the authorities if the facility was extended to beet-sugar. It was feared that exports from mills close to the frontier could be profitably smuggled back into the *Zollverein*, whereas this was a more difficult proposition for cane-sugar refineries located in the ports and interior cities. It was also foreseen that, if the *Zollverein* were to permit a rebate of duty on beet-sugar exports and a disguised bounty were to emerge, and the neighbouring beet-sugar producing countries Austria-Hungary and France responded likewise, the si-

[23] Lippmann, *op. cit.*, p. 10. See also U. Teichmann, *Die Politik der Agrarpreisstützung*, (Cologne, 1955), p. 317.

utation could arise in which the producers in each country could profitably export their entire output rather than supply the home market.[24] In 1861, however, in response to pressure from the industry the rebate facility was extended to beet-sugar, although the authorities precluded a general bounty on exports by fixing the rebate at a level that imposed an export penalty at the average sugar yield of beet.

The rebate of duty on beet-sugar exports fixed in 1861, at 165 *taler* per tonne of raw sugar, corresponded to a notional requirement of 11 tonnes of beet paying 15 *taler* per tonne raw material tax being required to produce one tonne of raw sugar. The actual average requirement for the season 1860/61 was 11.6 tonnes of beet, which implied a tax penalty of 9 *taler* per tonne on exports at the average sugar-yield of beet. Nevertheless, by the early 1860s a few mills, on account of their efficiency in production, were in a position to add an absolute bounty on exports to a relative saving on the raw material tax. At one mill near Magdeburg, for example, between 1858 and 1863 the annual average ratio of beet processed to raw sugar produced ranged from 10.2:1 to 10.65:1.[25] Assuming that the average annual output of 6,324 tonnes of raw sugar was the mill's actual output in each of the six years, then the outlay on the raw material tax ranged from 967,572 *taler* (6,324 × 10.2 × 15) to 1,019,259 *taler* (6,324 × 10.65 × 15) rather than 1,043,460 (6,324 × 11 × 15) required at the notional ratio of beet to raw sugar. Initially, therefore, this highly efficient mill saved from 33,201 to 75,888 *taler* a year on its outlay for raw material tax. If its entire output had then been exported, from 1861, the mill would have doubled its initial saving on raw material duty with a rebate of 1,043,460 *taler*.

Very few mills operating in the early 1860s were in a position to avoid a tax penalty on exports and the growth of sugar

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[24] LIPPMANN, *op. cit.*, p. 9; EBELING, *op. cit.*, p. 10; GRIFFIN, *op. cit.*, p. 23.

[25] SCHUCHART, *op. cit.*, pp. 53–4.

exports during the decade — from 3,863 tonnes in 1860/61 to 23,193 tonnes in 1870/71 — consisted almost entirely of refined cane-sugar. Such exports were assisted by increases in the margin between the import duty on raw sugar and the export rebate. In 1861 the rebate was 121,2 per cent of the import duty, in 1864 it was raised to 122.1 per cent and in 1869 it was fixed at 122.3 per cent. These steps were taken to compensate the cane-sugar refining industry for the continuing loss of domestic markets, with the output of the beet-sugar industry matching domestic consumption from 1865 onwards. Nevertheless, the decision of 1861 to allow a rebate on exports of beet-sugar does mark a radically new departure in the sugar taxation policy of the *Zollverein*. It provided a bounty on exports for highly efficient producers and provided an added stimulus to the raw material tax for the industry as a whole to increase the sugar yield of beet. Moreover, it indicated that the state foresaw the future expansion of the industry, in response to the additional stimulus it provided, as coming to depend increasingly upon exports rather than domestic consumption. This was confirmed in 1864 and in 1869 when the import duty on raw sugar was increased, to 172 and 188 *taler* respectively. At the same time, from 1864 the principle of an export bounty at the average sugar yield of beet was conceded, with a rebate of 172 *taler* per tonne coinciding with average raw material tax payments of 165 *taler* per tonne of raw beet-sugar. Finally, from 1869 the export drawback was raised in unison with increases in the raw material duty in order to maintain the existence of a disguised bounty.[26]

Although a few producers were in a position to derive a bounty on exports from 1861, and one was conceded on the average sugar yield of beet from 1864, the continued rapid expansion of the beet-sugar industry to the mid-1870s was almost entirely confined to the supply of the home market. The volume of beet processed

[26] Teichmann, *op. cit.*, pp. 319-20; Schuchart, *op. cit.*, pp. 54-6.

increased from 1,467,702 tonnes in 1860/61 to 4,161,284 tonnes in 1975/76, or at an annual average rate of 12.2 per cent, with raw sugar output rising from 126,526 to 185,696 tonnes. Exports in 1895/76, on the other hand, amounted to 57,391 tonnes of mainly refined cane-sugar and net exports were only 36,067 tonnes. Until the mid-1870s it would appear that transport costs for exports from the punctiformly located beet-sugar industry more than offset the bounty for the overwhelming majority of producers, and the latter were unable to raise the bounty substantially by increases in the sugar yield of beet. Thereafter, however, raw cane-sugar imports declined markedly, from 21,324 tonnes in 1875/76 to 5,607 in 1880/81, and net exports of almost entirely beet-sugar increased rapidly, to 278,300 tonnes in 1880/81 and to 494,748 tonnes in 1885/86. Subsequently, this expansion was maintained to the early 1900s, with net exports reaching 742,295 tonnes in 1890/91, and 1,060,000 tonnes in 1899/1900 when Germany achieved the position of leading sugar exported in the world.[27]

Up to the mid-1870s, as Table 1 below indicates, the losses of revenue through the export rebate system were more than compensated by increased income from the raw-material tax and import duties on cane-sugar for domestic consumption. The net sugar-tax yield per capita actually increased from 1.00 mark in 1869/70 to 1.46 marks in 1875/76. Consequently, until the mid-1870s the continued expansion of the beet-sugar industry was compatible with the state's objective of maintaining revenue from sugar taxation. Thereafter, however, the situation changed radically, with the phenomenal expansion of beet-sugar exports on which an increasing disguised bounty was paid with the increasing sugar yield of beet. In 1875/76 the average sugar yield of beet was 8.60 per cent. By 1885/86 it was 11.43 per cent. The net per capita sugar-tax yield declined to 1.13 marks in 1878/79 and to 0.93

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[27] LIPPMANN, *op. cit.*, Preface; FAO, Commodity Reference Series No. 1, *The World Sugar Economy in Figures, 1880-1959*, pp. 39-42.

marks in 1881/82.[28] In the short-term, the overall effect on the state's revenue was offset by the imposition of a duty from 1879 on Germany's increasing imports of cereals. In fact, it is possible that the loss of revenue from sugar was one factor motivating the decision to adopt a grain-tariff in 1879, as an alternative source of revenue from an article of mass consumption. At the same, time however, the declining revenue from sugar prompted a revival in official circles of support for the replacement of the beet-tax with a duty on raw sugar.

TABLE 1

SUGAR TAXATION REVENUE IN GERMANY 1869/70 TO 1882/3
(MILLIONS OF MARKS)

Season	1 Sugar-Beet Tax	2 Duty on Imported Cane-Sugar	3 Rebate on Sugar Exports	4 Net Revenue from Sugar	5 Administrative Costs	6 4-6	7 5 as proportion of 6 (0)
1869/70	41.35	1.51	4.05	38.81	1.65	37.16	4.3
1872/73	50.90	7.13	3.33	54.70	2.04	52.66	3.7
1875/76	66.58	5.67	10.26	62.00	3.67	58.33	5.9
1878/79	74.06	2.11	26.37	49.81	2.97	46.84	6.0
1879/80	76.88	1.73	25.79	52.83	3.08	49.75	5.8
1880/81	101.18	1.6	55.87	46.91	4.04	42.87	8.6
1881/82	100.35	1.5	60.03	41.84	4.02	37.82	9.6
1882/83	139.95	1.7	90.04	51.64	5.60	46.04	10.8

Source: W. HENNEBERG, 'Die neuere Entwicklung der Produktion und Besteuerung des Rübenzuckers im Deutschen Reiche', *Journal für Landwirtschaft*, Vol. XXXVI, 1888, p. 733.

A duty on raw sugar was widely accepted as more rational than the beet-tax, in that it placed the incidence of taxation closer to the point of consumption. Such a tax, it was considered, might control the escalation of administrative costs for the sugar taxation system, which had almost doubled between 1878/79 and 1882/83. A raw-sugar tax would facilitate the abolition of the export bounty,

[28] HENNEBERG, *op. cit.*, p. 373; B. AMROGOWICZ, *Die Zuckerindustrie der Provinz Posen*, (Berlin, 1903), pp. 12-4.

as it was impossible under the raw material tax to equate the rebate with the duty actually paid. The application of the duty on raw sugar would assist producers by reducing the fluctuations of returns between good and bad seasons which had been intensified by the addition of the bounty to the raw material tax. Finally, in the situation of a worsening agricultural depression from the late 1870s, the shift to a raw-sugar duty was favoured on the ground that it would promote the diffusion of beet-sugar production to areas where the sugar yield of beet was relatively low. By this means some 'compensation for the *misère* of cereals cultivation' might be provided.[29]

In the middle years of the 1880s the continued expansion of beet-sugar exports, and a pronounced decline of sugar prices, brought about a crisis in both the industry and the revenue system. Between 1882/3 and 1885/86 the net yield of revenue from sugar was more than halved, from 51.83 to 24.49 million marks. At 14.68 million marks in 1887/88 it reached its lowest point of the century. The fall was almost entirely the product of an escalation of the amount of duty rebated on exports which, with declining prices, accounted for a rising proportion of export receipts. By 1885/86 the average price of sugar on the world market was an estimated 86.46 per cent of that of 1881/83, and by 1886/87 it was down to 65.45 per cent. The decline was partly offset by the reduction of the costs of producing beet-sugar, of an estimated 12.31 per cent between 1881/83 and 1886/87.[30] However, the overall situation was such that the state was compelled to act to protect both its own revenue and that of the industry, although it demonstrated considerable reluctance to abandon the raw-material tax that had made such an important contribution to the development of the industry.

Initially, in 1886, the state responded to the crisis of the mid-

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[29] Wolf, *op. cit.*, p. 299; Henneberg, *op. cit.*, p. 381; W. Schippel, 'Zuckerkrisis, Ausfuhrprämien und Zuckerring', *Neue Zeit*, Vol. XV, Part I, 1897, p. 621.

[30] Henneberg, *op. cit.*, p. 373, 309; W. Katzenstein, *Die deutsche Zuckerindustrie und Zuckerbesteuerung in ihrer geschichtlichen Entwicklung*, (Berlin, 1897), pp. 38-9, 77.

1880s along the lines of existing policy, by raising the raw material tax from 16 to 17 marks per tonne of beet and by a substantial increase of import duties on sugar. The inadequacy of this measure, however, stimulated a radical revision of the sugar taxation system, which began in 1888 and was completed in 1892.[31] In essence this involved a transition from the raw-material tax to a duty on raw sugar, with a direct or open bounty replacing the former disguised one. In 1888 the beet-tax was reduced to 8 marks per tonne and a levy of 120 marks per tonne was placed on raw sugar, which yield an estimated export bounty of 25.00 marks per tonne. From 1892 the beet-tax was finally abolished and the raw sugar duty was raised to 180 marks per tonne, with an open bounty of 12.50 marks per tonne being paid by the state. In 1892 it was foreshadowed that the bounties would be abolished within three years if other states agreed to do likewise. When the anticipated response did not materialize, and instead other countries (such as France) raised the level of their bounties, Germany responded in 1896 by doubling its open bounty to 25.00 marks.[32]

Apart from the increase in the bounty on exports the 1896 Act was significant in two other respects. In the first place, a raw material tax was again applied, at a much lower level than previously, with the rate increasing according to the scale of the sugarmilling enterprise. For mills processing up to 400,000 tonnes of beet the levy was 2.00 marks per tonne, for those processing 400,000 to 500,000 tonnes the rate was 1.25 marks increasing to 1.5 marks for between 500,000 and 600,000, and an additional 0.25 marks was levied for every tonne of beet processed in excess of 500,000. By this measure the government's objective was to assist the smaller enterprises, which were typically adjuncts of Junker farms, at the expense of large-scale corporate producers. In the second place,

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[31] MARTINEAU, *op. cit.*, p. 301; P. CLASSEN, *Kürzer Überblick über die Zuckerindustrie Deutschlands*, (Bernburg, 1888), 0.67; TEICHMANN, *op. cit.*, pp. 325-7; H. HAACKE, *Handel und Industrie der Provinz Sachsen*, (Stuttgart, 1901), pp. 60, 115.

[32] SCHUCHART, *op. cit.*, pp. 69-70; TEICHMANN, *op. cit.*, pp. 325-8.

the Act of 1896 was the first to attempt to control the growth of the industry by fiscal means, in that an additional tax of 2.5 marks per tonne of beet was levied on the quantity of beet that a mill processed above the average of the previous three years.[33] Both of these measures were ineffectual at the time but they foreshadowed the efforts of the 1920s to rationalize the size of the industry.

In the intervening period between 1896 and 1914 the most important measure affecting the German, and for that matter the world sugar industry, was the abolition of bounties on beet-sugar exports under the Brussels Convention of 1902. This step, which was initiated by the Conservative government of Britain, as a means of providing support for the ailing West Indian sugar industry, was actually supported by the German government, which had expressed a desire for the removal of bounties from the early 1890s onwards.

III

The relative efficiency of cane- and beet-sugar production has been a contentious issue since the inception of the latter. On the one hand, the development of the temperate-zone beet-sugar industry has been likened to that of a hothouse plant: as something both unnatural and uneconomic. One of the earliest to refer to it in this vein was Justus Liebig, considered the founder of modern agricultural chemistry, who spoke of the German beet-sugar industry in the 1840s as ' a presumptuously usurious hothouse plant, which is nurtured at the expense of the community and has no future '.[34] In equally hyperbolic and mammalian terms, a turn-of-the-century economist stated: ' Born under the exceptionally artificial conditions of Napoleon's " Continental

[33] TEICHMANN, *op. cit.*, p. 335; HAACKE, *op. cit.*, p. 115.
[34] CITED in EBELING, *op. cit.*, p. 7.

System", fed in its infancy on the rich food of governmental bounties and prizes, the industry has at no time been completely weaned from governmental support'.[35] In the more prosaic language of latter-day economists the development of the industry represents an outstanding instance of unwarranted distortion by governments of the rational distribution of factors of production in the international economy by means of the free play of market forces. In particular, it has been emphasized that an artificial diversion of income has occurred, through the development and continued existence of the beet-sugar industry, from the principally Third World producers of a presumably lower-cost product to the affluent sugar-beet farmers of advanced industrial countries.[36] On the other hand, the beet-sugar industry has not lacked supporters, from those persuaded by Friedrich List's "infant industry" argument to some present-day agricultural economists.[37]

A number of factors have contributed to the existence of conflicting views on the comparative advantage of beet- and cane-sugar production. Firstly, it is virtually impossible to evaluate the impact of the rise of the beet-sugar industry from the XIXth century upon the level of efficiency in cane-sugar production and upon the price of the final product. Secondly, the actual costs of the two crops are difficult to establish accurately. Such costs vary so widely between areas of production and from year to year that averages become meaningless. In the case of cane-

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[35] GRIFFIN, *op. cit.*, p. 4.

[36] See, in particular, R.H. SNAPE, 'Some Effects of Protection in the World Sugar Industry', *Economica*, Vol. XXX, 1963, pp. 63-73; H.G. JOHNSON, 'Sugar Protectionism and the Export Earnings of Less Developed Countries: Variations on a Theme by R.H. Snape', *Ibid.*, Vol. XXXIII, 1966, pp. 41-4; and R.H. SNAPE, 'Sugar: Costs of Protection and Trade', *Ibid.*, Vol. XXVI, 1969, pp. 29-41.

[37] See especially, G.B. HAGELBERG, 'Economic Comparisons: The Cautionary Case of Beet and Cane Sugar', *Economy and History*, Vol. XVI, 1973, pp. 37-53; and the same writer's 'Anhaltspunkte zur vergleichenden Wirtschaftsgeschichte von Rohr - und Rübenzucker bis zur Mitte des 20. *Jahrhunderts*', *Jahrbuch für Wirtschaftsgeschichte*, 1971, Part III, pp. 141-80.

sugar, currently and more especially in the past, many inputs in important producing areas have not been monetized, so that values cannot be accurately computed. In the case of beet-sugar, apart from the inadequacy of farm accounting procedures in the past, the cultivation of beet in rotations with other crops, and the utilization of by-products such as tops and pulp to support livestock, make it difficult to accurately apportion costs and benefits between the various farm activities. Finally, for the purpose of international comparisons of costs of production, it can only be assumed that actual exchange rates for currencies reflect actual comparative purchasing power.[38]

The problems involved in calculating comparative costs of production for cane- and beet-sugar have not deterred economists from the attempt and the results have by no means uniformly favoured the former over the latter. F.G. Sturrock, for example, has calculated that in 1965 the comparative costs of production of Jamaican cane-sugar, including freight to the United Kingdom, and beet-sugar produced in Britain, were £ 65 and £ 57 per tonne respectively.[39] Over a hundred years earlier a German economist concluded that, although the cost of cane-sugar in the colonies was ' considerably cheaper ' than beet-sugar (excluding duty) in Germany, the wholesale prices of both (excluding duty) in Germany were quite comparable. According to one estimate made in the 1890s, beet-sugar produced at Germany's two largest mills cost £ 9.3 and £ 9.38 per tonne respectively, which compared with a cost of ' a trifle under £ 9 ' per tonne

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[38] See, W. Lilienthal, *Die Bedeutung des Hackfruchtbaus namentlich des Zuckerrübenbaus für die Steigerung der Getreide- und Viehproduktion in Deutschalnd*, (Jena, 1895), p. 19; F.G. Sturrock, ' Sugar Beet or Sugar Cane: A Reply ', *Journal of Agricultural Economics*, Vol. XXII, No. 2, 1971, pp. 198-201.

[39] F.G. Sturrock, ' An Economic Comparison of Sugar Beet and Sugar Cane ', *Sucrerie Belge*, Vol. LXXXVIII, 1969, pp. 491-4. *cf.* D. Belshaw and J. Bryden, ' Sugar Beet or Sugar Cane: A Comment ', *Journal of Agricultural Economics*, Vol. XXII, No. 2, 1971, pp. 95-7.

for cane-sugar from the best-equipped estates in Guyana.[40] However, the slight cost advantage of Guyanan cane-sugar was offset by higher freight costs to European markets. In addition, the low-grade sugar that made up a large proportion of shipments from the Caribbean, and the considerable loss of sucrose yield during shipment, enhanced freight costs relative to the landed value of the product. Germany, on the other hand, supplied high-grade raw and refined sugar, much of which was in the granulated form that found increasing favour with consumers and the jam and confectionery industries in Britain from the later XIXth century.[41]

Even if an overall cost advantage were to be conceded to cane-sugar, this did not apply to the German beet-sugar industry before 1914. Admittedly, before their abolition under the Brussels Convention of 1902, bounties were paid on German beet-sugar exports and at the same time the home market was protected by a tariff. However, it would appear that the main purpose of both of these measures was to protect the German industry from the bounty-fed exports of other beet-sugar producers, especially against those of France. In 1891/92, for example, the average costs of production of raw sugar in Germany were estimated at 207.9 marks per tonne, as compared with 228.1 marks in France. The German bounty, at 18.7 marks, amounted to 9 per cent of the estimated average costs of production and an even smaller proportion with the inclusion of freight costs. The French bounty of 52.2 marks was the equivalent of 22.9 per cent of average costs of production and more than offset Germany's cost advantage. Nevertheless, and despite a reduction of the

[40] G. Hanssen, 'Die Entstehung und Fortentwicklung der Rübenzucker-Fabrikation und insbesondere die Concurrenz zwischen Rohr- und Rübenzucker', *Archiv der politischen Oekonomie und Polizeiwissenschaft*, New Series, Vol. X, 1852, p. 95; J.W. Root, *The British West Indies Sugar Industry*, (Liverpool, 1899), p. 50.

[41] R.W. Beachey, *The British West Indies Sugar Industry in the Late 19th Century*, (Oxford, 1957), pp. 143–4; Root, *op. cit.*, pp. 50–1, 93; Martineau, *op. cit.*, p. 323; Ebeling, *op. cit.*, p. 74.

German bounty from 1892, beet-sugar exports from that country continued to expand relative to those of France: to a peak in 1897 when they accounted for 25.30 per cent of world sugar exports.[42]

The relative efficiency of beet-sugar production in Germany is indicated by the export experience of the industry after 1902, when the bounty-system was finally abolished. Admittedly, exports declined from their earlier peak in 1897. From an annual average of 21.01 per cent of world exports between 1898 and 1902, Germany's share declined to 16.46 per cent between 1903 and 1907, and to 13.09 per cent between 1908 and 1913 (omitting the year 1912 when exports slumped in the wake of the disastrous drought of 1911). However, a considerable portion of the decline was attributable to factors other than the abolition of the bounties. In the first place, the export boom of the 1890s had been to a large extent the result of the disruption of Cuban cane-sugar exports by the Spanish-American War and its aftermath. At the time a considerable portion of German sugar exports had been shipped to the North American market. Subsequently, the recovery of the Cuban sugar industry — provided with preferential access to the large U.S. market — inevitably confined German exports to the European market and in particular to Britain.[43]

Secondly, the growth of German exports from the late 1890s was constrained by the slowing down of the rate of growth (if not virtual stagnation) of per capita sugar consumption and by the falling rate of population growth in Britain — the dominant sugar market in Europe. Thirdly, with the reduction of German sugar duties under the terms of the Brussels Convention, the lower price of sugar on the domestic market occasioned a marked in-

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[42] R. ZIMMERMANN, *Der Zucker im Welthandel*, (Berlin, 1895), p. 49.

[43] FAO Commodity Reference Series, *op. cit.*, *passim*; J. WOLF, 'Die Eroberung Kubas durch die Vereinigten Staaten und die Zukunft der europäischen Zuckerindustrie', *Zeitschrift für Sozialwissenschaft*, Vol. II, 1899, pp. 102-7.

crease in per capita consumption: the effects of which were enhanced by the rate of growth of German population reaching its historical peak during the 1900s. Nevertheless, the decline of German sugar exports was not pronounced in absolute terms: from an annual average in terms of raw value of 1.063.6 million tonnes between 1898 and 1902, to 991.7 between 1903 and 1907, and to 945.3 between 1908 and 1913 (excluding 1912). Moreover, contrary to the expectations of the British refining industry, the proportion of refined sugar in total German exports actually increased after the Brussels Convention: from an annual average of 52.04 per cent in terms of raw value between 1898 and 1902 to 57.75 per cent from 1903 to 1913.[44]

Germany's position as a major sugar exporter by the later XIXth century was overwhelmingly a product of the outstanding technological progress and productivity growth in its beet-sugar industry from the 1840s. Between 1836/37 and 1899/1900 the raw-sugar yield of beet increased from an average of 5.55 per cent to 14.25 per cent. By 1913/14 the German yield of beet per hectare was 113 per cent of that of France and 124 per cent of that of Austria-Hungary as her closest rivals. In the period 1895/96 to 1905/06 the German average raw sugar yield per hectare was 130 per cent of the French and 131 per cent of the Austro-Hungarian.[45] This pronounced superiority of the German beet-sugar industry which emerged from as early as the 1850s, and enabled its product to compete effectively with cane-sugar on the world market, was primarily attributable to the stimulus that the raw-material tax provided to the 1890s. At the same time, the "spin-off" effects upon other activities stemming

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[44] FAO, Commodity Reference Series, *op. cit.*, *passim*; T. Zeller, *Der Kampf zwischeu Rohr- und Rübenzucker*, (Tagesfragen der Auslandswirtschaft, No. 14, Leipzig, 1920), p. 22; H. Birschel, *Die Bedeutung der Brüsseler Zucker-Konvention für Deutschland*, (Berlin, 1909), pp. 54-7.

[45] *De Deutsche Zuckerindustrie*, (*Berichte über Landwirtschaft*, New Series, Supplement 18, Berlin, 1931), p. 15; Schuchart, *op. cit.*, 0. 366; *Report on the Sugar Beet Industry at Home and Abroad*, *op. cit.*, p. 26.

from the development of the beet-sugar industry more than offset the element of subsidy for beet-sugar production that the form of taxation created.

IV

Beet-sugar production commenced as a large-scale or *Grossindustrie* in Germany at a time, in the 1830s, when the overwhelmingly majority of industrial production was organized in the handicraft form in small workshops. As such it provided a model of the factory form of production for subsequent emulation in other areas, with its effectiveness in this respect being enhanced by the punctiform location of sugarmills.[46] Thereafter, the development of the beet-sugar industry continued to be unparalleled by any other German industry in terms of productivity growth, technological change and increases in the scale of production. Between 1836/37 and 1899/1900 the average volume of beet processed per mill increased from 208 to 31,905 tonnes and average raw-sugar output expanded from 11.5 to 4,433 tonnes. In 1836 the largest mill processed about 1,400 tonnes of beet. By the 1900s there were a number in existence with capacities in excess of 80,000 tonnes. From a position of technological backwardness in the 1830s in comparison with the French industry, German beet-sugar manufacture by the early 1850s was sufficiently advanced for one observer to comment that 'it is difficult to think of an area of production in which a significant cost reduction or improvement could occur; for it cannot be denied that the industry has already achieved a high level of technical perfection'.[47]

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[46] Baxa & Bruhms, *op. cit.*, p. 165; Schuchart, *op. cit.*, p. 144; E. Neuss, *Die Entwicklung des halleschen Wirtschaftsleben vom Ausgang des 18. Jahrhunderts bis zum Weltkrieg*, (Halberstadt, 1924), p. 91.

[47] Helferich, *op. cit.*, p. 92.

The beet-sugar industry was one of the earliest and most extensive employers of steampower in Germany. Whereas the sugarmills of the 1830 s had relied exclusively upon waterpower or teams of oxen, by 1845 nearly two-thirds of those operating in the Prussian province of Saxony employed steampower. Even as late as 1877 some 13 per cent of all fixed steam-engines in Germany were employed in sugarmills and distilleries, as compared with 11.54 per cent in textiles, 5.50 per cent in machine-tools and 17 per cent in the iron and steel industry. The beet-sugar industry was particularly outstanding in respect of the size of the steam engines it employed. In 1877 the average size of boiler in the industry, at 63.85 square metres, was 35 per cent larger than that of the iron and steel industry and more than double the average in the machine-tool industry. The total boiler capacity in sugarmilling was two-and-a-half times that in machine-tools in 1877 and, together with distilling, it was equivalent to that employed in coalmining and coke-ovens combined.[48]

As a substantial source of demand for steam-engines that were almost entirely locally produced even in the 1840s, the beet-sugar industry played an important role in the initial and later development of the German engineering industry. In its utilization of the products of the latter industry for a form of chemicals manufacture, the beet-sugar industry played a pioneering role in the emergence of a specialist chemical-engineering industry and in the development of educational facilities for the training of industrial chemists during the second half of the XIX century. From their initial establishment to meet the requirements of sugarmilling, firms in the chemical-engineering industry employed the expertise acquired in this area to produce equipment for the manufacture of other chemicals. Subsequently, in the later XIX century, there was a move towards specialisation in the chemical-engineering industry, with firms producing sugar-

[48] Schuchart, *op. cit.*, p. 79n.

milling equipment gaining access to export markets that included the more progressive of the cane-sugar producers.[49]

Another branch of engineering that owed much of its XIXth-century development to the stimulus imparted by the growth of beet-sugar manufacture was agricultural engineering. The use of the seed-drill — the most complex of XIXth-century agricultural machines — and the related implement the horsehoe, was initiated in Germany to meet the requirements of row cultivation in sugar-beet growing. The heavy demand for labour on sugar-beet holdings during the autumn and winter months, for the purposes of harvesting and processing beet during what was the slack season in agriculture generally, awakened an early interest in the substitution of the threshing-machine for the handflail that had traditionally provided employment during that period of the year. The necessity in sugar-beet cultivation to shallow-plough stubbles immediately after the corn harvest and then, later in autumn, to plough the land to depths approximately double those required for other crops, largely accounts for improvements in the range, design and manufacture of ploughs. In particular, deep ploughing for sugar beet occasioned the adoption of the steamplough from the 1860s. Finally, the perfect tilth required in the seedbed for spring-sown beet revolutionized the form, range and quality of harrows, rollers and scarifiers employed in German farming.[50]

Initially, in the 1840s and for much of the 1850s, the demand for improved agricultural machinery emerging with the expan-

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[49] *Ibid.*, p. 80; G. AUBIN, *Entwicklung und Bedeutung der mitteldeutschen Industrie*, (Halberstaft, 1924), p. 17.

[50] A.F. KIEHL, *Sechzigjährige Erlebnisse und Erfahrungen eines alten Rübenbauers*, (2nd edn., Berlin, 1918), pp. 1, 85; G. SCHACK-SÉMMER, *Home-Grown Sugar*, (London, 1890), p. 17; 'Carlyn', *Sugar Beet: Hints on Cultivation*, (np., nd.,) pp. 24-6; R. BERTHOLD, 'Die Entwicklung der deutschen Landwirtschaft von den Agrarreformen bis zum Ausbruch der allgemeinen Krise des Kapitalismus' in V. KLEMM (ed.), *Von den bürgerlichen Agrarreformen zur sozialistischen Landwirtschaft in der DDR*, (Berlin, 1977), p. 38. See also J.A. PERKINS, 'The Agricultural Revolution in Germany, 1850-1914', *Journal of European Economic History*, Vol. X, n. 1, 1981, pp. 71-118.

sion of sugar-beet cultivation was met by imports from Britain. Many examples of these were tested by the Magdeburg Society for Exhibiting Agricultural Machines and Implements, which was the first of its kind to be established in Germany (in 1840) and was located in the district with the greatest concentration of sugar-beet cultivation. During the 1850s German workshops engaged in the repair of British equipment began to produce local examples, many of which incorporated improvements on the original construction. The first German steampowered threshing-machine was built at Magdeburg in 1858 and the first steamplough at nearby Wegeleben in 1861. During the 1860s the size and rate of growth of the German market attracted some British companies to establish manufacturing subsidiaries in the sugar-beet districts, as in the case of Garretts at Breslau in Silesia and Fowlers at Magdeburg. Similarly, in the same decade, the numerous indigenous firms that made the transition from workshop to factory production were overwhelmingly concentrated in Breslau, in the towns of Prussian Saxony and in the nearby city of Leipzig.[51]

Lignite mining in central Germany is another activity that owed much of its development as a large-scale industry, especially during the crucial early phase of growth in the middle decades of the century, to the stimulus emanating from the beet-sugar industry. Admittedly, the extensive lignite deposits of that region were exploited long before the XIXth century to provide fuel for households and for the salt manufactories in the Halle district. However, to the 1840s output was limited and, as a consequence of the dispersed market, the mines were operated by small-scale enterprises employing primitive techniques of extraction. The household market for lignite was adversely

[51] G. Fischer, 'Die Entwicklingsbedingungen des landwirtschaftlichen Maschinenwesens und seine Bedeutung für die Landwirtschaft' in *Die Entwicklung des landwirtschaftlichen Maschinenwesens in Deutschland*, (Arbeiten der Deutschen Landwirtschafts-Gesellschaft, No. 177, Bonn, 1910), pp. 6–8, 10; A. Zander, *Die wirtschaftliche Entwicklung der Provinz Sachsen im 19. Jahrhundert* (Dissertation: University of Halle, 1934), pp. 108–11.

affected during the middle decades of the century by the spread of railways, which enabled west German and Silesian pitcoal to meet the fuel requirements of urban centres in central Germany. Pitcoal per unit of weight possessed approximately three times the heating value of lignite and the rail freight costs of the latter for 70 to 75 kilometres were equivalent to the cost of production. In this situation the punctiform dispersal and extensive fuel requirements of sugarmills provided the first large-scale market for central German lignite. In the season 1860/61, for example, an estimated 330 to 440 kilos of lignite were required to process one tonne of beet and in that year the average mill processed 5,992 tonnes of beet. The manufacture of such a volume of beet into sugar would have required between 98,868 and 131,824 tonnes of lignite.[52]

In the early 1860s sugarmilling absorbed between 30 and 75 per cent of the output of the various lignite fields in central Germany and was by far the largest single industrial consumer. Of the non-household output of the Halle field in 1860, for example, 60 per cent went to sugarmills, 22 per cent to brickkilns, 11 per cent to saltworks and 6 per cent to distilleries. Subsequently, the relative importance of sugarmilling as a source of demand for lignite declined, in response to the achievement of substantial fuel economies in sugar manufacture and as the lignite industry itself became the basis for other industries emerging in central Germany.[53] As the economic historian Gustav Aubin put it: 'The sugar industry raised the lignite industry and guided it to the point at which it found other opportunities for the utilization of its product, and thereby located the focus of its development within itself'.[54] Such opportunities included the ma-

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[52] F. Schotte, *Die Produktionsgrundlagen der Provinz Sachsen*, (Dissertation: University of Halle, 1943), pp. 87-8; Zander, *op. cit.*, p. 15; Neuss, *op. cit.*, pp. 69-70; F. Voigt, *Die Entwicklung und der Stand der anhaltischen Industrie*, (Halle, 1933), p. 12.

[53] Zander, *op. cit.*, pp. 65, 96; Schuchart, *op. cit.*, p. 78.

[54] Aubin, *op. cit.*, p. 17.

nufacture of paraffin, a widening market for household fuel with the adoption of presses to produce briquettes with a low moisture content and the growing requirements of electric power generation. However, perhaps the most significant new source of demand to emerge was the heavy chemical industry of central Germany, which in turn was closely linked to the development of the beet-sugar industry.

The initial basis for the development of the heavy chemicals industry in central Germany was the potash deposits of the Stassfurt area. Until the 1860s these were regarded as a waste-product of saltmining operations. Then, early in that decade, local sugar-beet growers began experimenting with the potash as an artificial fertilizer, which attracted the attention of chemists and entrepreneurs to the material. Subsequently, after an initial period in which the majority of potash production was utilized for non-agricultural purposes, the proportion absorbed in the manufacture of artificial fertilizer increased steadily from 42.5 per cent in 1880 to 89.3 per cent in 1910. A considerable portion of the latter was employed for the cultivation of sugar beet in areas outside central Germany, where the natural potash content of soils was low. In addition, Germany's virtual monopoly of potash production before 1914 formed the basis for an extensive export market.[55]

Apart from potash an important linkage existed between the beet-sugar industry and the development of nitrogenous and phosphatic sources of artificial fertilizers. Sugar beet was the first crop in German agriculture to be systematically dressed with artificial fertilizers and the rates of application per hectare remained substantially higher than for other crops. To a considetable extent knowledge of the efficacy of various types and combinations of artificial fertilizers originated with experimentation connected with sugar-beet growing. Given the necessity under

[55] ZANDER, *op. cit.*, pp. 99-100; VOIGT, *op. cit.*, p. 34; K. VAN DELHAES-GUENTHER, *Der Kali in Deutschland*, (Cologne, 1974), pp. 46, 57, 68.

the raw material tax to maximize the sugar content of beet, sugarmillers were vitally interested in analayses of the impact of fertilizers upon the sugar-forming properties of beet. At the same time, the potential profits of the industry attracted the attention of landowners, farmers and others to the possibilities of extending the range of soils adapted to the crop by means of artificial fertilizer inputs.[56]

Overall, the emergence and rapid growth of the beet-sugar industry from the 1830s onwards contributed more than any other factor to the modernization of German farming. It stimulated the enclosure of open fields and commons for the cultivatory requirements of beet to be met. It was responsible for the initial adoption of rotational farming, which involved an integrated succession of crops, in place of traditional crop sequences designed simply to maximize the recurrence of grain crops. It was the first crop in Germany to which scientific methods of plantbreeding were applied, and the host of pests to which it was subject played a major role in the application of science to plant protection. The yields of crops succeeding sugar beet in rotations increased notably and the fluctuations in such yields diminished considerably. With the expansion of sugar-beet cultivation the practice of bare-fallowing, or the leaving of land free of crops for a period to restore fertility and enable weed infestation to be controlled, diminished considerably in German agriculture. Finally, the by-products of beet cultivation — the tops and the pulp returned from the sugarmills that yielded the equivalent in fodder per hectare of clover — formed the basis of an extensive and economically viable livestock husbandry.[57]

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[56] AMROGOWICZ, *op. cit.*, pp. 78-9; LILIENTHAL, *op. cit.*, p. 94; SCHUCHART, *op. cit.*, pp. 210-3; W. CROOKES, *On the Manufacture of Beet-Sugar in England and Wales*, (London, 1870), pp. 29-30; O. SCHMIDT, *Die Entwicklung der Landwirtschaft der Stadt Aschersleben im 19. Jahrhundert unter dem Einfluss des Samenbaues*, (Halle, 1910); HUMBERT, *op. cit.*, pp. 75-6, 76n.

[57] For a more detailed analysis of the role of the beet-sugar industry in agricultural development see Perkins, *op. cit.*

V

Lack of space precludes a fully comprehensive analysis of the impact on the German economy of the development of the beet-sugar industry from the 1830s. Its influence on the export sector and terms of trade, for example, would merit detailed examination. Nevertheless, on the putatively negative side one aspect that cannot be neglected is the influence of fiscal policy on the domestic consumption of sugar. As a critic of the industry observed: 'the interests of the sugar industrialists rather than the food requirements of the people were decisive in the development of the sugar industry'.[58] This judgement might be extended to include agriculturalists and the state among the decisive interests in the determination of sugar taxation policy. Otherwise, it is substantially correct that the interests of consumers were relatively neglected and the growth of sugar consumption was restricted by the duty. In 1913, for example, per capita sugar consumption in Germany was approximately half that in Britain. Nevertheless, the margin between the two countries was not entirely, and perhaps not even substantially, a result of the duty levied on sugar in Germany. Here it is notable that in the earlier XIXth-century, when sugar was heavily taxed in both countries, German per capita consumption was an even smaller proportion of British than later. In 1843, for example, the figure was 17 lbs. per head of population in Britain und under 6 lbs. in the *Zollverein*, whereas by 1913 the levels were 41.9 and 21.3 kilos respectively.[59]

Amongst the non-fiscal factors contributing to the lower level of per capita sugar consumption in Germany as compared with Britain were, firstly, the lower level of per capita income in the former country that persisted up to the First World War.

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[58] E. Wurm, 'Die deutsche Zuckerindustrie und die Volksernährung', *Neue Zeit*, Vol. XXXIII, 1915, p. 87.

[59] FAO, Commodity Reference Series, *op. cit.*, pp. 111-2; British Parliamentary Papers, 1842, VI, 305.

The price and income elasticity of sugar were exceptionally high throughout the 19th century: in excess of one and in fact higher than for any other food item between 1850 and 1914.[60] Secondly, the margin between the two countries reflected the comparatively delayed onset of the XIXth-century process of urbanization in Germany and the lower proportion of urban dwellers in the decades before 1914. In that era per capita sugar consumption was appreciably higher in urban than in rural areas. In 1843, for example, the average urban dweller in the *Zollverein* consumed 27 per cent more sugar than his rural counterpart. In part this reflected the higher level of average incomes in urban areas. However, it was also to a considerable extent a product of differences in diet and the relative lack of acquaintance of the rural masses with the commodity sugar. It was mainly for the latter reason that the German sugar industry campaigned in the 1890s to have sugar included in the army diet in order to accustom rural recruits to the product.[61] Finally, the margin between per capita sugar consumption in Britain and Germany reflected general dietary differences between the two countries.

The rapid increase of sugar consumption in XIXth-century Britain was closely associated with that of tea. In Germany, on the other hand, coffee was the preferred drink — taken without or with at most a small sugar additive — although the relatively high price restricted the growth of consemption. Instead, beer and wine continued to be widely drunk in place of infusion beverages. In addition, the open sandwich (*Butterbrot*), eaten with processed meats took the place in Germany of the British sandwich spread with jam containing a large proportion of sugar, which became increasingly popular from the 1870s onwards. Admittedly, the growth of the British jam and confectionery

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[60] W.G. Hoffman, *Das Wachstum der deutschen Wirschaft seit der Mitte des 19. Jahrhunderts*, (Berlin, 1965), pp. 120-1, 135; N. Kaumanns, *Die volkswirtschaftliche Bedeutung des Rübenzuckers für Deutschland*, (Berlin, 1904), p. 16.

[61] Baxa & Bruhms, *op. cit.*, p. 203.

industries was greatly assisted by the cheap bounty-fed sugar exports of Continental Europe. However, it is doubtful whether the absence of the tax on sugar would have brought about a radical change in the German dietary towards a marked increase of sugar consumption. An analogy here is the failure of Germans to take advantage of the cheap mutton that became available from the 1880s onwards, with refrigerated and later chilled shipments from the Antipodes. This illustrates the points that while price influences the consumption of a commodity, it requires more than a fall of price to initiate a substantial change in the dietary pattern of a country.

After subtracting other influences than taxes on per capita sugar consumption in Germany, the remaining negative effect of fiscal policy on consumption has to be set against the benefits that Germany derived from the XIXth-century emergence and growth of its beet-sugar industry. The proposition advanced here has been that the latter considerably outweighed the former in importance, although it is not intended to press the point quite as far as Werner Sombart when he stated that: ' It has been rightly emphasized that the sugar and distilling industries have been the sectors on which Germany developed as a capitalist great power: in the same manner in which the cotton and iron industries have laid the basis of England's greatness '.[62]

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[62] W. SOMBART, *Der moderne Kapitalismus, Vol. II, Die Theorie der Kapitalistischen Entwicklung*, (Leipzig, 1902), p. 14.