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Forms of innovation throughout time: insights from the British business elite

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ABSTRACT

Widening the scope to all forms of innovation and paying more attention to the service sector are some of the remaining challenges of innovation studies. The standard innovation indicators are not useful to deal with them, so other alternatives must be explored. Based on a prosopographic approach, we have constructed an ad hoc data set of significant innovations developed by the top two hundred British business leaders/firms active in the nineteenth and twentieth centuries. We have considered innovation in the wide Schumpeterian sense and included patented and non-patented as well as domestic and imported innovations. The main results are: that most innovations (63%) were not patented; that product innovations increased their relative importance compared to process ones up to 1920, the contrary happening afterwards; that in the long run the most 'traditional' Schumpeterian forms of innovation (the finding of new markets and new sources of supply) lost weight in favour of the most 'modern' ones (organisational and marketing innovations); that the innovations appeared in clusters over time; that the service industry showed greater innovative dynamism than manufacturing; and that the British business elite maintained a very low technological dependence over time.

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Schumpeterian forms of innovation; patented and non-patented innovations; manufacturing and services; British business elite

1. Introduction

1.1. Motivation

Our knowledge of the nature of innovation has greatly improved in the last decades (Fagerberg, Mowery, & Nelson, 2005; Hall & Rosenberg, 2010), but many aspects are still unknown or in need of further research, as some experts in the field have pointed out (Cohen, 2010; Fagerberg, 2005; Martin, 2016). Broadening the research horizons to all the Schumpeterian forms of innovation is one of the most cited remaining challenges. Much has been learnt by distinguishing product from process innovations since the seminal empirical studies (e.g., Freeman, Curnow, Fuller, Robertson, & Whitaker, 1968; Pavitt, 1984; Scherer, 1982), but the analysis of the other forms – organisational, marketing, new markets, new sources of supply – although already with some results (e.g., Gunday, Ulusoy, Kilic, &

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Alpkan, 2011; Ruef, 2002; Tavassoli & Karlsson, 2015), is still in its initial state. Thus, we still know very little about the relative importance of the different types of innovation at the firm, industry or macroeconomic level (Shane, 2003, p. 34). It is frequently taken for granted that innovation is mainly developing new products and processes; and maybe that is the case, but specific data supporting this idea are lacking. That is, we do not know what the share of product and process innovations is over all the innovations introduced in the economy, specific sectors or even firms. Having at least an approximate idea of that proportion is important because if it were, let us say, 50% rather than 95%, this would mean that innovation is much more than new products and processes, so we should pay more attention to the other types of innovation. In addition, although the relative importance of product and process innovations over time has been studied (e.g., Freeman, Soete, & Townsend, 1982; Kleinknecht, 1987), we lack that information for the other types of innovation.

Another problem is that non-patented innovations have received much less attention than patented ones. This would not be very relevant if most innovations were patented, but there is evidence that many innovations have never been patented (e.g., Nagaoka, Motohashi, & Goto, 2010, pp. 1106–1111). Hence, probably a great deal of the innovation activity has been neglected, particularly in those industries with lower propensity to patent. This is one of the reasons why it is interesting to include both patented and non-patented innovations in the analysis. The presumably different nature of each type is another one. It is also convenient because without knowing the proportion of patented and non-patented innovations in the economy or other more specific spheres, it is difficult to evaluate the relevance of the studies based on one type or the other.

The experts have also highlighted our still superficial knowledge of innovation in services compared to manufacturing (Cohen, 2010, p. 198; Martin, 2016, Table 2), in spite of the progress made in this aspect (Miles, 2005; Silva, Simões, Sousa, Moreira, & Mainardes, 2014; Toivonen & Tuominen, 2009). Given the weight of services in the economy, filling this lacuna is also essential to have a comprehensive view of innovation. In other words, if we exclude services from the analysis, we are missing a significant part of the innovation activity in the economy and will obtain a distorted view of the general trends in innovation. This is one of the reasons for considering both manufacturing and services in innovation studies. Another one is the interest of finding out the specific innovation features and necessities of each sector, which would determine different innovation practices and policies.

Although there are many other challenges for the innovation studies (Martin, 2016), the present paper tries to contribute to the three aforementioned ones. This requires, first of all, having the adequate disaggregated and long-term data on innovation. As these are not readily available, we have constructed an ad hoc data set to carry out our investigation.

1.2. Method and objectives

In general terms, it can be assumed that an innovation is the effective implementation of an invention (Fagerberg, 2005, pp. 4–9; Kline & Rosenberg, 1986). Although the latter may have different origins, the final step – innovation – is, in some way or other, always accomplished by an entrepreneur and/or inside a firm[1] (Edquist, 2005, p 189; Fagerberg, 2005, p. 5). Hence, the most direct way to measure and understand innovation is by analysing the entrepreneurial activity.[2] But this is not so easy because of the lack of broad, long-term and systematic information on the innovations actually implemented by the entrepreneurs

or their firms (Geroski, 1994, p. 7). Patent data allow for wide and long-term analyses, but they cannot give a comprehensive view of the innovation activity, not only because many innovative firms choose not to patent, but also because some of the Schumpeterian types of innovation are by definition not patentable.[3] R&D statistics are also abundant, but they are also an incomplete indicator as many innovations do not come from R&D (Geroski, 1994, p. 23; Mansfield, 1968; Vivarelli, 2015, pp. 2–3). Case studies on particular companies may overcome these problems, but they lack general perspective.

Some researchers have tried to overcome the aforementioned limitations by constructing databases of innovations from other specific sources (e.g., Fontana, Nuvolari, Shimizu, & Vezzulli, 2012; Moser, 2005), but they still have the problem of not providing a comprehensive view of the innovation activity. A significant effort in this sense is the Community Innovation Survey (CIS),[4] but it is not useful for our purposes, mainly because it lacks the long-term perspective needed. In this sense, several data banks of major innovations/inventions constructed during the 1970s and 1980s are particularly interesting from our viewpoint because they cover long periods of time. The well-known SPRU database contains significant innovations in some British manufacturing sectors from 1945 to 1980 (Townsend, Henwood, Thomas, Pavitt, & Wyatt, 1981), but there are other less well-known similar data banks covering longer historical periods such as those collected by Baker (1976), Mensch (1979), Freeman et al. (1982) or Van Duijn (1983).[5] Although these data sets have a long-term perspective, they mainly deal with the manufacturing sector and present a limited disaggregation of the data. Hence, although some of them have been important reference points for our study (see Section 4.4), they still lack some of the requisites we are looking for.

Given the abovementioned limitations of the available sources on innovation for our purposes, other ones must be explored. An alternative not yet or sufficiently used by innovation studies is the prosopographic approach. Although not free of limitations, it is a promising method as it allows developing a detailed, comprehensive and long-term analysis of the innovation activity of a large enough group of firms.[6]

Prosopographic studies are feasible thanks to the effort made in the last decades in compiling business biographical dictionaries in several countries. From the entrepreneurs' biographies it is possible to obtain specific data about them and their companies in order to analyse different aspects of their activity. In fact, this method has already demonstrated its usefulness to analyse questions dealing with the education, management, wealth distribution, financing and performance of business leaders in some countries (Fellman, 2014; Nicholas, 1999a, 1999b; Toninelli & Vasta, 2014; Tortella, Quiroga, & Moral-Arce, 2013), but not with their innovation activity. This is precisely the aim of the present paper, which is focused on Britain, a single but internationally influential country. But even restricted to one nation, the field of study is huge and must be delimited in time and scope. Our option has been to focus on the top two hundred British business leaders active in the nineteenth and twentieth centuries. From their biographies we have collected information about their significant innovations, these data being the base of the study.

Our main objective is to find out the relative importance of the different (Schumpeterian) forms of innovation developed by the British business elite and how they changed throughout the nineteenth and twentieth centuries. Some studies have been made in this line, but mainly focused on product and process innovations and in the manufacturing sector. Without neglecting the latter the present study will also provide evidence on the other forms of innovation and on the service industry. In relation with the evolution of product and

process innovations, we aim at checking two classical hypotheses, namely the clustering of major innovations in certain periods (Schumpeter, 1939) and the shift from product to process innovation over the industry lifecycle.[7] In relation with the other Schumpeterian types, we expect to find a decrease of the more 'traditional' forms (new markets, new sources of supply) in favour of the more 'modern' ones (organisational and marketing innovations). Other insights on the British business elite innovation activity will be also highlighted.

The rest of the paper is organised as follows. In Section 2, the source and population of the study are presented. Section 3 describes the data set of significant innovations recorded. The results of the analysis of those innovations, disaggregated by types, sectors and throughout time, are shown in Section 4. Section 5 concludes.

2. Source and population of the study

As has been said, this study focuses its attention on the allegedly top two hundred British business leaders of the nineteenth and twentieth centuries. They have been selected among those included in the well-known *Dictionary of Business Biography* (DBB) (Jeremy & Shaw, 1984–1986), which is at the same time the main source for this investigation. In words of its promoters, the DBB provides 'a balanced and comprehensive coverage of those who have made a significant contribution to business leadership in Britain over the last 120 years' (Jeremy & Shaw, 1984–1986, Vol. I, p. viii).[8] The prime qualification for entry to the DBB was the 'achievement of some considerable business impact […] rather than political, charitable or community work' (Jeremy, 1984, p. 5). The outstanding business impact of the entrepreneurs/firms included in the DBB is observable in several indicators, such as the size achieved by the firms in terms of employment, their longevity, their opening of new business paths, their international presence and influence, etc. According with these criteria, although there is always room for debate, the great majority of them have the merits to be included in the dictionary.[9]

The elite of two hundred entrepreneurs/firms has been selected with the same criteria as the DBB, that is, according to their 'business impact' and 'contribution to business leadership'.[10] Hence, they are presumably the two hundred most outstanding leaders among those included in the DBB.[11] Although this selection can also be debated, the majority of entrepreneurs/firms included (such as Armstrong, Austin, Baring, Cadbury, Clark, Deloitte, Du Cross, Holden, Lever, Lewis, Marks, Morris, Platt, Royce, Reuter, Vickers, etc.) are not questionable and all of them are outstanding (see the Appendix for the complete list). It is important to point out that we have not selected these entrepreneurs (nor has the DBB done so for the whole list) because of their innovative character, but mainly considering the outstanding impact of their businesses. That is, the selection is not a list of the most innovative but of the most remarkable businesses. To sum up, the study deals with the innovation activity of a very elitist group of entrepreneurs/firms, presumably the most remarkable ones in Britain during the nineteenth and twentieth centuries. Thus we are focusing on a small share of the entrepreneurs, but a very relevant one, as it includes the most famous British firms, which in some way or another shaped the character of the economy.

The temporal distribution of the two hundred selected leaders follows, by and large, that of the DBB as a whole. The first of them was born in 1793 and the last one in 1918 (1789 and 1925 respectively for the DBB), while the first to fold was in 1872 and the last one in

2002[12] (1868 and 2008 respectively for the DBB). A particularly relevant temporal coordinate – as it is taken as the firm's entry date in our analysis – is the year when the entrepreneurs founded (or became leaders of)[13] their companies, the first one doing so in 1816 and the last one in 1957. Although there were no entrepreneurs of our selection really active after the 1980s, in most of the cases their firms survived them, even to 2013, when the data were collected. In any case, given that the DBB was published in 1984, the bulk of our information refers to the period going from about 1800 to the 1970s. An idea of how the activity of the selected business elite was distributed during those years can be obtained from Figure 1, which shows the number of entrepreneurs alive throughout time.

For analytical reasons, we have divided this long period of time into three sub-periods that can be broadly speaking identified with three different stages of British economic development: (1) the nineteenth century until 1875 (the golden age of the British economy); (2) from 1876 to 1914 (the so-called 'Climacteric'); and (3) the period following the First World War. In accordance with this temporal division, we have divided our two hundred selected entrepreneurs/firms into three sub-groups by assigning each of them to one of the three indicated periods. Given that most of the firms extended their activities throughout more than one period, the year when the entrepreneur founded (or became leader of) the company has been the assignment criterion. As shown in Table 1, each of the first two sub-groups – those beginning from 1816 to 1875 and from 1876 to 1914 – account for about 40% of the companies, and the third one – those starting from 1915 to 1957 – for the remaining 20%.

Table 1 also shows the division of our selected companies by their main sector of activity, manufacturing being the most represented one with 70% of the firms. This is a well-known bias of the DBB considering that the weight of manufacturing in a balanced list of firms should be rather smaller, of around 46%.[14] The other sector with a relevant representation is services, accounting for 28% of the firms, while construction represents only 2%.[15] Hence, the present study deals mainly with manufacturing and services.

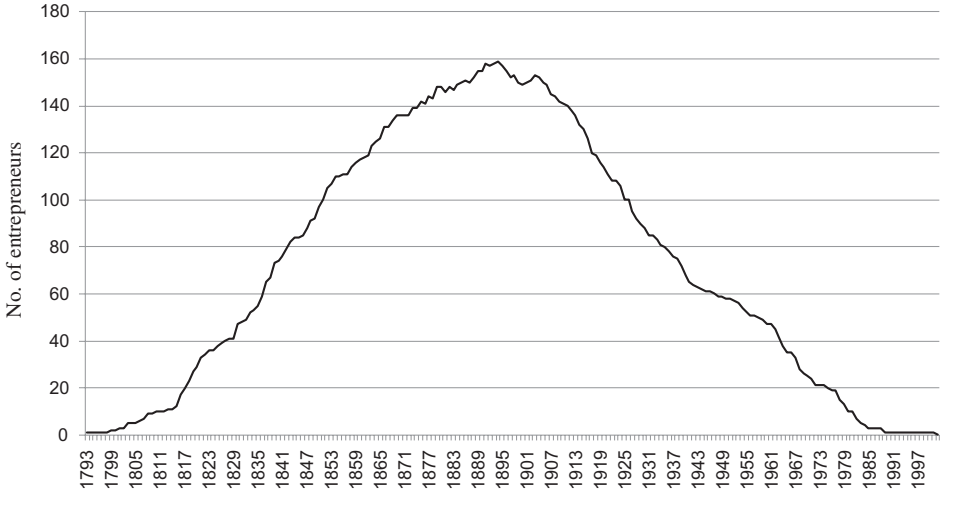

Figure 1. Number of entrepreneurs of the British business elite alive, 1793–2002.

Table 1. Selected British business leaders/firms by period of starting up and by main sector of activity.

	All sectors		Manufacturing		Services		Construction	
Period	No. of firms	%	No. of firms	%	No. of firms	%	No. of firms	%
1816–1875	84	42.0	61	72.6	23	27.4	0	0.0
1876–1914	76	38.0	49	64.5	24	31.6	3	3.9
1915–1957	40	20.0	30	75.0	9	22.5	1	2.5
Total	200	100.0	140	70.0	56	28.0	4	2.0

3. Data

The specific data compiled for this study are the significant innovations developed by the two hundred selected business leaders/firms[16] as reported in the biographies of the DBB. In other empirical studies based on significant innovations (e.g., Baker, 1976; Fontana et al., 2012; Freeman et al., 1982; Kleinknecht, 1981; Mensch, 1979; Pavitt, 1984; Scherer, 1982),[17] these have been selected by experts. In the present one, the 'experts' are the authors of the biographies. Like the well-known SPRU database – used by Pavitt (1984) and Geroski (1994) among others – we have collected innovations 'successfully commercialized or used in the United Kingdom, whether first developed in the UK or in any other country' (Pavitt, 1984, p. 344). We have assumed as well that 'the data on significant innovations are the visible manifestations of deeper processes, involving incremental and social […] innovations' (Pavitt, 1984). But, unlike the latter and the other mentioned studies – mostly centred in the manufacturing sector and product and process innovations – we have considered innovations in the wide Schumpeterian sense (new products or services, new processes or methods of production, new ways of organisation, new markets, new sources of supply and new marketing methods),[18] patented and non-patented, of both manufacturing and services.

The DBB summarises in a few pages the main features and achievements of each entrepreneur/firm based on the available sources. Obviously, the information provided by the DBB is limited, so it probably does not include all the innovations developed by the entrepreneurs. Hence, we cannot expect to have a complete data set of innovations. Nevertheless, we assume that the biographies do not omit their 'significant innovations', that is, the innovations that were particularly important for their businesses, including those with a more general impact. Thus, as they have been recorded precisely because of their outstanding effect, we assume that, although not many in number, the innovations reported in the biographies may be considered the key ones to evaluate the firms' innovation activity. In all, we have collected 523 significant innovations, which were distributed over time as shown in Figure 2.

Some of those innovations are: the introduction of the modern concept of the travel agency by Thomas Cook (1841); the setting up of the first continuously running biscuit machinery in the world by Huntley & Palmers (1846); the invention of the first steel converter by Henry Bessemer (1856); the laying of the first transatlantic telegraphic cable, achieved by the entrepreneurial vision of John Pender supporting Cyrus Field (1866); the development of various radical innovations that revolutionised the insurance sector, such as covering the loss of profits in the aftermath of a fire or the introduction of burglary insurance, by Cuthbert E. Heath (1885); the new concept of partnership – implying transferring of property to the employees and other radical changes – conceived by John S. Lewis to be implemented in his department stores (1918); the development by Ferranti Ltd of one of

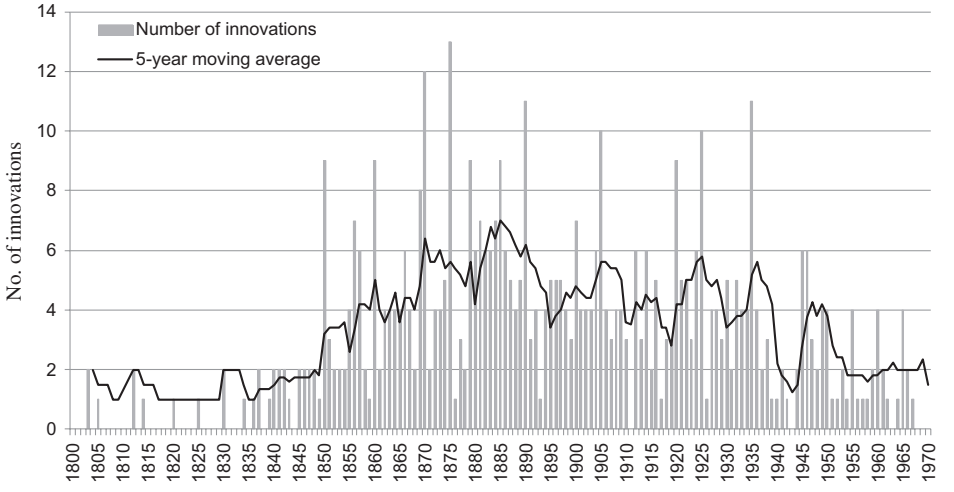

Figure 2. Significant innovations introduced by the British business elite, 1800–1970.

the most successful audio-frequency transformers for wireless (1923); the revolution of the book publishing sector by mixing low prices and selling outside the customary market for books, introduced by Allen Lane with Penguin Books (1935); the vision of John Cadman (British Petroleum) leading to the search for and discovery of oil in the UK (1939); etc.

It is not possible to include here the complete list and details of the 523 innovations recorded, but the aforementioned examples may serve as an illustration. Anyhow, the classification of the innovations by periods, sectors, Schumpeterian types, patented and non-patented, and domestic and foreign, has permitted us to develop a sufficiently detailed analysis in order to achieve our objectives. The results of this study are presented in the following section.

4. Results

A first division of the 523 significant innovations shows that 194 (37%) of them were patented and 329 (63%) were not. Simple as it is, this piece of information is noteworthy as it makes clear how limited the innovation studies based only on patents may be; not just because they exclude an important part of the innovations, but also because patented and non-patented ones may be quite different in nature. For instance, as marketing and organisational innovations are not patentable,[19] it would be expected that non-patented innovations were less 'technological' than patented ones. This can be easily checked by classifying the innovations according to the technological complexity of the sectors they were implemented in.[20]

Table 2 confirms that patented innovations were predominantly of high technology, while the opposite applied to non-patented ones. It also shows a wide range of technological levels among the innovations, both patented and non-patented. Just these two pieces of information indicate the complexity of the innovation activity (Kline & Rosenberg, 1986, pp. 279–285) and the convenience of analysing it in disaggregated terms, as we are precisely doing.

Table 2. British business elite's patented and non-patented innovations by technological level.

Technological level	Patented	%	Non-patented	%	All	%
Low	33	17.0	173	52.6	206	39.4
Medium	39	20.1	86	26.1	125	23.9
High	122	62.9	70	21.3	192	36.7
All	194	100.0	329	100.0	523	100.0

4.1. Forms of innovation by periods

Table 3 shows the distribution of the 523 significant innovations by Schumpeterian types and over time, taken altogether (Panel C) and divided by non-patented (Panel A) and patented (Panel B). Focusing on the 329 non-patented innovations (Panel A), the first evidence is that product innovations were the most abundant type with a 31.3% share for the whole period, followed by marketing (21.6%), organisational (19.8%) and process innovations (19.5%). The discovery of new sources of supply and new markets accounted only for 7.9% altogether. Second, process innovations, new sources of supply and new markets were more important before 1875 than afterwards, contrary to marketing and organisational innovations, which flourished specially after 1875. So it seems that the three former types were more proper ways of innovation of earlier stages of development, while the latter two were more proper of further stages. Product innovations were more evenly distributed before and after 1875, thus indicating that they were important in both stages. Nevertheless, they had a noticeable drop after 1915 mainly in favour of organisational innovations, which became the most important type of innovation in that period.

Four of the six Schumpeterian forms of innovation (marketing, organisational, new market, new source of supply) were not patentable. This implies that among the patented innovations only two types – new products and processes – can be found. Table 3 (Panel B) shows that new products were predominant among patented innovations taking the period

Table 3. Significant innovations of the British business elite by Schumpeterian types and periods.

	1800–1875		1876–1914		1915–1970		All	
Type of innovation	No.	%	No.	%	No.	%	No.	%
A. Non-patented innovations								
Marketing	15	14.0	29	25.7	27	24.8	71	21.6
Product	36	33.6	38	33.6	29	26.6	103	31.3
Process	29	27.1	19	16.8	16	14.7	64	19.5
Organisational	14	13.1	20	17.7	31	28.4	65	19.8
New source of supply & New market	13	12.1	7	6.2	6	5.5	26	7.9
All	107	100.0	113	100.0	109	100.0	329	100.0
B. Patented innovations								
Product	21	35.0	46	60.5	47	81.0	114	58.8
Process	39	65.0	30	39.5	11	19.0	80	41.2
All	60	100.0	76	100.0	58	100.0	194	100.0
C. All innovations (patented and non-patented)								
Marketing	15	9.0	29	15.3	27	16.2	71	13.6
Product	57	34.1	84	44.4	76	45.5	217	41.5
Process	68	40.7	49	25.9	27	16.2	144	27.5
Organisational	14	8.4	20	10.6	31	18.6	65	12.4
New source of supply & New market	13	7.8	7	3.7	6	3.6	26	5.0
All	167	100.0	189	100.0	167	100.0	523	100.0

as a whole (58.8%), but it was not so in the earlier stages. Before 1875 process innovations were clearly dominant, although they dropped dramatically from then onwards, confirming the tendency previously observed for non-patented innovations. The predominance of product innovations in more recent stages is probably reflecting the increase in the range of products associated with economic development. It could indicate that the more developed the economy the more important is competition (innovation) by quality (product) rather than price (process), although this needs further evidence.

If we take patented and non-patented innovations altogether (Panel C), the main trends previously observed are confirmed, but some nuances and a general appraisal can be highlighted. First, although product innovations were below process ones before 1875, they increased in importance afterwards becoming the most important form of innovation on the whole (41.5%). Second, the drop of process innovations both in absolute and relative terms over time was so remarkable that they descended from the first position before 1875 to the fourth one after 1915. Nevertheless, they were the second most important form of innovation in all (27.5%). Third, marketing and organisational innovations were far below process and product innovations before 1875, but they grew importantly over time, overtaking process innovations after 1915. Fourth, the search for new markets and sources of supply accounted only for 5% of the innovations, which suggests that they were only marginal ways of innovation for the British business elite. However, it seems that they had certain relevance before 1875, which shows – as seems reasonable – that they were probably more important in earlier stages of development.

To sum up, the data show that the relative importance of the forms of innovation among the top British business leaders changed clearly throughout time. The increasing importance of the 'modern' forms of innovation (new organisational and marketing methods) and the decrease of the 'traditional' ones (the finding of new sources of supply and new markets) confirms our expectations. On the contrary, the growing share of product compared to process innovations from the first to the third period seems to contradict the hypothesis about the shift from product to process innovations along the lifecycle. Nevertheless, the annual evolution of the data presented in Section 4.4 will show a more nuanced view and, in some ways, a conciliation of our data with that hypothesis. But before that, in what follows, how the different types of innovation were distributed by sectors is shown.

4.2. Forms of innovation by sectors

In addition to disaggregating the forms of innovation by industries, Table 4 differentiates between the entrepreneurs mainly active in the nineteenth and in the twentieth centuries in order to capture changes over time. Some evidence emerges from this exercise. First, the great majority of innovations (77.4%) were oriented towards manufacturing, although this predominance declined from the nineteenth-century leaders (85.6%) to the twentieth-century ones (70.4%), the opposite happening with services (with an increase from 13.6% to 27.1%). Second, the proportion of marketing and organisational innovations was clearly higher in services (22.0% and 24.8% respectively) compared to manufacturing (11.6% and 8.6% respectively), the latter predominantly innovating by developing new products (45.7%) and processes (29.9%). Nevertheless, the most important form of innovation in the service sector was not marketing or organisational but the development of new products (26.6%) like in manufacturing. Third, comparing the nineteenth- and twentieth-century elites, the

Table 4. All significant innovations of the British business elite by Schumpeterian types and industries.

	Manufacturing		Construction		Services		All	
Type of innovation	No.	%	No.	%	No	%	No	%
Entrepreneurs mainly active in the nineteenth century								
Marketing	19	9.1	0	0	4	12.1	23	9.5
Product	75	36.1	2	100.0	9	27.3	86	35.4
Process	87	41.8	0	0	8	24.2	95	39.1
Organisational	18	8.7	0	0	7	21.2	25	10.3
New source of supply & New market	9	4.3	0	0	5	15.2	14	5.8
All innovations	208	100.0	2	100.0	33	100.0	243	100.0
%	85.6		0.8		13.6		100.0	
Entrepreneurs mainly active in the twentieth century								
Marketing	28	14.2	0	0	20	26.3	48	17.1
Product	110	55.8	1	14.3	20	26.3	131	46.8
Process	34	17.3	3	42.9	12	15.8	49	17.5
Organisational	17	8.6	3	42.9	20	26.3	40	14.3
New source of supply & New market	8	4.1	0	0	4	5.3	12	4.3
All innovations	197	100.0	7	100.0	76	100.0	280	100.0
%	70.4		2.5		27.1		100.0	
All entrepreneurs								
Marketing	47	11.6	0	0	24	22.0	71	13.6
Product	185	45.7	3	33.3	29	26.6	217	41.5
Process	121	29.9	3	33.3	20	18.3	144	27.5
Organisational	35	8.6	3	33.3	27	24.8	65	12.4
New source of supply & New market	17	4.2	0	0	9	8.3	26	5.0
All innovations	405	100.0	9	100.0	109	100.0	523	100.0
%	77.4		1.7		20.8		100.0	

importance of marketing innovations increased both in manufacturing (from 9.1% to 14.2%) and services (from 12.1% to 26.3%), while organisational innovations increased in services (from 21.2% to 26.3%) but slightly declined in manufacturing (from 8.7% to 8.6%). Fourth, the share of process innovations declined both in manufacturing (from 41.8% to 17.3%) and services (from 24.2% to 15.8%), and that of product innovations declined in services (from 27.3% to 26.3%) but clearly increased in manufacturing (from 36.1% to 55.8%). Fifth, innovation through finding new sources of supply and new markets was more important in services (8.3%) than in manufacturing (4.2%), but they declined in both sectors over time.

As a general appraisal, it can be said that the service sector showed greater innovative dynamism than manufacturing, both because it increased over time its share in the total amount of innovations and because the 'modern' forms of innovation – marketing and organisational – were much more important for it than for manufacturing.[21] However, the great increase in the proportion of new products – also a 'modern' form of innovation – in the manufacturing sector, shows that the British business elite continued to be technologically dynamic in manufacturing in the twentieth century. The last two mentioned insights – the greater dynamism of services and the apparent recovery of the manufacturing sector's innovativeness after 1914 – seem to support the revisionist (more optimistic) views about the British technological performance since the last decades of the nineteenth century. Although this is an important issue,[22] we will not go any more deeply into it as the object of the present paper is another one, namely to bring some new light about the nature of innovation by exploring a data set concerning the British case.

4.3. Domestic and imported innovations

Another relevant feature of the innovation activity is its origin, domestic or foreign. Among the 523 significant innovations recorded we have identified only 80 imported ones, either through patent licenses or through the adoption of non-patented innovations previously developed in other countries (Table 5). This means that only 15.3% of the innovations were imported, which indicates a very low technological dependence of the British business elite, most probably due to its high technological creativity. This is not surprising given that Britain was a world leader in technology during the period under study, particularly before 1875. Nevertheless, the data show a considerable increase in the share of imported innovations from 1800–1875 (11.4%) to 1876–1914 (19%). This may be seen as a sign of the relative decline of the British innovativeness in relation to Germany or the USA, the main sources of the technology imported into the UK. It is also certain that in the following period (1915–1970) the share of imported innovations descended to 15%, showing that the recovery of the innovativeness previously observed (Table 4) was probably more related with domestic than with imported technology. Other interesting evidence shown by Table 5 is that patent licenses were in all the predominant way for introducing foreign innovations (56.3%) but their proportion declined over time to the point that after 1915 they were overtaken by non-patented innovations. This could be reflecting the adoption of new American organisational and marketing methods, particularly significant since the beginning of the twentieth century (Schröter, 2005).

Table 5. Imported significant innovations by the British business elite.

	1800–1875		1876–1914		1915–1970		All	
Type	No.	%	No.	%	No.	%	No.	%
Non-patented innovations	6	31.6	16	44.4	13	52.0	35	43.8
Foreign patent licenses	13	68.4	20	55.6	12	48.0	45	56.3
All (imported)	19	100.0	36	100.0	25	100.0	80	100.0
% of all innovations	11.4		19.0		15.0		15.3	

4.4. Clusters and shift from product to process innovations over time?

One of the bases of Kuznets' (1940) pioneering famous critique of the Schumpeterian hypothesis about the cyclical clustering of innovations was its lack of empirical evidence. Subsequent empirical research on the evolution of significant innovations in the long run has by and large supported the Schumpeterian view as well as the one sustaining the shift from product to process innovation along the industry lifecycle (see Kleinknecht, 1987 for an overview). In what follows we will show what our data can add to previous evidence on these matters.

The distribution of our 523 significant innovations by three historical stages from 1800 to 1970 (Table 3) has shown a decline in the share of process innovations and an increase in the share of product ones from the first to the third period. The same can be concluded if we include – as does Schumpeter – marketing innovations in the group of process ones. By contrast, for a sample of 195 radical innovations introduced in the UK from 1920 to 1980, selected from the Sussex data bank, Freeman et al. (1982) have found just the opposite trend, that is, an increasing importance of process contrary to product innovations. Nevertheless, these two results cannot be said to be conflicting because they are not comparable as they

refer to different historical periods. In fact, a study based on Baker's (1976) list of about 1000 significant innovations[23] introduced from 1750 to 1970 shows, like ours, a declining share of process innovations in favour of product ones in the long run (Kleinknecht, 1987, Figure 7.1). But the two abovementioned studies have looked at the annual evolution of the innovations, while, so far, we have grouped our innovations by periods. This has allowed them – and not us – to capture fluctuations over time in the share of product and process innovations as well as possible cyclical clusters of innovations. Hence, we need to display our data annually in order to check the two mentioned hypotheses and to properly compare our data with the other samples.

The annual evolution of our 523 innovations by Schumpeterian types[24] is shown in Figure 3.[25] It confirms the declining share of process innovations compared to product ones in the long term, but also shows that this tendency is reversed after 1920 as Freeman et al. (1982) found for their data and as is also clearly observable in Baker's data (Kleinknecht, 1987, Figure 7.1). Hence, when we compare annual data and discriminate by historical periods, the aforementioned conflicting result disappears and a more nuanced innovation behaviour is observable. Namely, product innovations grew in importance compared to process ones throughout the nineteenth century to circa 1920, that tendency reversing afterwards. The coincidence shown by these three quite different data sets gives credibility to them and reinforces the view that the relative importance of product and process innovations is not stable overtime. Our database is the only one including the other Schumpeterian forms of innovation – organisational, new markets, new sources of supply – Figure 3 confirming the trends reflected in the analysis by periods (Table 3), that is, an increasing importance of organisational innovations and a declining share of the other types in the long run.

A simple glance at Figures 2 and 3 is enough to realise that the significant innovations in our database did not appear in a continuous trend but rather discontinuously over time. This – which happens with all the types of innovations – is empirical evidence supporting Schumpeter's hypothesis on major innovations occurring in clusters.[26] The other samples we have taken as a reference point – the Sussex and Baker's data banks – show similar patterns

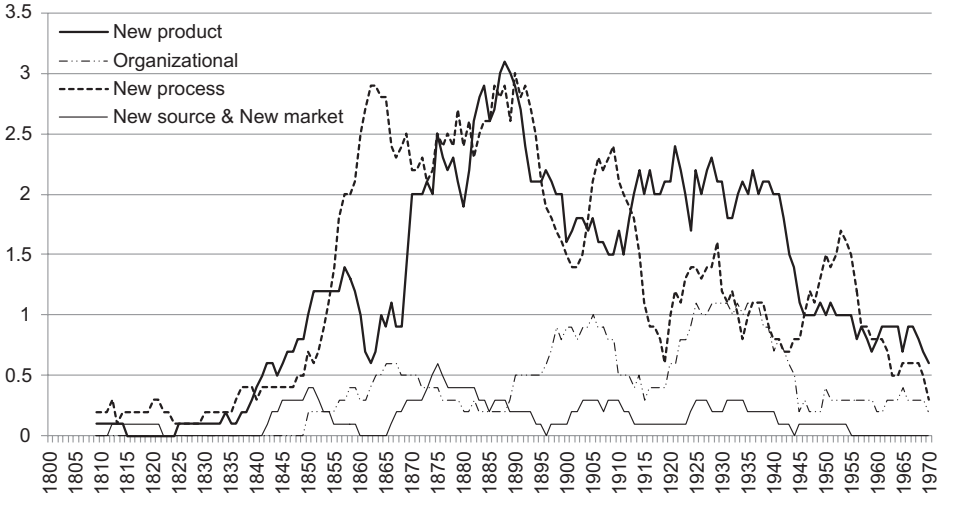

Figure 3. Significant innovations of the British business elite by Schumpeterian types in manufacturing and services, 1800–1970 (10-year moving averages).

both for product and process innovations, which confirm the consistency of the three data sets. In addition, if we compare the clusters or waves of product and process innovations in Figure 3, it is easily observable that there is a lead/lag relationship between them. That is, the peaks in product innovations are usually followed by the corresponding peak in process innovations with a certain time lag. This could also be evidence in favour of the validity of the already explained hypothesis on the shifting from product to process innovation over time. Given the limits of the sample, this argument can be seen as rather speculative, but the highly similar behaviour shown by Baker's data set (Kleinknecht, 1987, pp. 130–132) gives it a certain consistency. The Sussex data bank shows as well to some extent this lead/lag trend between clusters of product and process innovations for the period 1920–1980 (Freeman et al., 1982), although not so clearly as the other two.

The evidence provided so far shows that our data set of significant innovations has more clear similarities with the Baker's than with the Sussex data bank. A possible explanation for this is that both the Baker sample and ours include innovations directed both to manufacturing and services in general, while the Sussex data bank focuses on innovations of a specific group of manufacturing industries. Hence, an interesting way to delve into the findings just presented and to confirm the consistency of the data would be to compare Baker's data and ours by industries. But this is not possible, because Baker's significant patents are not disaggregated in this way. Anyhow, we can do it for our 523 significant innovations and check to what extent the innovation trends differ between the two industries.

The evolution of the innovations implemented either in manufacturing or in services is shown, respectively, in Figures 4 and 5. As already explained (Table 4), of the 523 significant innovations in our data set, 405 were oriented to the manufacturing sector and 118 to the service industry.[27] The low number of service innovations reduces its analytical possibilities, but does not prevent us obtaining some valuable insights from the comparison with manufacturing in relation with the share and trends of the different forms of innovation. Indeed, from Figures 4 and 5 some obvious differences between the innovation activity of the British business elite in manufacturing and in services appear. First, the dominant form

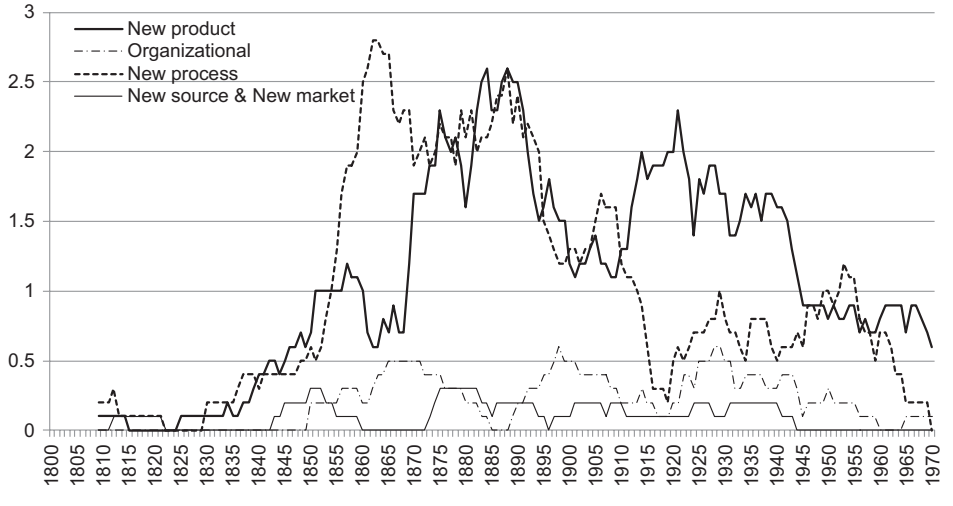

Figure 4. Significant innovations of the British business elite by Schumpeterian types in manufacturing only, 1800–1970 (10-year moving averages).

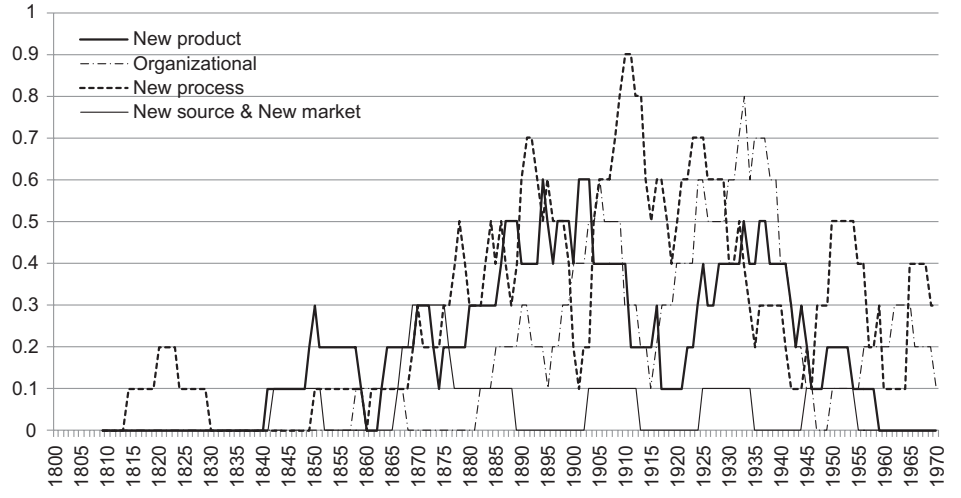

Figure 5. Significant innovations of the British business elite by Schumpeterian types in services only, 1800–1970 (10-year moving averages).

of innovation in manufacturing is the introduction of new products, while new processes dominate in services. Second, organisational innovations are relatively more important in services than in manufacturing. Third, in manufacturing there was a major concentration of innovations in the nineteenth than in the twentieth century, the opposite happening in services. Forth, the long-term evolution of the proportion of process compared to product innovations in manufacturing is by and large the same as the one observed for the innovations as a whole (decreasing up to 1920 and increasing afterwards), while for services the proportion tends to increase up to 1920, to decrease from then to 1940 and to increase again from then onwards. Fifth, both the significant innovations in manufacturing and services tend to appear in clusters, this confirming the Schumpeterian view. The periods when these clusters happened coincide by and large in both industries, although there are some noticeable divergences. Finally, the lead/lag shift from product to process innovations along these waves of innovations is observable both in manufacturing and services, although less clearly in the latter. Much more could be said on the matter, but these brief remarks may suffice for now to show the interest of analysing separately manufacturing and services as their innovation behaviours seem to be quite different.

Although all the previous results deal specifically with the British business elite, it would not be surprising to observe similar patterns in other advanced industrial economies.[28] In fact, the high similarities found between our data and Baker's data bank – containing significant patents worldwide – support this view. Nevertheless, only similar studies on other countries' business elites will show to what extent they have followed the innovation patterns just explained.

5. Conclusions

The standard innovation indicators exclude a great deal of innovations, such as non-patented ones, some of the Schumpeterian forms and, very frequently, innovations in services, so they cannot provide a comprehensive view of the innovation activity. This problem may

be at least partially overcome by resorting to the prosopographic approach as it makes it possible to gather various types of innovations for a wide group of entrepreneurs over a long period of time. Based on this method, we have collected the significant innovations developed by a selection of two hundred top British business leaders/firms active during the nineteenth and twentieth centuries. This has allowed us to analyse different features of their innovation activity over time.

The main conclusions of the study can be summarised as follows. First, considering both patented and non-patented innovations is crucial to have a comprehensive view of the innovation activity. In fact, the dominance of non-patented innovations in our database invites to consider whether they are receiving the attention they deserve by researchers and policymakers. Second, the more 'modern' Schumpeterian forms of innovation (new organisational and marketing methods) increased their importance over the years, while the more 'traditional' ones (new markets and sources of supply) lost weight. This confirms empirically the expected change in the relative importance of these types of innovation with economic development. Third, product innovations increased their weight after 1875 with respect to the previous period, the opposite happening to process ones. This would indicate that competition by quality (product) grew in importance compared to competition by price (process) contrary to the hypothesis of the shift from product to process innovation along the lifecycle. Nevertheless, when we look at the annual evolution of the data, a more nuanced picture appears: from 1800 to 1920 product innovations had a growing share compared to process ones, but from 1920 onwards, the opposite happened, thus confirming the aforementioned hypothesis. The Baker and Sussex data sets show the same trends, which gives consistency to this result. Fourth, the service sector's firms showed an increasing innovative dynamism over time compared with the manufacturing ones, thus coinciding with other studies on the British innovativeness since the last decades of the nineteenth century. Fifth, the low share of imported innovations over the nineteenth and twentieth centuries indicates an outstanding creativity of the British business elite. Sixth, the Schumpeterian hypothesis of the clustering of major innovations is confirmed by our data, both for manufacturing and services. Seventh, the greater importance of process and organisational innovations in services compared to manufacturing, together with other differences, show distinct sectoral patterns of innovation.

To sum up, the aforementioned results confirm the usefulness of the prosopographic approach and of disaggregating innovations by types and industries in order to better understand the characteristics and evolution of the innovation activity in the long term. They also point to several aspects for future research. A deeper analysis of the innovations recorded, focusing in detail on each of the different types, would probably add interesting nuances to the results. Testing the influence of the different forms of innovation on the firms' performance would give an idea about their relative effectiveness, thus improving our understanding of the nature and relevance of each type of innovation. The construction of similar databases of significant innovations from other countries would show to what extent the patterns found here can be extrapolated.

In addition to illuminating the past, the insights gained by this study can guide future research on innovation in several ways. For instance, we have seen that the share of product relative to process innovations grew in the nineteenth century to 1920 and decreased afterwards, but we do not know what has happened from 1970 onwards. It would be interesting to know whether this trend has continued or has reversed in the last decades in order to

check the possible existence of long cycles in the relative importance of product and process innovations. This would require studies focusing their attention on the business elite active from 1970 to nowadays. These investigations could also tell us whether other patterns found by our analysis have continued to this day or not. Namely, the clustering of major innovations, the lead/lag trend between clusters of new products and processes, the trends in organisational and marketing innovations, the different innovative behaviour between manufacturing and services, or the shares of patented and non-patented innovations. Having empirical evidence on all these aspects is important to understand the patterns of innovation in our times and to develop adequate innovation policies at the firm and more general levels.

Notes

1. We speak of entrepreneurs and firms because we are thinking of innovations with a commercial aim, that is, dealing with the production of goods and services for the market. Innovations in other spheres – artistic, cultural, ideological, educational, political, social, etc. – are not normally accomplished by entrepreneurs/firms, but by artists, philosophers, politicians, scientists, educationalists, etc. using ad hoc instruments. Of course, in many occasions they are implemented in organisations (schools, hospitals, political parties, NGOs, ministries, etc.), usually not-for-profit but very similar to firms in many aspects. To sum up, it is difficult to imagine an effective innovation of any sphere implemented without the impetus of a leader through a certain human organisation.
2. Of course this does not mean that all entrepreneurs/firms innovate. On the contrary, as Schumpeter (1934) pointed out, most of them are followers of a few innovators that open new business paths over time.
3. Other limitations are that patents are biased towards the manufacturing sector, not reflecting most of the innovations in services; that their value is very different from one another; and that many of them are not actually implemented so they may not reflect real innovations (see Griliches, 1990 and Geroski, 1994, pp. 6–7 for a wider discussion). Although some of these problems can be solved (e.g., Schankerman & Pakes, 1986), the partial view of the innovation activity cannot be.
4. Carried out in Europe since 1992, it reached its eighth edition in 2012. The CIS collects information about (1) innovation inputs (not only R&D) and outputs (patented and non-patented) at the firm level and (2) significant technological innovations through expert appraisal and specialised journals' information (Cohen, 2010, p. 197; Smith, 2005, pp. 160–168). Some non-European countries, such as Canada, Australia and New Zealand, perform similar surveys.
5. For a complete overview of all of them, see Kleinknecht (1987).
6. See Fellman (2014) for an overview of the contributions and possibilities of prosopographic studies of business leaders.
7. According to the well-known theory of the product lifecycle, product innovation is the most common one in early stages of an industry, but as the product tends to standardise over time, process innovation increases its importance as cost reduction becomes the key for competition (Vernon, 1966).
8. The entrepreneurs were selected by a rigorous process with the advice of a group of experts. For more details, see the Introduction to the first volume of the DBB.
9. For a good assessment of the pros and cons of the DBB, see Nicholas (1999b, pp. 692–694).
10. Among other outstanding features, the average firm in the elite achieved a size of almost 24,000 employees and longevity of 85 years. Just these two indicators illustrate their impact and leadership given that, in general, very few firms survive more than five years and add more than 100 employees throughout their lifetimes (Shane, 2003, pp. 5–6).
11. Strictly speaking, our database of top leaders/firms includes information of 211 biographies (see the Appendix for more details), hence accounting for 18% of the entrepreneurs of the DBB, which contains 1163 biographies.

12. The DBB gives information previous to c. 1980, so we have used other sources (e.g., the *Oxford Dictionary of National Biography* or the companies' web pages) to obtain some data for the subsequent years, such as the date of death of those entrepreneurs that passed away after the DBB was published.
13. Not all the entrepreneurs included in the DBB are founders: there are also heirs and some managers. The date when the latter began to be entrepreneurs is when they became the heads of the company or were appointed as managers or CEOs.
14. This is the estimation made by Nicholas (1999b, p. 694) based on the sectoral shares of employment in Britain calculated by Broadberry (1998) for the period 1870–1990. The share of the manufacturing sector in the DBB as a whole is 66% (Nicholas, 1999b, p. 694), almost the same as the elite's.
15. Agricultural firms were excluded from the DBB.
16. We have included not only the innovations developed by the entrepreneurs themselves, but also by their employees and partners as well as those they imported from abroad, provided that the firm was the pioneer in implementing them, at least in the UK.
17. The innovation data and/or its definition are not the same in all these studies. Baker (1976) uses 'significant patents'; Mensch (1979) differentiates between 'basic inventions' and 'basic innovations'; Kleinknecht (1981) and Freeman et al. (1982) use 'radical innovations'; Fontana et al. (2012), 'breakthrough inventions'; and Pavitt (1984), 'significant innovations'. Of course, the sources, size and temporal and geographical coverage of these studies' databases differ between them as well.
18. Strictly speaking, Schumpeter established only five types of innovation as he considered marketing innovations a kind of process one, but he clearly granted a singularity to the former by saying that a new process 'can also exist in a new way of handling a commodity commercially' (Schumpeter, 1934, p. 66). Thus, in our classification we have differentiated new industrial processes from new marketing methods, the latter having played an important role in modern business and economic development as McKendrick, Brewer, and Plumb (1982) and Church (2000) have shown for the British case. For two collective works on the development of modern marketing, see Nevett and Fullerton (1988), and Church and Godley (2003).
19. This is because they do not properly incorporate new technology in the sense of a new product or a new process using tangible technological elements, such as machinery.
20. We have assigned to each sector – including services – a technological level following the Eurostat standard classification (Eurostat, 2010, pp. 246–247).
21. The dynamism of the British service firms shown by our data is in accordance with the findings of several experts on the matter, such as Pearson (1997) and Broadberry (2006).
22. For two surveys on this topic, see Edgerton (1996) and Nicholas (2014).
23. More specifically, Baker tried to identify the list of the most 'significant patents' related with 363 important items discovered from 1750 to 1970, allegedly the major inventions of that period. Although a list of patents, they are related with inventions successfully implemented, so to some extent they can be taken as innovations (see Kleinknecht, 1987, pp. 77–80 for a wider explanation).
24. For reasons of comparability, marketing innovations have been included in the 'New process' category. New sources of supply and the finding of new markets have been grouped together due to their low number.
25. The number of innovations at the beginning and at the end of the period is very low due to the temporal distribution of the population under study (Figure 1). Hence, the data are mainly useful to analyse the fluctuations and relative importance of the different types of innovations, but not so much the innovation activity in absolute terms.
26. Our data can also be used to check the relation between these clusters of innovations and the economic cycles, a central point in Schumpeter's analysis. But that is a broad topic and not the object of the present paper. For an overview on the matter, see Kleinknecht (1987, Chapters 3 and 4).
27. Given the negligible weight of the construction sector, we have included its innovations (only nine) in the service industry ones for this analysis.

28. As Pavitt maintained in his classical study based on British innovations: 'Although the pattern of innovative activities in the UK does have some distinctive features, what we are measuring on the whole reflects patterns in most industrial countries, rather than the specific characteristics of the UK' (Pavitt, 1984, p. 344).

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Appendix. List of the 200 selected British entrepreneurs/firms[a]

Entrepreneur	Main company or brand
Entrepreneurs active mainly in the nineteenth century[b]	
Armstrong, William George	W G Armstrong, Whitworth & Co Ltd
Baldwin, Alfred	Baldwins Ltd
Barham, Sir George	Express Dairy Co Ltd
Bartlett, Sir Herbert Henry	Perry & Co
Beecham, Sir Joseph	Beecham's Pills
Beit, Alfred & Wernher, Sir Julius Carl	Rand Mines Ltd / Central Mining & Investment Corporation
Bell, Sir Isaac Lowthian	Bell Brothers
Bessemer, Sir Henry	Henry Bessemer & Co
Bolckow, Henry William Ferdinand	Bolckow Vaughan & Co
Brown, Sir John & Ellis, John Devonshire	John Brown Ltd
Browne, Sir Benjamin Chapman	R. & W. Hawthorn Leslie and Company
Bryant, Wilberforce	Bryant & May Ltd
Burbidge, Sir Richard	Harrods Ltd
Cadbury, George	Cadbury Brothers Ltd
Cavendish, William – 7th Duke of Devonshire	Burlington Slate Quarry / Furness Railway
Chadwick, David	Chadwick, Boardman & Co
Chamberlain, Arthur	Kynoch Ltd
Chamberlain, Joseph	Nettlefold & Chamberlain
Clark, William Stephens	C & J Clark Ltd (Clarks)
Cockshut, John	Allan, Cockshut & Co / Wallpaper Manufacturers
Colman, Jeremiah James	J. & J. Colman Ltd
Cook, Thomas & John Mason Cook	Thomas Cook & Son
Courtauld III, Samuel	Samuel Courtauld & Co

(*Continued*)

Appendix. (*Continued*)

Entrepreneur	Main company or brand
Crossley, Francis William & Sir William John Crossley	Crossley Brothers Ltd
Currie, Sir Donald	Union-Castle Mail Steam Ship Co Ltd
D'Arcy, William Knox	Anglo-Persian Oil Co
Deloitte, William Welch	Deloitte, Plender, Griffiths & Co
Doulton, Sir Henry	Doulton & Co, Burslem / Royal Doulton
Du Cross, William Harvey	Dunlop Rubber Co
Firth, Mark	Thomas Firth & Sons
Foley, Patrick James	Pearl Life Assurance Co Ltd
Foster, William	John Foster & Son
Fry, Joseph Storrs	J S Fry & Sons Ltd
Furness, Christopher – 1st Lord Furness of Grantley	Furness, Withy & Co
Gamble, Sir David	J C Gamble & Son
Gibbs, Henry Hucks – 1st Lord Aldenham	Antony Gibbs & Sons
Gossage, William	William Gossage & Sons
Guinness, Edward Cecil – 1st Earl of Iveagh	Arthur Guinness & Son & Co Ltd
Hambro, Sir Everard Alexander	Hambros Bank Ltd
Harland, Sir Edward James	Harland & Wolff Ltd
Haslam, Sir Alfred Seale	Haslam Foundry and Engineering Company
Hattersley, Richard Longden	Hattersley, Sons & Co. Ltd
Heath II, Robert	Robert Heath & Sons
Hewlett, Alfred	Wigan Coal & Iron Co
Hickman, Sir Alfred	Alfred Hickman Ltd
Hingley, Sir Benjamin	N. Hingley & Sons
Holden, Sir Edward Hopkinson	London & Midland Bank / Midland Bank Ltd
Hollins, Sir Frank	Hollins Bros / Horrockses, Miller and Co
Houldsworth, Sir William Henry	Thomas Houldsworth & Co Ltd
Illingworth, Alfred	Daniel Illingworth & Sons
Inman, William	Inman Steam Ship Co Ltd
Ismay, Thomas Henry	White Star Line
Johnston, John Lawson	Bovril Company
Keen, Arthur	Watkins & Keens Ltd / Guest, Keen & Co
Lawson, Edward Levy – 1st Lord Burnham of Hall Barn	Daily Telegraph and Courier
Lee, Henry & Lee, Sir Joseph Cocksey	Lee Spinning Co
Lewis, William Thomas – 1st Lord Merthyr of Senghenydd	Bute Welsh Estates
Liberty, Sir Arthur Lasenby	Liberty & Co
Lloyd, Howard & Phillips, John Spencer	Lloyds Bank Ltd
Lysaght, John	John Lysaght Ltd
Manfield, Sir Moses Philip	Manfield's & Sons Ltd
Matheson, Hugh Mackay	Rio Tinto Co
Mond, Ludwig & Brunner, Sir John Tomlinson	Brunner, Mond & Co Ltd
Morrison, Charles	Morrison, Sons & Co
Newnes, Sir George	George Newnes Ltd
Nixon, John	Nixon's Navigation Co Ltd
Palmer, George	Huntley & Palmers Ltd
Palmer, Sir Charles Mark	Palmers Shipbuilding and Iron Company
Pender, Sir John	Eastern and Associated Telegraph Companies / Cable & Wireless Ltd
Perkin, Sir William Henry	Perkin & Sons
Pirrie, William James – Viscount Pirrie	International Mercantile Marine Co / African Steamship Co
Platt, John	Platt Brothers & Co
Ransome, James Edward & Ransome, Robert Charles	Ransomes, Sims & Jefferies
Reuter, Paul Julius – 1st Baron de Reuter	Reuters Ltd
Richardson, John Wigham	Wigham Richardson & Co
Rothschild, Nathan Meyer – 1st Lord Rothschild of Tring, Hertfordshire	N M Rothschild & Sons
Rowntree, Joseph	Rowntree & Co Ltd
Rylands, John	Rylands & Sons Ltd
Sainsbury, John James & John Benjamin Sainsbury	Sainsburys
Salt, Sir Titus	Daniel Salt & Son
Siemens, Sir Charles William	Siemens Brothers & Co
Simon, Henry	Henry Simon Ltd
Swan, Sir Joseph Wilson	Edison and Swan United Electric Light Co Ltd
Tate, Sir Henry	Henry Tate & Sons

(*Continued*)

Appendix. (*Continued*)

Entrepreneur	Main company or brand
Thomas, Richard	Richard Thomas & Co
Thomas, Sidney Gilchrist	North-Eastern Steel Co Ltd
Thornycroft, Sir Jonh Isaac	John I Thornycroft & Co Ltd
Twining III, Richard	Twining & Co
Vickers, Thomas Edward & Vickers, Albert	Vickers Ltd
Walter III, John	The Times
Waterhouse, Edwin	Price, Waterhouse & Co
White, Sir George	British & Colonial Aeroplane Company
Whitworth, Sir Joseph	Joseph Whitworth, Toolmaker
Williams, Sir George	Hitchcock, Williams & Co
Wills, William Henry – Lord Winterstoke of Blagdon	W.D. & H.O. Wills / Imperial Tobacco
Wilson, Charles Henry – 1st Lord Nunburnholme of the City of Kingston-upon-Hull & Wilson, Arthur	Wilson Line / Thomas Wilson, Sons & Co
Entrepreneurs active mainly in the twentieth century [b]	
Aitken, William Maxwell – 1st Lord Beaverbrook	Royal Securities Corporation / Daily Express
Austin, Herbert – Lord Austin of Longbridge	Austin Motor Co Ltd
Barford, Edward James	Aveling-Barford Ltd
Baring, John – 2nd Lord Revelstoke	Baring Brothers & Co
Barlow, Sir Robert	The Metal Box Co
Baron, Bernhard	Carreras & Marcianus Cigarette Co
Barratt, Arthur William	W Barrat & Co Ltd
Bartlett, Sir Charles John	Vauxhall Motors Ltd
Beatty, Sir Alfred Chester	Selection Trust
Belling, Charles Reginald	Belling & Co Ltd
Bellman, Sir Charles Harold	Abbey National
Benn, Sir Ernest John Pickstone	Benn Brothers
Berry, William Ewert – 1st Viscount Camrose & Berry, James Gomer – 1st Viscount Kemsley	Amalgamated Press / Financial Times
Blackwell, Richard	Basil Blackwell & Mott Ltd
Bolton, Sir George Lewis French	Bank of London and South America
Boot, Jesse – 1st Lord Trent of Nottingham	Boots Pure Drug Co
Bowater, Sir Eric (Frederick) Vansittart	W V Bowater & Sons Ltd
Broadhurst, Sir Edward Tootal	Tootal Broadhurst Lee Co
Brookes, Raymond Percival	GKN
Burton, Sir Montague Maurice	Montague Burton, the Tailor of Taste, Ltd
Butlin, Sir William Heygate Edmund Colbourne	Butlin's Ltd
Cadman, John – 1st Lord Cadman of Silverdale	British Petroleum Co
Cassel, Sir Ernest Joseph	Cassel (Merchant Banker)
Chancellor, Sir Christopher John Howard	Odham Press / Bowater Paper Corporation
Clark, Alfred Corning	Electric & Musical Industries Ltd (EMI)
Clark, Sir Allen George	Plessey Co Ltd
Cohen, Sir John Edward	Tesco Stores Ltd
Collins, Douglas Raymond	Douglas Collins & Co / Sutton Seeds
Colston, Sir Charles Blampied	Hoover Ltd
Combe, Simon Harvey	Watney Mann Ltd
Crowther, Geoffrey	The Economist
Dalziel, Davison Alexander – Lord Dalziel of Wooler	Cie Internationale des Wagons-Lits (CIWL)
De Ferranti, Sebastian Ziani	Ferranti Ltd
De Havilland, Sir Geoffrey	de Havilland Aircraft Co Ltd
Ellerman, Sir John Reeves	Ellerman Lines / J Ellerman & Co
Ferguson, Henry George	Harry Ferguson Ltd
Gestetner, David	Gestetner Company
Gollancz, Sir Victor	Victor Gollancz Ltd
Goodenough, Frederick Crauford	Barclays Bank
Grenfell, Arthur Morton	Canadian Agency Ltd
Hadfield, Sir Robert Abbott	Hadfield's Limited
Harmsworth, Alfred Charles William – Viscount Northcliffe	Associated Newspapers Ltd / Daily Mail
Harmsworth, Harold Sidney – 1st Viscount Rothermere of Hemsted	Northcliffe Newspapers Ltd / Daily Mirror
Heath, Cuthbert Eden	C E Heath & Co
Hill, Philip Ernest & Lazell, Henry George Leslie	Hill Richards & Co Ltd / Beecham Group Ltd
Hirst, Hugo – 1st Lord Hirst of Witton	General Electric Company
Hulton, Sir Edward	E Hulton & Co Ltd / Daily Sketch

(*Continued*)

Appendix. (*Continued*)

Entrepreneur	Main company or brand
Isaacs, Godfrey Charles	Marconi's Wireless Telegraph Company Ltd
Jephcott, Sir Harry	Glaxo Laboratories
Joseph, Sir Maxwell	Grand Metropolitan Hotels Ltd
Kemnal, Sir James & James Hermann Rosenthal	Babcock & Wilcox Ltd
Korda, Sir Alexander	London Film Productions
Laing, Sir John William	John Laing & Son plc
Lane, Sir Allen	Penguin Books
Lever, William Hesketh – 1st Viscount Leverhulme of the Western Isles	Lever Brothers Ltd
Lewis, John Spedan	John Lewis Partnership
Lipton, Sir Thomas Johnstone	Thomas J Lipton Ltd
Llewellyn, Sir David Richard	Amalgamated Anthracite Colliery Co
Longman, Charles James	Longman
Lyle, Charles Ernest Leonard – 1st Lord Lyle of Westbourne	Abram Lyle & Sons
Lyons, Sir William	Jaguar Cars Ltd
Mackintosh, John	John Mackintosh Ltd
Marks, Simon – 1st Lord Marks of Broughton & Sieff, Israel Moses – Lord Sieff of Brimpton	Marks & Spencer
Milne-Watson, Sir David	Gas Light & Coke Co
Mitchell, Sir Godfrey Way	George Wimpey
Mond, Alfred Moritz – 1st Lord Melchett of Landford	Imperial Chemical Industries (ICI)
Morris, William Richard – Viscount Nuffield of Nuffield	Morris Motors
Mountain, Sir Edward Mortimer	Eagle Star & British Dominions Insurance Co
Owen, Sir Alfred George Beech	Rubery Owen Holdings
Pam, Albert Samuel	Ethelburga Syndicate / Pressed Steel Co
Parsons, The Honourable Sir Charles Algernon	C. A. Parsons and Company
Pasold, Eric Walter	Pasolds Ltd / Ladybird
Pearson, Weetman Dickinson – 1st Viscount Cowdray	Pearson Plc
Perkins, Francis Arthur	Perkins Engines Company Ltd
Philipps, John Wynord – 1st Viscount St Davids of Lydstep Haven	Omnium Investment Co
Philipps, Owen Cosby – Lord Kylsant of Carmarthen	Royal Mail Group
Pilkington, William Henry – 1st Lord Pilkington of St Helens	Pilkington Brothers Ltd
Rank, Joseph Arthur – Lord Rank of Sutton Scotney	Joseph Rank Ltd / Rank Organization
Reith, John Charles Walsham – 1st Lord Reith of Stonehaven, Kincardineshire	British Broadcasting Corporation (BBC)
Rootes, William Edward – 1st Lord Rootes of Ramsbury	Rootes Motors Ltd
Royce, Sir Frederick Henry & Johnson, Claude Goodman & Rolls, The Honourable Charles Steward	Rolls-Royce Co
Samuel, Marcus – 1st Viscount Bearsted	Shell Transport and Trading Co Ltd
Selfridge, Harry Gordon	Selfridge & Co Ltd
Siddeley, John Davenport – 1st Lord Kenilworth	Siddeley Autocar Co
Simon, Ernest Emil Darwin – 1st Lord Simon of Wythenshawe	Simon Carves Ltd
Simpson, Samuel Leonard	S Simpson Ltd / DAKS
Sopwith, Sir Thomas Octave Murdoch	Hawker Siddeley Aircraft Co
Spurrier, Sir Henry	Leyland Motors Ltd
Stamp, Josiah Charles – 1st Lord Stamp of Shortlands	London Midland & Scottish Railway
Stevens, Marshall	Trafford Park Estates Ltd
Stoll, Sir Oswald	Opera House Syndicate Ltd
Tetley, Henry Greenwood	Courtaulds Ltd
Thorn, Sir Jules	Thorn Electrical Industries Ltd
Touche, Sir George Alexander	George A Touche & Co
Unwin, Sir Stanley	George Allen & Unwin Ltd
Van den Bergh, Jacob & Van den Bergh, Henry	Margarine Union Ltd
Vestey, William – 1st Lord Vestey of Kingswood & Vestey, Sir Edmund Hoyle	Vestey Brothers - Union Cold Storage Co
Ward, William Humble Eric – 3rd Earl of Dudley	Himley Estates Ltd
Wedgwood, Josiah	Josiah Wedgwood & Sons
Weir, William Douglas – 1st Viscount Weir of Eastwood	The Weir Group
Wellcome, Sir Henry Solomon	Burroughs, Wellcome & Co / The Wellcome Foundation

(*Continued*)

Appendix. (*Continued*)

Entrepreneur	Main company or brand
Weston, William Garfield	Associated British Foods / George Weston Ltd
Wilson, Peter Cecil	Sotheby & Co
Wyatt, Sir Myles Dermot Norris	British United Airways

Source: Jeremy and Shaw (1984–1986).

[a]The basis for this selection has been the one made by Tortella, Quiroga, and Moral-Arce (2008), 'Nature or Nurture? Factors of Entrepreneurship: A Comparative Approach' (https://www.factorsentrepreneurship.es/archive.htm), which includes 200 top British entrepreneurs, 100 active in the nineteenth century and 100 in the twentieth century. But we have introduced some modifications mainly because our focus is more the firm than the entrepreneur himself. Hence, we have considered that two (or three) entrepreneurs are a 'unit' when they have worked together in the same company. Following this criterion, in some cases we have unified two (or three) different DBB biographies into one. This means that, although our list has also 200 entries (firms), it includes information on 211 biographies and 217 different entrepreneurs.

[b]The entrepreneurs considered of the nineteenth century are those born before 1850 or, if born later, dead before 1920; while the ones assigned to the twentieth century are those dead after 1920 provided that they were born after 1850. According with these criteria, the DBB includes 470 entrepreneurs of the nineteenth century (40.4%) and 693 of the twentieth century (59.6%), whereas our selection includes 96 (48.0%) and 104 (52.0%) respectively. Hence, the nineteenth century is slightly overrepresented in the elite with respect to the DBB as a whole.