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The revealed comparative advantages of late-Victorian Britain

Brian Varian
London School of Economics

Economic History Department, London School of Economics and Political Science, Houghton Street, London, WC2A 2AE, London, UK. T: +44 (0) 20 7955 7084. F: +44 (0) 20 7955 7730

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Brian Varian
London School of Economics
b.varian@lse.ac.uk

Abstract

This paper calculates indicators of revealed comparative advantage (RCA) and revealed symmetric comparative advantage (RSCA) for 17 British manufacturing industries for the years 1880, 1890, and 1900. The resulting indicators show that the late-Victorian 'workshop of the world' was at a marked comparative disadvantage in a number of manufacturing industries. The paper then proceeds to identify the factor determinants of Britain's manufacturing comparative advantages (disadvantages) using a four-factor Heckscher-Ohlin model that relies upon these indicators. In contrast with previous scholarship, the manufacturing comparative advantages of late-Victorian Britain were in the relatively labour non-intensive industries, and this pattern became more pronounced throughout the period. The paper concludes with the observation that the factor determinants of Britain's manufacturing comparative advantages appear closer to those of the United States than had traditionally been thought.

Keywords: comparative advantage, Heckscher-Ohlin, manufacturing, Britain, nineteenth century

JEL codes: F11, F14, N63, N73

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Introduction

Despite the voluminous literature on British trade during the nineteenth century, there are no systematic calculations of Britain's comparative advantages for any year prior to 1899, which were undertaken by Crafts (1989). Until now, economic historians have generally settled for the casual understanding that, according to Harley (2014), 'the industries of the Industrial Revolution retained their comparative advantage until the First World War'.[1] Indeed, the staple industries of textiles and iron continued to dominate the composition of British exports through the late-Victorian era.[2] However, it remains uncertain whether Britain realized comparative advantages in the many other industries that characterized its manufacturing sector and, increasingly, the manufacturing sectors (and exports) of other industrial countries. Accordingly, this paper contributes to the existing literature by calculating indicators of revealed comparative advantage (RCA) and revealed symmetric comparative advantage (RSCA) for 17 British manufacturing industries for the years 1880, 1890, and, 1900.

These indicators are then extended into the debate over the factor determinants of Britain's manufacturing comparative advantages. The RSCA indicators serve as the dependent variable in, initially, a three-factor Heckscher-Ohlin (H-O) model of trade. Here, the novel finding is that Britain's comparative advantages were in the relatively labour non-intensive manufacturing industries during the late-Victorian era. This finding is inconsistent with that of Crafts and Thomas (1986), who estimated the factor determinants of just (non-normalized) British exports for the year 1880.[3] Even after controlling for human capital using a four-factor H-O model, it remains that the comparative advantages of late-Victorian Britain were in the relatively labour non-intensive manufacturing industries.

Why is a factor-based explanation for the manufacturing comparative advantages of late-Victorian Britain a particularly deserving item on the agenda of economic history? Broadberry (1997) attributed the comparative *labour productivity* levels of late nineteenth-century British manufacturing industries partly to relative factor endowments. One of the several patterns that emerged was that Britain tended to realize its highest comparative labour productivity levels (vis-à-vis the United States and Germany) in those manufacturing industries that used intensively Britain's relatively abundant supply of human capital.[4] Drawing upon a spectacular range of secondary sources, Broadberry explained the relative

[1] Harley, 'Early start', p. 6.

[2] The staple industries of textiles and iron accounted for fully 66% of British manufactured exports in 1902-4. Schlote, *British overseas trade,* p. 74.

[3] Crafts and Thomas, 'UK manufacturing trade', p. 637.

[4] Broadberry, *Productivity race*, p. 158.

performance of various manufacturing industries during the period from 1850-1914. These analyses were, nevertheless, constrained by the unavailability of estimates of comparative manufacturing labour productivity disaggregated by industry for any year prior to 1907.[5] The unavailability of estimates was due to the deficiency of output data. Here, there emerges an opportunity for this paper. The trade statistics of industrial countries contain data sufficient for calculating RCA indicators of British manufacturing industries for the period before 1907. Of course, comparative advantage is not the same as comparative labour productivity, and this paper avoids any conflation of these concepts. Still, measurements of comparative advantage can provide some indication of the relative performance of British manufacturing industries during the late-Victorian era. Moreover, systematic measurements of comparative advantage facilitate the identification of the factor determinants thereof, via the H-O model.

This paper proceeds as follows. The first section presents a review of the literature. The next section calculates RCA and RSCA indicators. The following section employs the RSCA indicators in three-factor and four-factor H-O models of trade, with the aim of identifying the factor determinants of Britain's manufacturing comparative advantages. The final section of this paper offers some concluding remarks.

Literature review

Under the H-O model of trade, a country exports those commodities which use intensively its relatively abundant factors of production.[6] Thus, relative factor endowments determine the comparative advantages of a country.[7] This model was used by Crafts and Thomas (1986), who estimated the factor determinants of Britain's manufacturing comparative advantages in selected years from 1910-35, by which time there were regular censuses of production from which factor intensities could be calculated. The authors employed a three-factor Heckscher-Ohlin model, with the factors being capital, human capital, and (unskilled) labour. Throughout the period from 1910-35, Britain realized comparative advantages in the relatively human capital non-intensive and in the relatively labour-intensive manufacturing industries, and these comparative advantages were unaffected by capital intensity.[8] The authors then applied the model to late-Victorian Britain, albeit using cruder data from the

[5] For the construction of these estimates, see Broadberry and Fremdling, 'British and German industry' and Broadberry, 'British and American manufacturing'.

[6] Ohlin, *International trade*.

[7] The H-O model departs from the earlier Ricardian model, which identifies technological differences between countries as the determinant of comparative advantage. Nevertheless, both models offer explanations for the occurrence of comparative advantages.

[8] Crafts and Thomas, 'UK manufacturing trade', p. 636.

Factory inspectorate returns of 1870, and found similar results, except that capital was a statistically significant and positive determinant of Britain's manufacturing comparative advantages during this earlier period.[9]

Crafts and Thomas used the phrase 'comparative advantage' loosely. For the period from 1910-35, they estimated the factor determinants of British gross and net exports. For the late-Victorian era, they estimated the factor determinants of just British gross exports in the year 1880, using factor proportions inferred from 1870 data. The problem here is that the value of gross exports alone does not indicate the presence of a comparative advantage. Consider silk manufactures and cement. In 1900, the value of British silk exports was more than double the value of British cement exports, yet Britain realized a comparative disadvantage in the former industry and a comparative advantage in the latter industry.[10] This paper improves upon Crafts and Thomas by normalizing exports for the composition of world exports, i.e. by calculating indicators of comparative advantage.

Crafts (1989) did, in fact, calculate RCA indicators for British manufacturing industries, along with the manufacturing industries of 10 other mostly industrial countries, for the years 1899, 1913, 1929, 1937, and 1950. In doing so, he employed the method advanced by Balassa (1965), which is discussed fully in the next section of this paper. For the year 1899, Crafts observed that Britain's comparative advantages were greatest in the more mature industries of shipbuilding, iron, and textiles, rather than in the industries of the Second Industrial Revolution, which exhibited greater scope for new technology by the closing decades of the nineteenth century.[11] However, no factor-based explanation for the pattern of Britain's manufacturing comparative advantages was offered.

Crafts and Thomas's portrait of manufacturing in late-Victorian Britain as intensive in labour and non-intensive in human capital was the opposite of what Harley (1974) argued was true of manufacturing in (slightly later) Edwardian Britain. He argued that Britain was relatively abundant in skilled labour and that the United States, given its influx of migrants from southern and eastern Europe, was relatively abundant in unskilled labour.[12] The work of Harley is not, however, entirely comparable to the work of Crafts and Thomas. Harley was concerned mostly with intra-industry differences between British and American manufacturing, specifically within the industries of shipbuilding, textiles, engineering, and

[9] Ibid., p. 637.
[10] *Annual statement* (1900). The RCA indicators for these industries are reported in table 1.
[11] Crafts, 'Revealed comparative advantage', p. 130.
[12] Harley, 'Edwardian industry', pp. 394-5.

iron and steel. In contrast, Crafts and Thomas were concerned with the pattern of specialization among industries.

Measuring comparative advantage

Balassa (1965) was interested in identifying the comparative advantages of industrial countries, not during the late nineteenth century, but rather during the period of trade liberalization that followed the Second World War. For Balassa to have determined comparative advantages directly would have required an enormous amount of systematically collected data on production costs for every industry-country pair. Instead, Balassa endeavoured to determine comparative advantages indirectly, based upon the pattern of world trade. Assuming that countries actually traded according to their comparative advantages, Balassa then argued that the pattern of world trade 'revealed' the comparative advantages of countries.[13]

Balassa's method for calculating an indicator of RCA is expressed as follows:

$$\mathrm{RCA}_{c,i} = \frac{X_{c,i}}{X_{n,i}} \Big/ \frac{X_c}{X_n} \qquad (1)$$

Here, *X* refers to the current value of exports, *i* to the manufactured commodity, *c* to the industrial country, and *n* to the whole basket of industrial countries. The RCA indicator is therefore the country-share of world exports of the manufactured commodity normalized for the country-share of world exports of total manufactured commodities. An indicator greater than 1 implies a comparative advantage, an indicator less than 1 a comparative disadvantage. Specialization according to comparative advantage would, theoretically, cause a country's RCA indicators to cluster around X_n/X_c ('complete' comparative advantage) and 0 ('complete' comparative disadvantage).[14] However, empirically, indicators fall anywhere between these two values, oftentimes quite close to the threshold value. One reason is that the manufactured commodity, as defined, encompasses enough heterogeneity such that a country may realize a comparative advantage in one variety of the commodity, but a comparative disadvantage in another variety of the commodity. This situation is especially likely when the RCA indicators are calculated at higher levels of aggregation, such as the industry level, as is done by Crafts and by the present author. Another reason is that transport costs and preferential tariffs, which distort the pattern of trade, are internalized in the RCA indicator.

[13] Balassa, 'Trade liberalisation', p. 103.

[14] In the case of complete comparative advantage, the indicator of RCA may be less than X_n/X_c, if country *c* completely satisfies world demand.

This last reason was addressed by Costinot et al. (2012), who sought to correct for such distortions in identifying comparative advantage. The main specification of their model takes the form of a country-pair panel regression, in which the log of pairwise relative productivity in an industry predicts the log of bilateral exports in that industry.[15] An exporter-importer fixed effect accounts for trade costs, such as transport costs and preferential tariffs, among others.[16] The approach undertaken by Costinot et al. could be employed to identify Britain's comparative advantages, vis-à-vis each of her trading partners, for the late nineteenth century, provided bilateral trade data disaggregated by industry actually existed for the years 1880, 1890, and 1900, which is not the case. Furthermore, employing the approach of Costinot et al. would involve the precarious assumption that the elasticity of bilateral exports to pairwise relative productivity was the same in the late nineteenth century as in the late twentieth century.

This paper therefore settles on Balassa's method for identifying comparative advantages. RCA indicators are calculated for 17 British manufacturing industries for the years 1880, 1890, and 1900. The industries—Balassa's method involved individual manufactured commodities—are beer; cement; chemicals; clocks and watches; copper manufactures; cotton manufactures; earthenware and chinaware; flax, hemp, and jute manufactures; glass; iron, steel, and manufactures thereof; leather and manufactures thereof; machinery; paper and manufactures thereof; rubber manufactures; silk manufactures; spirits; and woollen and worsted manufactures. These 17 industries differ noticeably from the 16 industries for which Crafts (1989) calculated RCA indicators. Crafts' industries were largely predetermined in the sense that he relied solely on Tyszynski (1951), rather than on the underlying government trade statistics, for data on manufactured exports. Crafts' industries are suitable for the period he considered, which was the early twentieth century. However, several of these industries are obviously unsuitable for the late nineteenth century, such as the electrical industry and the cars and aircraft industry. The textile industry also presents a problem. In 1899, textiles comprised 34 per cent of world manufactured exports and 46 per cent of British manufactured exports.[17] Earlier in the nineteenth century, the share of textiles in British manufactured exports was even higher, at 61 per cent in 1882-4.[18] Concentrating half of British manufactured exports and a third of world manufactured exports into a single

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[15] Costinot et al., 'Ricardo's ideas', p. 595.
[16] Ibid., p. 602.
[17] Tyszynski, 'Manufactured commodities', p. 277.
[18] Schlote, *British overseas trade*, p. 74.

industry obscures the actual comparative advantages held by countries, which differed based upon the particular class of textile. Therefore, for the purpose of calculating RCA indicators for the late nineteenth century, textiles are divided into four classes: cotton manufactures; flax, hemp, and jute manufactures; silk manufactures; and woollen and worsted manufactures. In general, the 17 industries included in this study mirror the industry classifications in the *Annual statement of overseas trade*, which is the source for data on the value of British manufactured exports.

Having obtained data on British manufactured exports per industry, the next step in calculating the indicators is to gather data on world manufactured exports per industry. This latter value is initially approximated by the manufactured exports, per industry, of Britain, Belgium, France, Germany, and the United States combined, as recorded in their respective trade statistics.[19] This step is immensely challenging due to the varying classifications of industries in the trade statistics of the different countries. Using British and American trade statistics, Crafts and Thomas (1986) matched British and American industries, in order to compare the factor determinants of British and American exports for a single benchmark year. They referred to this process as a ‘problematic and protracted exercise’.[20] When the trade statistics of five countries are involved, the process of matching industries is considerably more problematic and protracted. For example, the British trade statistics keep leather and manufactures thereof separate from saddlery and harnesses, whereas the trade statistics of other countries do not. Such inconsistencies are, however, generally reconcilable, since the finest levels of disaggregation in the trade statistics usually permit the ‘reconstruction’ of industries. Where inconsistencies are ultimately irreconcilable, such inconsistencies are minor and do not materially alter the resulting RCA indicators. In order to add together the values of the manufactured exports, per industry, of the five industrial countries, these values are converted to sterling using the exchange rates reported in Mitchell (1988).[21]

[19] The trade statistics are: *Annual statement of the trade of the United Kingdom*, *Annuaire statistique de la Belgique*, *Tableau du commerce extérieur de la France*, *Statistisches jahrbuch für das Deutsche reich*, and *Foreign commerce and navigation of the United States*. The American data are for the years 1879/80, 1889/90, and 1899/1900, the fiscal year having spanned from 1 July to 30 June.

[20] Crafts and Thomas, ‘UK manufacturing trade’, p. 632.

[21] Mitchell, *Historical statistics*, p. 702. Because the Belgian franc traded at par with the French franc during the classical gold standard, Belgian francs are converted to sterling using the (French) franc-sterling exchange rate.

The manufactured exports of Britain, Belgium, France, Germany, and the United States accounted for most, though not all, manufactured exports in the late nineteenth century. In 1899, the manufactured exports of these five countries accounted for 87 per cent of the manufactured exports of the 11 countries considered by Tyszynski.[22] A coverage rate of 87 per cent would suggest a rescaling factor (γ) of 1.15 for the value of manufactured exports, per industry, of the five industrial countries ($X_{n,i}$). Balassa's original method, represented in Equation 1, is therefore modified to include a rescaling factor:

$$\mathrm{RCA}_{\mathrm{UK,i}} = \frac{X_{\mathrm{UK,i}}}{\gamma X_{\mathrm{n,i}}} \Big/ \frac{X_{\mathrm{UK}}}{X_{\mathrm{n}}} \qquad (2)$$

However, a constant rescaling factor for all industries wrongly implies that the industry-composition of manufactured exports was identical between the basket of five industrial countries and the basket of excluded countries. The excluded countries were in an earlier stage of industrialization, which was often characterized by light manufacturing, particularly textiles.[23] Consequently, the five industrial countries likely accounted for more than 87 per cent of the exports of heavy manufacturing industries and less than 87 per cent of the exports of light manufacturing industries. A slightly reduced rescaling factor of 1.1 is applied to the heavy manufacturing industries of cement; chemicals; copper manufactures; iron, steel, and manufactures thereof; and paper and manufactures thereof. A slightly more generous rescaling factor of 1.2 is applied to the remaining industries. Although the rescaling factors of 1.1 and 1.2 are based upon data from 1899, these rescaling factors are applied to the calculations for 1880, 1890, and 1900, since annual data on world manufactured exports pre-1899 is not available.

The next step is to normalize the British share of world manufactured exports per industry ($X_{UK,i}/\gamma X_{n,i}$) by, according to Balassa's method, the British share of world manufactured exports in total (X_{UK}/X_n). Normalizing by the country-share of only secondary-sector world exports provoked criticism from Vollrath (1991), who argued for the inclusion of the primary sector in determining comparative advantage.[24] Because the British share of secondary-sector world exports exceeded the British share of total world exports, the exclusion of the primary sector from the normalization factor reduces the levels of the RCA

[22] The 11 countries include the five abovementioned industrial countries, as well as Italy, Sweden, Switzerland, Canada, India, and Japan.

[23] See Hoffman, *Industrial economies* and Maizels, *Industrial growth*, pp. 339-40.

[24] Vollrath, 'Theoretical evaluation', p. 269.

indicators for British manufacturing industries.[25] Balassa's procedure for normalization, which was employed by Crafts, risks misidentifying a comparative advantage as a comparative disadvantage. Because the objective of this study is not to identify Britain's *intra-sector* industrial comparative advantages, but rather her *multi-sector* industrial comparative advantages, the normalization factor includes both the primary and secondary sectors. Of course, the choice of normalization factor only alters the levels of the indicators, not their rank order. Data on the value of total British exports for the years 1880, 1890, and 1900 come from the *Annual statement*. Data on total world exports for these years come from Lewis (1981).[26]

Table 1 presents the resulting RCA indicators for British manufacturing industries, with their ranks indicated in parentheses. Given the data assembled, calculating indicators of RCA for the manufacturing industries of the other four industrial countries is simple. Since these indicators may be of interest to future economic historians, corresponding tables for Belgium, France, Germany, and the United States are supplied in Appendix A.

As evident from the table, the RCA indicators for textiles differed greatly depending upon the particular class. By 1890, the industry of cotton manufactures held pride of place, not just among textiles, but among all British manufacturing industries. The industry of silk manufactures, on the other hand, was the only textile industry for which Britain realized a consistent comparative disadvantage. Other industries in which the 'workshop of the world' had a consistent comparative disadvantage were clocks and watches; glass; and leather and manufactures thereof. Of the 17 industries, the sharpest movements were in copper manufactures (downward) and spirits (upward).[27] Britain also advanced its comparative advantage in woollen and worsted manufactures considerably, even in spite of the heavy protection that this industry received in other industrial countries.[28]

There is a well-defined scholarly debate over the international competitiveness of the British engineering (machinery) industry in the late 1890s, when the American engineering

[25] In contrast, the American share of secondary-sector world exports (11%) was less than the American share of total world exports (14%) in 1900. Thus, excluding the primary sector from the normalization factor increases the levels of the RCA indicators for American manufacturing industries. In 1900, the primary sector contributed 68% of American exports. *Foreign commerce* (1900).

[26] Lewis, 'World trade', pp. 54-7.

[27] For some of the reasons behind these movements, readers are referred to Broadberry, *Productivity race*, pp. 174-5, 196-7.

[28] See especially Saul, *British overseas trade*, p. 151. While Britain's comparative advantage in woollen and worsted manufactures would not be affected by foreign protection *per se*, if such protection enabled foreign manufactures to become internationally competitive, as per the infant industry argument, then Britain's comparative advantage would be affected.

Table 1. *Britain, RCA indicators, 1880-1900*

Industry	1880	1890	1900
Beer	3.2 (5)	3.3 (3)	2.9 (3)
Cement	2.7 (7)	2.4 (8)	1.2 (12)
Chemicals, including dyestuffs, medicine, and paint	1.6 (11)	1.5 (11)	1.2 (11)
Clocks and watches	0.5 (15)	0.4 (17)	0.2 (17)
Copper manufactures	4.3 (1)	3.9 (2)	1.5 (10)
Cotton manufactures, including yarn	4.3 (2)	4.1 (1)	4.1 (1)
Earthenware and chinaware	2.4 (8)	2.4 (7)	1.8 (9)
Flax, hemp, and jute manufactures, including yarn and cordage	3.2 (4)	3.2 (5)	3.1 (2)
Glass	0.9 (13)	0.9 (14)	0.7 (15)
Iron, steel, and manufactures thereof, excluding machinery	3.6 (3)	3.3 (4)	2.6 (4)
Leather and manufactures thereof	0.8 (14)	0.9 (15)	0.9 (13)
Machinery, including steam engines and locomotives	3.0 (6)	2.8 (6)	2.2 (7)
Paper and manufactures thereof	1.0 (12)	1.0 (13)	0.8 (14)
Rubber manufactures	2.3 (9)	2.3 (9)	1.9 (8)
Silk manufactures	0.5 (16)	0.5 (16)	0.5 (16)
Spirits	0.5 (17)	1.2 (12)	2.3 (6)
Woollen and worsted manufactures, including yarn	1.9 (10)	2.1 (10)	2.5 (5)

Sources: See text.
Note: Rankings of indicators are noted in parentheses.

Table 2. *Spearman correlation coefficients of Britain's RCA indicators, 1880-1950*

	1890	1899/1900	1913	1929	1937
1880	0.95	0.66	--	--	--
1890	--	0.80	--	--	--
1899/1900	0.80	--	0.77	0.41	0.32
1913	--	0.77	--	0.76	0.70
1929	--	0.41	0.76	--	0.89
1937	--	0.32	0.70	0.89	--
1950	--	0.18	0.38	0.47	0.75

Sources: Coefficients for intervals spanning the years 1880, 1890, and 1900 are calculated using data from this paper. Coefficients for intervals spanning the years 1899, 1913, 1929, 1937, and 1950 are calculated using data from Crafts, 'Revealed comparative advantage', p. 130.

industry greatly increased its exports, especially its exports to Britain.[29] Nicholas (1980) argued that the rise in American machine exports to Britain resulted from a strong upswing in the British business cycle, which caused domestic demand to exceed domestic supply.[30] Irwin (2003), however, attributed the phenomenon to the increasing international competitiveness of American machinery, driven by the declining price of American iron ore.[31] Although the RCA indicator for the British machinery industry was slightly eroded between 1890 and 1900, the indicator for 1900 hardly suggests a lack of international competitiveness. Though, in fairness, the heightened level of American machine exports to Britain abated after 1899. If the indicator were calculated for a year between 1896 and 1899, it could be substantially lower.

In order to gauge the relative persistence of Britain's comparative advantages, Spearman correlation coefficients are calculated for various intervals, following the approach undertaken by Crafts. Table 2 presents coefficients for the intervals covered in this paper, as well as for the intervals covered by Crafts. Different industry classifications prohibit the calculation of coefficients for intervals that span the turn of the twentieth century. Persistence during the late-Victorian era was roughly on par with persistence during the early twentieth century. The correlation coefficient is slightly lower for 1880-1900 than for 1899-1913, but this should be expected given the greater length of the former interval. What can be claimed with some certainty is that Britain's comparative advantages underwent a more substantial reordering during the 1890s than during the 1880s, when the comparative advantages were

[29] Though, Clapham noted, 'Long before the 'nineties, exports of new American machinery, or of American mechanical notions, had affected the course and pace of industrial change in Britain' in *Modern Britain*, p. 36.

[30] Nicholas, 'Export invasion', p. 581.

[31] Irwin, 'America's surge', p. 369. In turn, Irwin attributed the declining price of American iron ore to the opening of the Mesabi Range in 1892.

remarkably persistent. By the 1890s, the protectionist backlash in Continental Europe had been underway for a decade, and the reshuffling of Britain's comparative advantages in the 1890s may have been influenced by Continental infant industries having attained international competitiveness.

Before proceeding to the next section, it is necessary to recognize a certain fundamental feature of the RCA indicators. With Balassa's measurement, the range for comparative disadvantage is between 0 and 1, while the range for comparative advantage is between 1 and the reciprocal of the country-share of world exports, which would be 6.8 for Britain in 1900. Such asymmetry is benign when the objective is to ascertain whether or not a country had a comparative advantage, or when the objective is to rank the RCA indicators. However, as Laursen observed, this asymmetry would tend to violate the assumption in regression analysis of normally distributed error terms, and it must therefore be corrected.[32] Laursen proposed the following transformation to symmetrize the indicators:

$$\text{RSCA} = \frac{\text{RCA}-1}{\text{RCA}+1} \qquad (3)$$

The next section relies on Laursen's RSCA indicators, not Balassa's RCA indicators, when estimating the factor determinants of Britain's comparative advantages.

Factor determinants

Three-factor model

This section begins with a three-factor H-O model of Britain's comparative advantages, with the factors being capital, labour, and material inputs. Factor intensities or proxies thereof for the 17 British manufacturing industries are calculated from the *Census of production* of 1907, which collected a limited amount of data on British manufacturing activity for the year 1906. Conveniently, the data is disaggregated at the industry and sub-industry level, thereby permitting the 'reconstruction' of industries so that they are consistent with the industries in the previous section of this paper. The process is rather straightforward, and the exact components of the reconstructed industries are detailed in Appendix B. One important assumption is that the sub-industry of (textile) bleaching, dyeing, printing, and finishing trades is allocated *pro rata* among the four classes of textiles.[33]

Capital intensity is proxied by horsepower per £1 million of gross output. Labour intensity is proxied by employees per £1 million of gross output. Both of these proxies

[32] Laursen, 'International specialization', p. 105.

[33] In 1906, the output of this sub-industry was £17.9 million, or about 6% of the entire textile industry. *Census of production*.

Table 3. *Factor intensities of British industries, 1906*

Industry	Capital intensity (horsepower per £1mn output)	Labour intensity (employees per £1mn output)	Material intensity (share of material inputs in output)
Beer	961	1,263	0.38
Cement	16,085	3,968	0.48
Chemicals, including dyestuffs, medicine, and paint	3,845	2,028	0.62
Clocks and watches	897	8,648	0.38
Copper manufactures	2,537	1,241	0.83
Cotton manufactures, including yarn	7,407	3,397	0.72
Earthenware and chinaware	10,360	8,659	0.36
Flax, hemp, and jute manufactures, including yarn and cordage	5,300	4,846	0.68
Glass	4,293	6,489	0.38
Iron, steel, and manufactures thereof, excluding machinery	8,688	3,863	0.63
Leather and manufactures thereof	992	3,994	0.68
Machinery, including steam engines and locomotives	3,218	4,485	0.47
Paper and manufactures thereof	11,080	3,957	0.64
Rubber manufactures	3,080	2,699	0.67
Silk manufactures	3,760	6,376	0.62
Spirits	1,768	865	0.79
Woollen and worsted manufactures, including yarn	4,472	3,607	0.71
Mean	5,220	4,140	0.59
Coefficient of variation	0.81	0.56	0.26

Source: Census of production (1907).

resemble the ones employed by Crafts and Thomas (1986) when they estimated the factor determinants of British exports for 1880, although their source of data was the cruder *Factory inspectorate returns*, as compiled by Musson (1976).[34] Because the *Census of production*

[34] See Musson, 'Motive power', pp. 437-9.

reported the value of material inputs, material intensity is measured directly as the share of material inputs in gross output. Factor intensities per industry are reported in Table 3. It should be observed that the coefficient of variation differs considerably depending upon the factor intensity, with capital intensity per industry being the most disperse of the factors.

Imposing Edwardian factor proportions on late-Victorian manufacturing industries is, recognizably, far from ideal. This approach is mostly necessitated by the availability of systematically collected data across a range of industries. Britain was a relative latecomer among industrial countries in collecting data on manufacturing output, and the *Census of production* was the first such exercise.[35] The error of backdating the factor portions is perhaps not so grave in the context of 'mature' industrial Britain. Matthews et al. (1982) have pointed to the similar growth rates of capital and output in the British manufacturing sector during the 1880s and 1890s, suggesting more or less constant capital intensity, though labour intensity likely declined during these decades.[36] Of course, the factor proportions of individual industries may have changed to a much greater extent than suggested by the manufacturing sector as a whole. Nevertheless, without dismissing the possibility of such changes, the foregoing analysis relies on the data from the *Census of production*, which represents the best available source for the given purpose.

Table 4 presents the results of a semi-log OLS regression that estimates the determinants of Britain's comparative advantages. The dependent variable, the RSCA indicator, is expressed in levels. All of the continuous explanatory variables are expressed in natural logarithms. Columns 1-4 pool the data for all three benchmark years. Column 1 clearly indicates that Britain's comparative advantages were in the relatively capital-intensive manufacturing industries and, inconsistent with Crafts and Thomas, in the relatively labour non-intensive manufacturing industries. The coefficients imply that a doubling of the capital intensity in an industry would increase its RSCA indicator by 0.20 and that a doubling of the labour intensity of an industry would decrease its RSCA indicator by 0.28. Based upon these coefficients, Britain would have realized a comparative advantage in the glass industry in 1880, for example, if its capital intensity was at least 40 per cent higher or if its labour intensity was at least 29 per cent lower.

That the coefficient of material intensity is not statistically significant may seem surprising, given Britain's limited natural resource endowments. There are three potential explanations for this finding. First, Victorian Britain espoused a policy of free trade, which

[35] By comparison, the United States was collecting such data nearly a century before Britain.
[36] Matthews et al., *British economic growth*, pp. 377-82.

Table 4. *Three-factor H-O model of RSCA indicators, 1880-1900*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Capital intensity (1906)	0.20*** (0.05)	0.20*** (0.05)		0.19*** (0.05)	0.20* (0.10)	0.20** (0.08)	0.17* (0.08)
Labour intensity (1906)	-0.28*** (0.08)	-0.35*** (0.09)		-0.25*** (0.06)	-0.17 (0.13)	-0.28** (0.11)	-0.31** (0.11)
Material intensity (1906)	-0.11 (0.17)	-0.32 (0.20)					
Textile		0.20* (0.11)					
Capital/labour (1870)			0.18*** (0.03)				
Constant	0.80 (0.57)	1.22** (0.60)	0.45*** (0.05)	0.71 (0.55)	0.01 (1.13)	0.84 (0.92)	1.29 (0.96)
R^2	0.33	0.38	0.44	0.33	0.24	0.41	0.40
Observations	51	51	48	51	17	17	17
Years	All years	All years	All years	All years	1880	1890	1900

Sources: See text.
Notes: * indicates statistical significance at the 10% level, ** at the 5% level, and *** at the 1% level. Standard errors are noted in parentheses. All variables, except for the dependent variable and the textile dummy, are expressed in natural logarithms. Col. 3 omits the cement industry, as it did not appear in the *Factory inspectorate returns*.

extended to raw materials and intermediate inputs. Unlike in other industrial countries, where a protectionist backlash had taken hold, the British manufacturing sector could obtain material inputs at close to the world price. The relatively material-intensive industry of woollen and worsted manufactures illustrates this point well. By the late nineteenth century, the majority of the raw wool used in the British woollen and worsted industry was imported, and this imported share reached as high as four-fifths by 1895-9.[37] The American woollen and worsted industry also relied heavily on imported wool. However, whereas Britain imported wool free of duty, the United States imposed a considerable duty on this imported material input. Following the passage of the McKinley Tariff of 1890, the *ad valorem* equivalent tariff on wool exceeded 40 per cent.[38] The divergent trade policies of Britain and the United States may account, at least in part, for why the RCA indicator of the British woollen and worsted industry steadily increased throughout the late nineteenth century, whilst the American woollen and worsted industry remained at a nearly perfect comparative disadvantage.

In addition to wool, Britain imported a range of material inputs for its manufacturing sector, and many of these material inputs were sourced from the British Empire, which

[37] Deane and Cole, *British economic growth*, p. 196.
[38] *Foreign commerce* (1891/2).

represents another potential explanation for the material neutrality of Britain's manufacturing comparative advantages. The recent gravity literature yields unambiguous evidence for an empire-effect on commodity trade. Mitchener and Weidenmier (2008) estimated that membership in the British Empire alone more than doubled intra-Empire bilateral trade flows.[39] Following a different empirical strategy, Jacks et al. (2010) estimated that membership in the British Empire reduced intra-Empire bilateral trade costs by half.[40] Indeed, recourse to a resource-rich empire mitigated the effects of Britain's relatively unfavourable natural resource endowments on its manufacturing sector.

A third potential explanation lies in what lay beneath Britain: coal. Insofar as coal was a material input in the manufacturing sector, Britain's natural resource endowments were exceptionally favourable. Surely, the factor proportion of this material input varied greatly across industries. In the British iron and steel industry, it can be estimated that the factor proportion of this material input was on the order of 11 per cent in 1887.[41] While the factor proportion of coal would have been lower in most other industries, it was hardly negligible.[42]

Returning now to Table 4, column 2 includes a dummy variable for the four textile classes, in order to test whether factor endowments adequately explain Britain's notoriously persistent comparative advantages in these industries of the (first) Industrial Revolution, the silk industry notwithstanding. The coefficient of this dummy variable is expectedly positive, and it is statistically significant at the 10 per cent level, suggesting some element of hysteresis in the textile industries.

As already mentioned, the regression imposes Edwardian factor proportions on late-Victorian comparative advantages. Given this inter-temporal mismatch, it would be advisable to perform a robustness check using the earlier, more rudimentary data from *Factory inspectorate returns*. As was done for the *Census of production*, industries are 'reconstructed' to match the RSCA indicators, and the components are listed in Appendix B. The *Factory inspectorate returns* reported the amounts of horsepower and employees in each industry and sub-industry, but not the value of output. Thus, it is necessary to standardize capital and

[39] Mitchener and Weidenmier, 'Trade and empire', pp. 1813-4.

[40] Jacks et al., 'Trade costs', p. 135.

[41] The British iron and steel industry consumed an estimated 27 million tonnes of coal in 1887 (Mitchell, *British coal industry*, p. 12). In that year, the export price of coal was £0.41 per tonne, as calculated from *Annual statement* (1887). The estimated average annual gross output at current value of the British iron and steel industry was £103 million during the interval from 1885-9 (Deane and Cole, *British economic growth*, p. 225). Accordingly, the factor proportion of coal in the British iron and steel industry is estimated at 11%.

[42] In 1887, the British iron and steel industry accounted for substantially less than half of the coal consumed in the manufacturing sector. Mitchell, *British coal industry*, p. 12.

labour relative to each other. Column 3 regresses the RSCA indicators against the log of the 1870 capital-labour ratio. The coefficient is statistically significant and positive, as expected. However, the relative contributions of capital intensity and labour intensity cannot be discerned from this single variable.

Did the factor determinants of Britain's manufacturing comparative advantages change throughout the 1880s and 1890s? Does pooling the data for all three benchmark years obscure an instability in the magnitudes (or possibly signs) of the factor coefficients? These questions are answered by estimating separate regressions for each of the three benchmark years. Due to the small number of industries (17) observed in any single year, the explanatory variables are limited to just capital and labour intensity. Column 4 regresses the RSCA indicators against the logs of these variables using the pooled data. Columns 5-7 estimate the same regression for each of the three benchmark years. While the signs of the coefficients do not change, it is noteworthy that the coefficient of labour intensity increases from 1880-90 and again from 1890-1900. Moreover, this coefficient is statistically insignificant at any conventional level in the regression for 1880.

The increasing coefficient of labour intensity reflects an increasing relative scarcity of labour in Britain. This relative labour scarcity has often been viewed in an American mirror. With respect to the late nineteenth century, Habakkuk (1962) stated, 'And if American labour was, except in the remoter parts of the country, no longer scarce, in England it was no longer as abundant as it had been earlier in the century'.[43] By the closing decades of the nineteenth century, the archetypes of labour-utilizing British manufacturing and labour-economizing American manufacturing had become compromised by an Anglo-American real wage convergence. Between 1870 and 1895, the British unskilled wage had increased from 60 to 69 per cent of the American unskilled wage.[44] O'Rourke and Williamson (1994) argued that this Anglo-American real wage convergence was primarily due to a convergence in commodity prices.[45] Indeed, not only was the sector composition of the British economy affected by commodity-price convergence, so too was the sub-sector composition of British manufacturing.

It is likely the manufacturing comparative advantages of *mid*-Victorian Britain would have tended less toward the relatively labour non-intensive manufacturing industries. But by 1890, a labour-economizing regime in British manufacturing had clearly emerged. To fully

[43] Habakkuk, *American and British technology*, pp. 194-5.
[44] O'Rourke and Williamson, 'Factor-price convergence', p. 895.
[45] Ibid., p. 909.

appreciate the relative labour non-intensity of late-Victorian Britain's manufacturing comparative advantages, it is necessary to consider the factor endowments of Continental Europe, which supplied more than half of world manufactured exports in 1899.[46] On the Continent, labour was relatively more abundant than in Britain. Moreover, as Williamson (1995) pointed out, the Anglo-French and Anglo-German real wage differentials had actually widened (slightly) in the late nineteenth century.[47] On the whole, the relative labour endowment of Britain was moving closer to that of the United States and farther from those of industrial Europe. It would not be disingenuous to argue that, in the late nineteenth century, the starker contrast is between the factor determinants of manufacturing in the Anglosphere and on the Continent, rather than between the factor determinants of manufacturing in Britain and the United States.

Four-factor model

Harley (1974) argued that, for Edwardian Britain, labour as a single factor cannot sufficiently explain the pattern of comparative advantages. Rather, skilled labour ought to be differentiated from unskilled labour because Edwardian Britain was relatively abundant in the former and relatively scarce in the latter.[48] In this vein, the present study considers whether human capital was a determinant of Britain's manufacturing comparative advantages using a four-factor H-O model of trade.

Human capital intensity per industry is proxied by the industry wage standardized for the wage of unskilled labour. The source for data on industry wages is the *Returns of wages* of 1887. This publication presents the weekly wage data that the British Board of Trade solicited from local chambers of commerce on an intermittent basis since 1830, the three most recent wage 'censuses' having occurred in the years 1877, 1880, and 1883. This paper makes use of just the wage data from 1883. The wage observations are disaggregated by occupation, locality, and industry. For example, a 'mill man' in the Macclesfield silk manufacturing industry earned a (quite low) wage of 18s. per week. Occasionally, the *Returns of wages* reports a range, rather than a single amount, for an occupation-locality-

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[46] Calculated from Tyszynski, 'Manufactured commodities', p. 277.

[47] Williamson, 'Global labor markets', p. 155. Between 1870 and 1900, the French unskilled real wage declined from 72 to 68% of the British, while the German declined from 84 to 83% of the British.

[48] As Harley noted, the distinction between skilled and unskilled labour offered a potential resolution to the famous Leontief paradox in post-war American trade. He speculated that there may have been a Leontief paradox in Edwardian British trade, whereby labour-scarce Britain exported labour-intensive manufactured commodities. While he did not quite advance such an assertion, he did claim that the two-factor (capital and labour) H-O model was inadequate. Harley, 'Edwardian industry', pp. 411-3.

industry wage observation. In these instances, the midpoint is used. Additionally, only the wages of adult men are used in calculating the proxy. In total, there are 737 occupation-locality-industry wage observations across 13 industries. Some industries enjoy more observations than do others, and the numbers of wage observations per industry are reported in Appendix C. There are no observations for the industries of cement; clocks and watches; copper manufactures; and rubber manufactures; and so these industries are unavoidably excluded from the four-factor H-O model.

Within each industry, which specific wage observation best captures the human capital attainment of its labour force? Here, it is worth mentioning that almost all industries had high-paid foremen and low-paid warehousemen and general labourers. The variation in human capital attainment is unlikely to manifest itself at the upper and lower endpoints of the wage scale in each industry. Instead, the ideal proxy for human capital falls somewhere between these endpoints. Without any pre-existing knowledge of where along the wage scale human capital attainment is best captured, this paper constructs three separate proxies for human capital intensity for each industry, corresponding to the first, second, and third quartile wage observations. These three wage observations per industry are then each standardized by the unskilled wage, taken to be the lowest of the 737 wage observations. The lowest observation is 13s. per week, the wage of a general labourer in the Belfast linen textile industry. All three proxies are presented in Appendix C.

Table 5 provides the results of the four-factor H-O model. The first column of Table 5 simply reproduces the first column of Table 4, but for the reduced sample of 13 industries. The loss of four industries does not alter the signs of the coefficients, but does reduce their statistical significance from the 1 to 5 per cent level. Columns 2-4 introduce the proxies for human capital intensity. Only the coefficient of the third-quartile proxy for human capital intensity is statistically significant, and at the 5 per cent level. This finding suggests that Britain's manufacturing comparative advantages were in those industries that required a high degree of human capital attainment to be possessed by a small share of employees. To be sure, such an interpretation begs for qualitative substantiation, which would far exceed the scope of this paper. Nevertheless, this finding does call into doubt the assertion by Crafts and Thomas that Britain's manufacturing comparative advantages were in the relatively human capital non-intensive manufacturing industries.

What is perhaps more remarkable is how, even after controlling for human capital, Britain's manufacturing comparative advantages remain labour non-intensive. The claim by Crafts and Thomas that Britain's manufacturing comparative advantages were labour

Table 5. *Four-factor H-O model of RSCA indicators, 1880-1900*

	(1)	(2)	(3)	(4)
Capital intensity	0.17** (0.08)	0.14* (0.08)	0.18** (0.08)	0.13 (0.08)
Labour intensity	-0.22** (0.10)	-0.20* (0.10)	-0.24** (0.10)	-0.22** (0.10)
Material intensity	-0.27 (0.20)	-0.35 (0.21)	-0.25 (0.20)	-0.30 (0.19)
Human capital intensity (first quartile)		-0.71 (0.70)		
Human capital intensity (second quartile)			0.42 (0.46)	
Human capital intensity (third quartile)				0.83** (0.41)
Constant	0.43 (0.66)	0.82 (0.75)	0.27 (0.68)	0.14 (0.64)
R^2	0.16	0.18	0.18	0.25
Observations	39	39	39	39

Sources: See text.
Notes: * indicates statistical significance at the 10% level, ** at the 5% level, and *** at the 1% level. Standard errors are noted in parentheses. All variables, except for the dependent variable, are expressed in natural logarithms.

intensive finds absolutely no confirmation here. In using a dependent variable normalized for the composition of world exports, this study finds the opposite.

Conclusions

This paper has calculated RCA and RSCA indicators for the manufacturing industries of late-Victorian Britain (and other industrial countries). To be sure, these indicators will prove useful to historians of individual industries, particularly since they correspond to the period when the pace of foreign industrialization accelerated. Here, however, the indicators were used for a more concerted purpose, which was to identify the factor determinants of Britain's manufacturing comparative advantages. The finding that Britain's manufacturing comparative advantages were in the relatively (unskilled) labour non-intensive industries departed from the earlier conclusion of Crafts and Thomas (1986). This finding was unaltered by the inclusion of human capital as a fourth factor determinant, although it remains ambiguous whether human capital itself determined the industries in which Britain had a comparative advantage. The discrepancy between this study and Crafts and Thomas may be attributed to the superiority of the data employed here.

With respect to relative labour scarcity, Britain was somewhere between the United States and Continental Europe. The labour non-intensity of late-Victorian Britain's manufacturing comparative advantages reflects a position closer to the United States than to the Continent. To be sure, differences between British and American manufacturing did exist on both the inter-industry and intra-industry levels, and these differences have been the subject of a well-developed scholarly literature. Given the findings of this paper, future scholars might instead prefer to emphasize some of the similarities between British and American manufacturing, rather than the differences.

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Appendix A

Belgium, *RCA indicators*, *1880-1900*

Industry	1880	1890	1900
Beer	0.1 (15)	0.1 (16)	0.0 (16)
Cement	2.6 (5)	1.3 (8)	5.8 (2)
Chemicals, including dyestuffs, medicine, and paint	0.9 (7)	2.0 (4)	2.3 (5)
Clocks and watches	0.0 (17)	0.0 (17)	0.0 (17)
Copper manufactures	0.3 (13)	0.4 (11)	0.3 (13)
Cotton manufactures, including yarn	0.3 (12)	0.3 (12)	0.3 (11)
Earthenware and chinaware	0.8 (8)	1.8 (5)	1.5 (8)
Flax, hemp, and jute manufactures, including yarn and cordage	4.4 (2)	4.9 (2)	5.1 (3)
Glass	8.7 (1)	7.0 (1)	8.3 (1)
Iron, steel, and manufactures thereof, excluding machinery	0.7 (9)	1.7 (6)	1.5 (7)
Leather and manufactures thereof	0.5 (11)	0.6 (10)	1.2 (9)
Machinery, including steam engines and locomotives	2.6 (4)	3.3 (3)	2.3 (4)
Paper and manufactures thereof	3.1 (3)	1.6 (7)	1.7 (6)
Rubber manufactures	0.1 (14)	0.1 (15)	0.2 (14)
Silk manufactures	0.0 (16)	0.1 (14)	0.1 (15)
Spirits	0.5 (10)	0.1 (13)	0.3 (12)
Woollen and worsted manufactures, including yarn	1.8 (6)	1.3 (9)	0.8 (10)

Sources: See text.
Note: Rankings of indicators are noted in parentheses.

France, *RCA indicators, 1880-1900*

Industry	1880	1890	1900
Beer	0.1 (17)	0.3 (17)	0.5 (16)
Cement	0.4 (14)	2.0 (8)	1.9 (7)
Chemicals, including dyestuffs, medicine, and paint	1.2 (9)	1.2 (10)	1.4 (10)
Clocks and watches	3.6 (3)	3.6 (3)	4.8 (2)
Copper manufactures	0.3 (15)	0.6 (14)	0.7 (13)
Cotton manufactures, including yarn	0.3 (16)	0.4 (16)	0.7 (14)
Earthenware and chinaware	1.4 (8)	1.9 (9)	1.8 (9)
Flax, hemp, and jute manufactures, including yarn and cordage	0.8 (11)	0.5 (15)	1.0 (12)
Glass	1.6 (7)	2.1 (7)	2.1 (6)
Iron, steel, and manufactures thereof, excluding machinery	0.5 (13)	0.8 (11)	0.6 (15)
Leather and manufactures thereof	4.1 (2)	3.6 (4)	3.0 (4)
Machinery, including steam engines and locomotives	0.5 (12)	0.7 (13)	0.5 (17)
Paper and manufactures thereof	2.7 (5)	2.3 (6)	1.9 (8)
Rubber manufactures	1.2 (10)	0.8 (12)	1.0 (11)
Silk manufactures	3.6 (4)	4.3 (2)	5.6 (1)
Spirits	4.5 (1)	4.8 (1)	3.7 (3)
Woollen and worsted manufactures, including yarn	2.5 (6)	2.4 (5)	2.2 (5)

Sources: See text.
Note: Rankings of indicators are noted in parentheses.

Germany, *RCA indicators, 1880-1900*

Industry	1880	1890	1900
Beer	2.7 (6)	2.2 (8)	2.2 (7)
Cement	3.1 (4)	2.8 (5)	2.8 (4)
Chemicals, including dyestuffs, medicine, and paint	4.4 (1)	4.5 (2)	3.8 (2)
Clocks and watches	2.2 (8)	2.7 (6)	2.1 (9)
Copper manufactures	1.3 (14)	1.4 (13)	1.2 (14)
Cotton manufactures, including yarn	0.7 (16)	0.9 (16)	1.0 (15)
Earthenware and chinaware	2.5 (7)	1.9 (11)	2.8 (5)
Flax, hemp, and jute manufactures, including yarn and cordage	0.5 (17)	0.5 (17)	0.5 (17)
Glass	1.9 (11)	2.2 (9)	1.6 (12)
Iron, steel, and manufactures thereof, excluding machinery	2.0 (10)	1.9 (12)	2.0 (10)
Leather and manufactures thereof	2.0 (9)	2.6 (7)	1.9 (11)
Machinery, including steam engines and locomotives	1.2 (15)	0.9 (15)	1.5 (13)
Paper and manufactures thereof	3.2 (3)	4.7 (1)	4.0 (1)
Rubber manufactures	2.9 (5)	3.2 (4)	2.9 (3)
Silk manufactures	3.7 (2)	3.6 (3)	2.5 (6)
Spirits	1.9 (12)	1.2 (14)	0.9 (16)
Woollen and worsted manufactures, including yarn	1.8 (13)	2.1 (10)	2.1 (8)

Sources: See text.
Note: Rankings of indicators are noted in parentheses.

United States, *RCA indicators, 1880-1900*

Industry	1880	1890	1900
Beer	0.1 (12)	0.4 (9)	0.9 (7)
Cement	0.1 (14)	0.1 (15)	0.1 (15)
Chemicals, including dyestuffs, medicine, and paint	0.2 (7)	0.4 (8)	0.6 (10)
Clocks and watches	1.2 (1)	1.6 (1)	1.4 (5)
Copper manufactures	0.2 (9)	0.5 (6)	3.6 (1)
Cotton manufactures, including yarn	0.2 (11)	0.2 (13)	0.4 (12)
Earthenware and chinaware	0.0 (15)	0.1 (14)	0.2 (14)
Flax, hemp, and jute manufactures, including yarn and cordage	0.1 (13)	0.2 (12)	0.4 (11)
Glass	0.2 (10)	0.2 (11)	0.4 (13)
Iron, steel, and manufactures thereof, excluding machinery	0.3 (5)	0.4 (7)	1.4 (4)
Leather and manufactures thereof	0.5 (4)	0.8 (2)	1.6 (3)
Machinery, including steam engines and locomotives	0.5 (3)	0.8 (3)	1.6 (2)
Paper and manufactures thereof	0.2 (6)	0.2 (10)	0.7 (8)
Rubber manufactures	0.2 (8)	0.6 (4)	1.1 (6)
Silk manufactures	0.0 (17)	0.0 (17)	0.0 (17)
Spirits	0.7 (2)	0.5 (5)	0.6 (9)
Woollen and worsted manufactures, including yarn	0.0 (16)	0.0 (16)	0.0 (16)

Sources: See text.
Note: Rankings of indicators are noted in parentheses.

Appendix B

Industry components, *Census of production*

Beer: Brewing and malting trades
Cement: Cement trade
Chemicals, including dyestuffs, medicine, and paint: Chemicals, coal tar products, drugs, and perfumery trade; Paint, colour, and varnish trades
Clocks and watches: Watch and clock trades
Copper manufactures: Copper and brass trades (smelting, rolling, and casting)
Cotton manufactures, including yarn: Cotton trade; 61% of Bleaching, dyeing, printing, and finishing trades
Earthenware and chinaware: Bricks and fireclay trades; China and earthenware trades
Flax, hemp, and jute manufactures, including yarn and cordage: Jute, hemp, and linen trades; 11% of Bleaching, dyeing, printing, and finishing trades; Rope, twine, and net trades
Glass: Glass, stone, roofing, felts, and miscellaneous trades
Iron, steel, and manufactures thereof, excluding machinery: Iron and steel, engineering, and shipbuilding trades (all sub-industries thereof); excluding Engineering trades (including electrical engineering); excluding Shipbuilding and marine engineering trades; excluding Small arms trades
Leather and manufactures thereof: Boot and shoe trades; Glove trade; Leather trade (tanning and dressing); Saddlery and harness trade; Traveling bag and fancy leather goods trade
Machinery, including steam engines and locomotives: Engineering trades (including electrical engineering)
Paper and manufactures thereof: Paper trade; Cardboard box trade
Rubber and manufactures thereof: Indiarubber trades
Silk manufactures: Silk trades; 2% of Bleaching, dyeing, printing, and finishing trades
Spirits: Spirit distilling trade; Spirit compounding, rectifying, and methylating trades
Woollen and worsted manufactures, including yarn: Woollen and worsted trades; 26% of Bleaching, dyeing, printing, and finishing trades

Industry components, *Factory inspectorate returns*

Beer: Breweries
Chemicals, including dyestuffs, medicine, and paint: Miscellaneous chemical works
Clocks and watches: Clocks and watches
Copper manufactures: Copper-mills
Cotton manufactures, including yarn: Cotton factories
Earthenware and chinaware: Potteries; Other earthenware; Bricks and tiles
Flax, hemp, and jute manufactures, including yarn and cordage: Flax factories; Hemp factories; Jute factories; Ropemaking
Glass: Glass-making
Iron, steel, and manufactures thereof, excluding machinery: Blast furnaces and iron-mills; Foundries; Nails and rivets; Cutlery; Files, saws, and tools; Locks
Leather and manufactures thereof: Leather manufactures (all sub-industries thereof); Boot- and shoe-making; Manufacture of gloves
Machinery, including steam engines and locomotives: Manufacture of machinery
Paper and manufactures thereof: Paper manufactures (all sub-industries thereof)
Rubber and manufactures thereof: India-rubber and gutta percha
Silk manufactures: Silk factories
Spirits: Distilleries
Woollen and worsted manufactures, including yarn: Woollen factories; Worsted factories

Appendix C

Human capital proxies, 1883

Industry	N	First quartile	Second quartile	Third quartile
Beer	6	1.69	1.74	1.92
Chemicals, including dyestuffs, medicine, and paint	19	1.46	1.97	2.38
Cotton manufactures, including yarn	85	1.62	1.92	2.77
Earthenware and chinaware	10	1.63	1.85	2.17
Flax, hemp, and jute manufactures, including yarn and cordage	46	1.46	1.82	2.11
Glass	29	1.92	2.28	2.54
Iron, steel, and manufactures thereof, excluding machinery	164	1.77	2.31	2.62
Leather and manufactures thereof	56	1.83	2.15	2.35
Machinery, including steam engines and locomotives	112	1.72	2.34	2.60
Paper and manufactures thereof	32	1.60	1.83	2.32
Silk manufactures	11	1.58	1.69	1.82
Spirits	4	1.66	1.82	2.06
Woollen and worsted manufactures, including yarn	164	1.49	1.78	2.31

Source: Wage returns (1887).
Notes: See text.