Rethinking Innovation Comparisons between Manufacturing and Services: The Experience of the CBR SME Surveys in the UK

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Abstract

Most previous research comparing innovation activity in the manufacturing and service sectors has taken insufficient account of the variation in the intensity and nature of innovation activity within those sectors. We address this question using a simple sectoral split and applying it to manufacturing and the business services sector. The results indicate that in some respects there is greater variation in innovation activity within manufacturing and business services than between them. In addition, there is strong similarity between corresponding groupings in each sector. Clear distinctions in innovation patterns do exist between the manufacturing and business service sectors, and imply a considerable depth of technological innovation capability within both sectors. These results imply that the supposed differences in innovation between manufacturing and services may have been exaggerated in earlier research. A previous version of this paper was presented at a workshop entitled "Conceptualising and Measuring Service Innovation" at the Centre for Research in Innovation and Competition (CRIC) at Manchester Business School in May 1998.

Acknowledgements

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RETHINKING INNOVATION COMPARISONS BETWEEN MANUFACTURING AND SERVICES: THE EXPERIENCE OF THE CBR SME SURVEYS IN THE UK

1. Introduction

There has in recent years been an increase in the use of large-scale surveys to measure the nature and extent of innovation activity. The most important development in a European context has been the development within the European Union of a harmonized Community Innovation Survey (CIS) (Archibugi et al (1995)). There have been two such surveys and a third is planned. They aim to cover the whole of the economy including both the manufacturing and service sectors. This commitment to an economy-wide sectoral coverage has provided the occasion for a debate about the appropriate way to measure innovation activity in surveys covering both services and manufacturing (OECD, 1992; Evangelista and Sirilli, 1995, 1997; OECD-Eurostat, 1997; Kleinkecht, 1998). This debate is part of a wider literature on the extent to which service activity generally is misrepresented by measurement techniques and theoretical perspectives developed primarily with goods and specifically manufacturing activity in mind (Hill, 1977).

In the main the literature on innovation measurement associated with the CIS survey, and the wider literature of which it is a part, has drawn a broad distinction between services and manufacturing as a whole. In the most recent CIS separate survey instruments were in fact used for firms in these two broad sectors (see e.g. Foyn, 1998). We argue in this paper that whilst a disaggreggated sectoral approach to the conceptualization and measurement of innovation activity is desirable, it is not necessarily most useful to base it around a broad division between manufacturing and services as conventionally defined. We argue, instead, that there is considerable variation in the content and nature of the innovation process within each of these sectors. Moreover, we argue that there are industrial groupings in manufacturing and in services respectively which have more in

common with each other than they do with industrial groupings in their 'home sector'. This important feature of the innovation process is obscured if the debate focusses on distinctions between manufacturing and services broadly defined using conventional official statistics criteria. We illustrate our argument using a well known innovation typology due to Freeman (1979), which we apply to a large sample of small and medium-sized firms in manufacturing and a subset of service industries. These firms were respondents to the biennial national University of Cambridge ESRC Centre for Business Research (CBR) survey of the SME sector in the UK (Cosh and Hughes, 1996, 1998). Since these surveys cover manufacturing as a whole but only business services our analysis is restricted to that part of the service sector. It is however the fastest growing and most dynamic component of service activity in the UK and other industrial economics (Vickery, 1998).

In the next section of this paper we provide a brief overview of the debate on measurement problems associated with innovation activity in the service sector. In section 3 we develop a framework for comparing innovation activity across groups of industries in the manufacturing and service sectors. In sections 4-6 we compare innovation characteristics across these groups of industries using a variety of survey based indicators of innovation activity. The final section contains our principal conclusions.

2. Problems in Measuring Innovation in Manufacturing and Services

A number of arguments have been advanced to support the view that measures of innovation traditionally developed for the manufacturing sector will distort the measurement of service sector innovation activity (Miles, 1995; Miles et al, 1995; Barras, 1986; Gallouj and Weinstein, 1997; Evangelista and Sirilli, 1995). On the input side it is argued, for instance, that there is a bias towards human capital in service production processes. This may be linked to a greater scope in the service sector for 'process' innovation associated with changes in

business organisation and work practices, rather than with changed plant and equipment. If this is so then service innovation inputs will be inadequately reflected in indicators based on R&D expenditures, or investment in new capital equipment. More generally it has been argued that there is a much greater simultaneity in service production and consumption than is the case with manufacturing. This then blurs the traditional manufacturing distinction between process and product innovation. Moreover it leads to a situation in which 'product innovation' is intimately linked to changes in methods of delivery or distribution, because the product may often be defined by a particular delivery or distribution mechanism. This may in turn, it is argued pose problems in trying to distinguish product innovation from product differentiation. Taken together these arguments are often associated with a general concern that an emphasis in innovation measurement on the 'technological' aspects of product and process innovation will be ill-suited to the service sector. Moreover it is argued that such an approach will systematically underestimate innovation activity in the service sector.

Many of these arguments are clearly matters of degree rather than substance. For instance, many service sector activities, such as energy, transport and retailing, clearly involve large-scale capital intensive production processes. It is also clear that service sector innovation may be intimately linked to investment in new plant and equipment and 'technologically' driven 'production' processes. This stretches all the way from the IT based revolution in supermarket check out and stock control activities, to the automated tellers in retail banking service provision, the delivery of Big Macs, and the provision of remote diagnostic services in health care (see e.g. Desai and Low, 1987; Barras, 1990; Gallouj and Weinstein, 1997). There is equally plenty of evidence for efficiency improvements in manufacturing associated with changes in work organization practices (Leibenstein, 1987; Frantz, 1987). These arguments are well acknowledged in the wider debate over the general nature of the distinction between goods and service activities. Their conceptual implications for the analysis of innovation are also the subject of a

growing theoretical literature (Kleinknecht and Bain, 1993; Barras, 1986; Miles, 1995; Saviotti and Metcalfe, 1984). There have however been few disaggregated empirical attempts to assess the significance of the overlaps between manufacturing and services in the context of innovation activity. Our paper is an attempt to begin to fill this gap in a way which spans the conventional manufacturing and services divide.

3. Comparing Innovation Activity in Business Services and Manufacturing

Our objective is to analyse innovation patterns in product groups both within and across the manufacturing and service sectors rather than simply drawing an aggregated comparison between the broad sectors taken as a whole. In order to create splits within the manufacturing and business service sectors, we ideally wanted a system of classification which met three criteria. Firstly, the system of classification should group sectors according to their innovation characteristics. Secondly, the system should be simple in the sense of creating a relatively small number of groupings. Thirdly, the system of sector grouping should be applicable in both the manufacturing and service sectors.

Pavitt's (1984) seminal paper identified four distinctive innovation groups within the manufacturing sector; supplier dominated; specialized equipment suppliers; scale-intensive and science-based. Pavitt et al. (1989) revised the grouping slightly, splitting supplier dominated into producers of traditional consumer goods and suppliers of traditional intermediate goods. While these classification systems meet the first and second criteria, they are not straightforward to apply to services. While it may be possible to identify some matches in the service sector, for example for science-based and perhaps scale-intensive, it proves more difficult in cases such as traditional consumer goods and traditional intermediate goods.

Freeman (1979) has proposed another classification of innovator types which is more amenable for our purposes. Table 1 shows a summary of the Freeman (1979) system. Freeman's classification rests on a three-way split within manufacturing between capital goods and chemicals, basic materials and consumer goods. Freeman argues that within the manufacturing sector, the primary site for the development of product technology improvements are the traditional engineering sectors including capital goods and chemicals sectors. In Freeman's view, innovation in the basic materials sectors is primarily oriented toward factor saving rather than the development of product technology. In consumer goods, advertising and fashion-based design are typically more important than the development of product technology.

At one level, Freeman's taxonomy does not appear to meet our criteria of applying in the service sector. Clearly, basic materials sectors do not have obvious correspondents in services. Nevertheless, Freeman's suggestion that the bulk of technological innovation within manufacturing is concentrated in a relatively small number of sectors may well be true for the service sector as well. Engineering consulting firms, R&D consulting firms, computer consulting firms, etc. constitute an "engineering sector" within services and may in the spirit of Freeman represent the primary site of innovation activity within services.

This approach permits a simple two-way split within both manufacturing and services. Table 2 shows how the 1995 CBR SME sample can be split in this way[1]. The sample of 576 firms is slightly weighted in favour of manufacturing firms which make up 56.1% of the total number. The proportion of firms in the "core engineering" sectors within manufacturing and services is similar. That is the proportion of capital goods and chemicals firms in manufacturing and the proportion of engineering and technical services firms in the business service sector are both approximately 38%. Thus, the bulk of the sample in both manufacturing and business services are not in the "core engineering sectors".

In the analysis below, we make the following standard comparisons of innovation outputs, innovation inputs, and barriers to innovation. Firstly, we compare manufacturing as a whole with business services. Secondly, within both manufacturing and business services, comparisons are made between the "core engineering sectors" and the "other" sectors. Lastly, within both the "core engineering sectors" and "other" sectors, comparisons are drawn between those firms in manufacturing and those in business services. This combination of tests provides a useful picture of variations between manufacturing and business services as well as within manufacturing and business services. An alternative split between knowledge based sectors within manufacturing and services respectively is presented in Hughes and Moore (1998).

4. Innovation Output in Manufacturing and Services

Figures 1-3 below provide different indicators of innovation output in terms of product and process innovations in manufacturing and business service sectors. For product and process innovations, the figures discriminate between imitation and novel innovations. Imitation and novel innovation were defined as follows. If a company indicated that it had introduced a product innovation, then it was defined as novel if they indicated that the product in question had not already been in use in the firm's own industry. Otherwise, if a product innovation was indicated to have already been in use in the firm's own industry then it was defined as an imitation innovation. (The actual innovation question asked is reproduced in the Appendix to this paper).

Figure 1 shows the proportion of firms which report imitative or novel product innovations in the period 1992-95. If one considers the business service and manufacturing sectors in aggregate, it can be seen that business service firms are marginally less likely than manufacturing firms to introduce imitation or novel innovations. In neither case are the differences significant.

Once the manufacturing and business service sectors are each split in the manner described in the previous section, larger differences in the probability of a firm introducing a novel product innovation become apparent. The "core engineering sectors" within manufacturing and business services are more likely to have introduced novel product innovations in the period 1992-95. The probability of a firm in capital goods and chemicals having introduced a novel product innovation is 35.2% by comparison with 16.2% in basic materials and consumer goods firms. The corresponding figure for engineering and technical services is 26.7% and for other business services 15.8%. In both cases the differences are significant at the 5% level using the Mann-Whitney non-parametric test. A Mann-Whitney test of differences in the probability of a novel product innovation between the "core engineering sectors" in manufacturing and business services was rejected at the 10% level as was the test of differences between the "other" sectors in manufacturing and business services. The differences in the likelihood of a firm reporting an imitation product innovation are small and not significant.

The above results for manufacturing confirm Freeman's (1979) assessment that the capital goods and chemicals sectors are the primary site of development of new product technology. The results for business services imply that Freeman's model can equally be applied in the business services sector, as engineering and technical service firms are significantly more likely to have reported the introduction of novel product innovations by comparison with other business service firms.

Figure 2 shows the comparisons for process innovation. In aggregate, business service firms are marginally more likely to introduce imitation process innovations and marginally less likely to introduce novel process innovations by comparison with manufacturing firms. Within manufacturing, capital goods and chemicals firms are less likely to introduce imitation process innovations. Likewise within business services, engineering and technical services are less likely to

introduce imitation process innovations. These differences are not significant. Capital goods and chemicals firms are significantly more likely to introduce novel process innovations by comparison with the other sectors. This implies that taking the manufacturing and business service sectors together the "core engineering sectors" within manufacturing are the primary site for the development of novel process technology.

Figure 3 provides further comparisons on product innovation activity, showing the proportion of total sales made up respectively of products newly introduced in the last 3 years, products upgraded in the last 3 years and products unchanged in the last 3 years. Business service firms and manufacturing firms have similar proportions of their product ranges made up of newly-marketed products at 12.7% and 11.4% respectively. Business service firms have a significantly higher proportion of sales consisting of upgraded products by comparison with manufacturing firms and a correspondingly lower proportion of sales consisting of unchanged products.

Within both manufacturing and business services, firms in engineering have a significantly higher proportion of their sales consisting of newly-introduced products by comparison with other firms. In capital goods and chemicals, 13.9% of sales is made up of newly-introduced products by comparison with 9.9% in other manufacturing firms. The figure for engineering and technical services is 15.4% and that for other business services 10.9%. The differences in the proportion of newly marketed products between capital goods/chemicals and engineering and technical services and between basic materials/consumer goods and other business services are not significant. These results for manufacturing are once again consistent with the Freeman (1979) model, as are those for the business service sector. This serves to strengthen the above suggestion that both in manufacturing and business service firms, it is the engineering firms which are the primary site for the development of new product technology.

Within manufacturing and business services, there are also significant differences in the proportion of upgraded products. In capital goods and chemicals, 25.1% of sales on average are made up of upgraded products by comparison with 14.9% in basic materials and consumer goods. This difference is significant at the 5% level. The figures for engineering and technical services and other business services are 31.4% and 25.9% respectively, which are significantly different at the 10% level. Amongst engineering firms, the difference in the proportion of sales made up of upgraded products between those in manufacturing and those in business services is not significant. For the remaining firms, however, other business service firms have a significantly higher proportion of sales made up of upgraded products by comparison with basic materials and consumer goods firms.

5. Innovation Inputs in Manufacturing and Services

Figure 4 provides two indicators of R&D activity. The first is the proportion of firms which report having any staff engaged in R&D either full or part time. For those firms which report having staff engaged in R&D, the figure shows the proportion of staff engaged either full or part time in R&D.

The proportion of firms in the business service and manufacturing samples which have staff engaged in R&D are similar at 50.6% and 53.6% respectively. Within manufacturing and business services, however, there is wide variation in the proportion of firms with staff engaged in R&D. In capital goods and chemicals firms the proportion is 66.4% by comparison with 45.5% in basic materials and consumer goods. Likewise, the proportion in engineering and technical services is 62.4% and in other business services 42.8%. In both cases, the differences are significant at the 5% level using the Mann-Whitney test. Amongst engineering firms, the difference in the proportion of firms with staff in R&D between manufacturing and services is insignificant. The same is true for the remaining firms outside of engineering, with the difference in proportion of firms with staff in R&D insignificant.

Amongst firms which do have staff in R&D, those in business services have a significantly higher proportion employed in R&D by comparison with manufacturing firms, with figures of 15.1% and 8.3% respectively. Within manufacturing and business services, the differences between the engineering and other firms in the proportion of staff in R&D is relatively small. Engineering and technical service firms have a significantly higher proportion of staff in R&D by comparison with capital goods and chemicals firms. Likewise, other business service firms have a significantly higher proportion of staff in R&D by comparison with basic materials and consumer goods firms.

Figure 5 shows the proportion of firms which employ technologists, scientists or higher professionals. For those firms which do employ such staff, the figure also shows the proportion of their total staff complement who fall into those occupational categories. A significantly higher proportion of business service firms employ technologists, scientists or higher professionals by comparison with manufacturing firms. Amongst those firms with staff in that category, the proportion of such staff is significantly higher in business service firms by comparison with manufacturing firms, at 35.8% and 11.3% respectively.

Within manufacturing and business services, firms in the engineering sector have a higher proportion of staff who are technologists, scientists or higher professionals. These differences are significant at the 5% level using the Mann-Whitney test. The differences are much larger between capital goods/chemicals and engineering/technical services, at 12.4% and 42.9% respectively. Likewise there is a large difference in the corresponding figures for basic materials/consumer goods and other business services at 9.7% and 29% respectively. These differences are not surprisingly also significant at the 5% level.

Table 3 shows an analysis of the importance of various sources of information for the innovation process. The sample of firms used in

this analysis includes only those firms which reported either a product or process innovation in the period 1992-95, as non-innovating firms were not asked to respond to the questions on the sources of information for innovation.

We can begin by considering manufacturing and business services in aggregate. It can be seen that for both manufacturing and business service firms, the most important external source of information for innovation is clients or customers. Information from suppliers of materials and components and from fairs/exhibitions is significantly more important for manufacturing firms by comparison with business service firms. Information from professional conferences, meetings, professional journals is significantly less important for manufacturing than for business service firms.

Information from suppliers of materials and components is significantly more important for capital goods and chemicals firms by comparison with engineering and technical services firms and for basic materials/consumer goods firms by comparison with other business service firms. Information from professional conferences, meetings, professional journals is significantly more important for engineering and technical service firms by comparison with capital goods and chemicals and for other business service firms by comparison with materials/ consumer goods firms.

Taken together these differences no doubt reflect the relatively greater physical nature of manufacturing production processes, and of inputs of parts and components in production, as well as the relatively greater human capital and disembodied knowledge content of business services. This echoes some of the more traditional bases for distinguishing in these general terms, between goods and services. For certain sources of information for innovation, similar levels of importance between manufacturing and business services mask differences within those sectors. Thus information from within the firm and from patent disclosures is significantly more important to capital goods firms by comparison with basic materials and consumer

goods firms. The aggregate differences in the importance of these sources between manufacturing and business services are, however, insignificant.

6. Barriers to Innovation in Manufacturing and Services

Our survey data allows us to compare constraints on innovation activity, as well as innovation inputs and outputs. Our analysis of the data in Table 4 suggests that there is relatively little difference in aggregate between manufacturing and business service firms in the importance of different barriers to innovation. The only significant difference which is apparent in Table 4 concerns the lack of skilled personnel. It appears that innovation in business service firms is significantly less likely to be hampered by the lack of skilled personnel than is the case in manufacturing firms.

More differences come to light in Table 4 when we consider the split between the manufacturing and service sectors. Within manufacturing, basic materials and consumer goods firms report significantly higher constraint on innovation due to excessive perceived risk by comparison with capital goods and chemicals firms. Within business services, engineering and technical service firms report significantly greater constraints on innovation due to lack of appropriate sources of finance, pay-off period of innovation too long, lack of information on markets, innovation costs hard to control, and lack of opportunity for co-operation with other firms and technological institutions.

Differences also exist between the respective sectors within manufacturing and business services. Engineering and technical service firms report significantly greater constraints on innovation due to excessive perceived risk, lack of appropriate sources of finance and lack of opportunity for co-operation with other firms and technological institutions by comparison with capital goods and chemicals firms. Basic materials and consumer goods firms report significantly greater constraints on innovation due to the lack of

skilled personnel and lack of information on markets by comparison with other business service firms.

This comparative emphasis on financial constraints by our engineering and technical services firms is consistent with evidence from other analyses (Cosh and Hughes, 1998; Hughes and Moore, 1998; Bank of England, 1998).

7. Conclusion

In terms of the probability of introducing novel product innovations, the proportion of sales made up of newly innovated products, the likelihood of a firm having staff engaged in R&D, and the likelihood of a firm employing technologists, scientists or higher professionals, it appears that the differences between the manufacturing and business service sectors are smaller than within them. In particular, engineering firms in both manufacturing and business services are significantly more innovation intensive by comparison with non-engineering firms in the same sector. And engineering firms in manufacturing and those in the business service sector show strong similarities in terms of their innovation intensity. More surprising perhaps is that manufacturing firms in basic materials/ consumer goods and other business service firms show strong similarities in terms of their innovation intensity.

Despite the strong similarities between the corresponding groupings in manufacturing and business services, significant differences do exist. Amongst firms which have staff engaged in R&D, those in engineering and technical services employ a significantly higher proportion by comparison with those in capital goods/chemicals and those in other business services employ a significantly higher proportion by comparison with those in basic materials/consumer goods. The same pattern applies for the proportion of staff who are technologists, scientists or higher professionals.

Engineering and technical service firms report significantly higher barriers to innovation due to excessive perceived risk, lack of

appropriate sources of finance and lack of opportunity for cooperation with other firms and technological institutions. Basic materials and consumer goods firms report significantly higher barriers to innovation due to lack of skilled personnel, lack of information on markets and lack of opportunity for cooperation with other firms and technological institutions.

These results would seem to suggest that there may in fact be far more in common between the manufacturing and business service sectors in terms of their innovation activity than has previously been supposed. Recent suggestions that innovation activity in manufacturing and services is so fundamentally distinctive that entirely different sets of indicators are required to measure such activity in these sectors appear to be misplaced. This is not to suggest that substantial differences do not exist. On the contrary, applying the same set of measurement indicators across the two sectors usefully captures important differences while also highlighting the strong similarities. More significantly our analysis also reveals that there are important similarities between industry groupings drawn from across the traditional manufacturing and services divide.

Notes

1. The CBR sample and survey methodology are discussed in detail in Cosh and Hughes (1996, 1998) and Bullock, Duncan and Wood (1996). Innovation activity in the sample is discussed in Cosh, Hughes and Wood (1996), Cosh and Wood (1998) and Cosh, Hughes and Wood (1999).

Table 1. Freeman's (1979) innovation groups for manufacturing industry

	Industry	Innovation characteristics
Group 1	**Capital goods and chemicals**	
	Aircraft and aero-engines	
	Electronics	Technical effort directed
	Other electrical	mainly to the design and
	Vehicles	development of new products
	Instruments	which have superior technical
	Chemicals	characteristics
	Machinery	
Group 2	**Basic materials**	
	Non-ferrous metals	
	Metal products	Technical effort is directed
	Stone, clay and glass	mainly to cost reduction
	Paper	through factor-saving
	Ferrous metal	innovation
Group 3	**Consumer goods**	
	Food	
	Textiles and apparel	Fashion-based design and
	Lumber and furniture	advertising more important
	Other manufacturing	than technical innovation

Table 2. Industry breakdown of SME respondents to 1995 CBR questionnaire

Industry Split	Number of firms	(percentage)
Manufacturing	**323**	**(56.1)**
• **Capital goods and chemicals**	**125**	**(21.7)**
Instrument engineering	10	(1.7)
Chemicals and chemical products	31	(5.4)
Electrical and electronic goods	27	(4.7)
Non-electrical machinery	57	(9.9)
• **Basic materials and consumer goods**	**198**	**(34.4)**
Rubber	3	(0.5)
Timber and timber products	11	(1.9)
Metals and non-metallic mineral products	12	(2.1)
Fabricated metal products	51	(8.9)
Pulp and paper	8	(1.4)
Publishing and printing	39	(6.8)
Textiles and clothing	36	(6.3)
Furniture	16	(2.8)
Food products and beverages	12	(2.1)
Manufacturing not elsewhere classified	10	(1.7)
Business Services	**253**	**(43.9)**
• **Engineering and Technical Services**	**101**	**(17.5)**
Computing services	46	(8.0)
R&D consulting and other technical services	55	(9.5)
• **Other Business Services**	**152**	**(26.4)**
Advertising	17	(3.0)
Financial and other business services	135	(23.4)
Total	**576**	**(100)**

Figure 1 Imitative and Novel Product Innovation in UK SMEs 1992-95

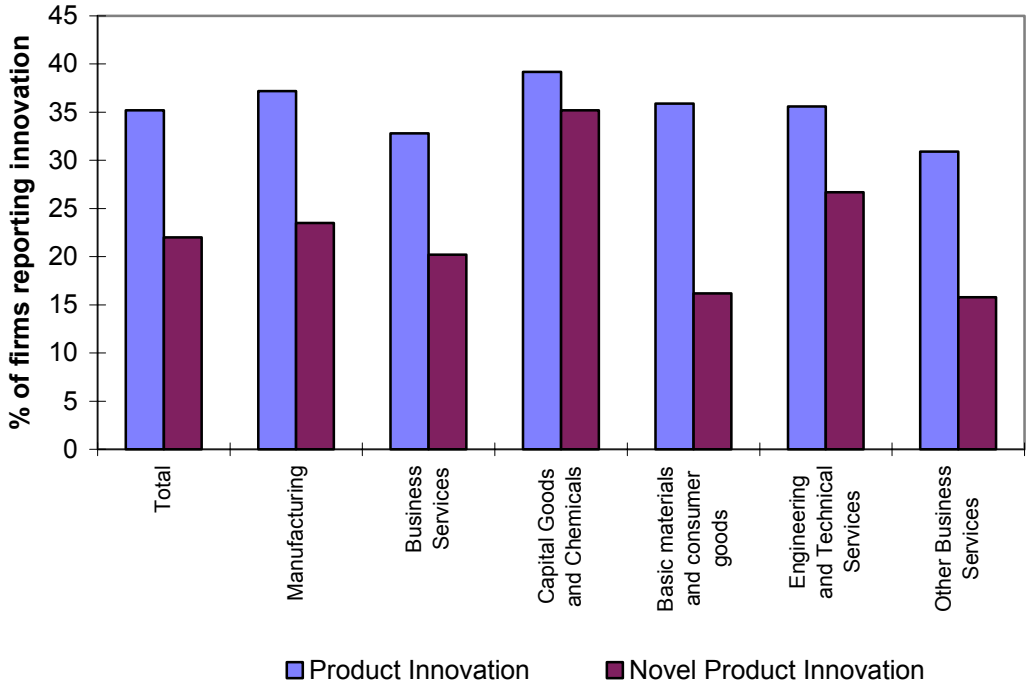

Figure 2 Imitative and Novel Process Innovation in UK SMEs 1992-95

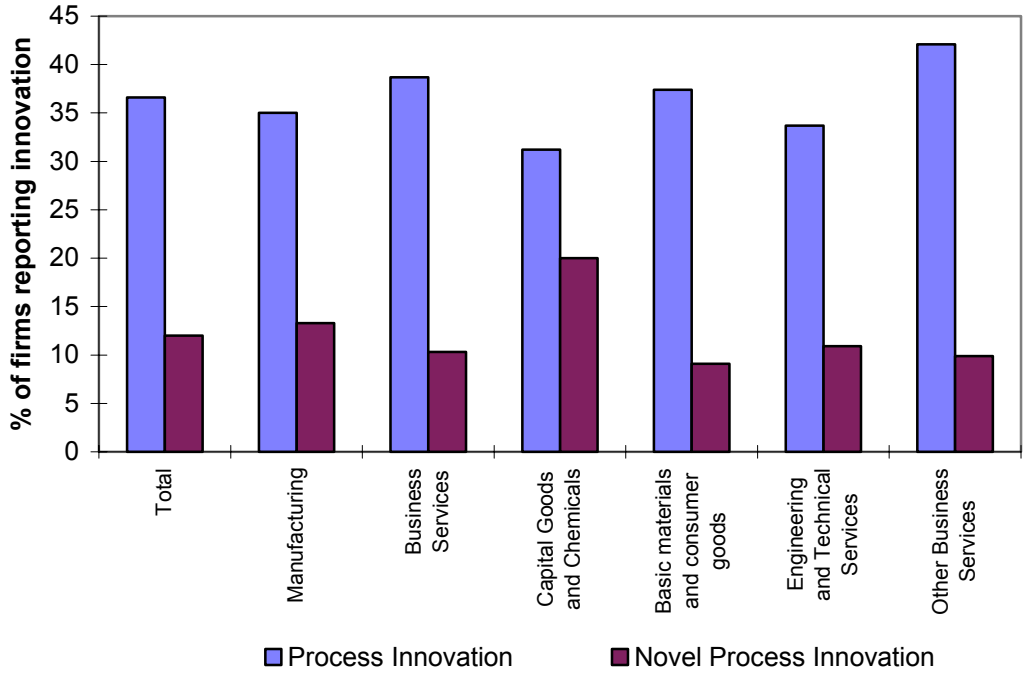

Figure 3 Proportion of Product Innovation, Product Upgrading and Unchanged Products in UK SMEs 1992-95

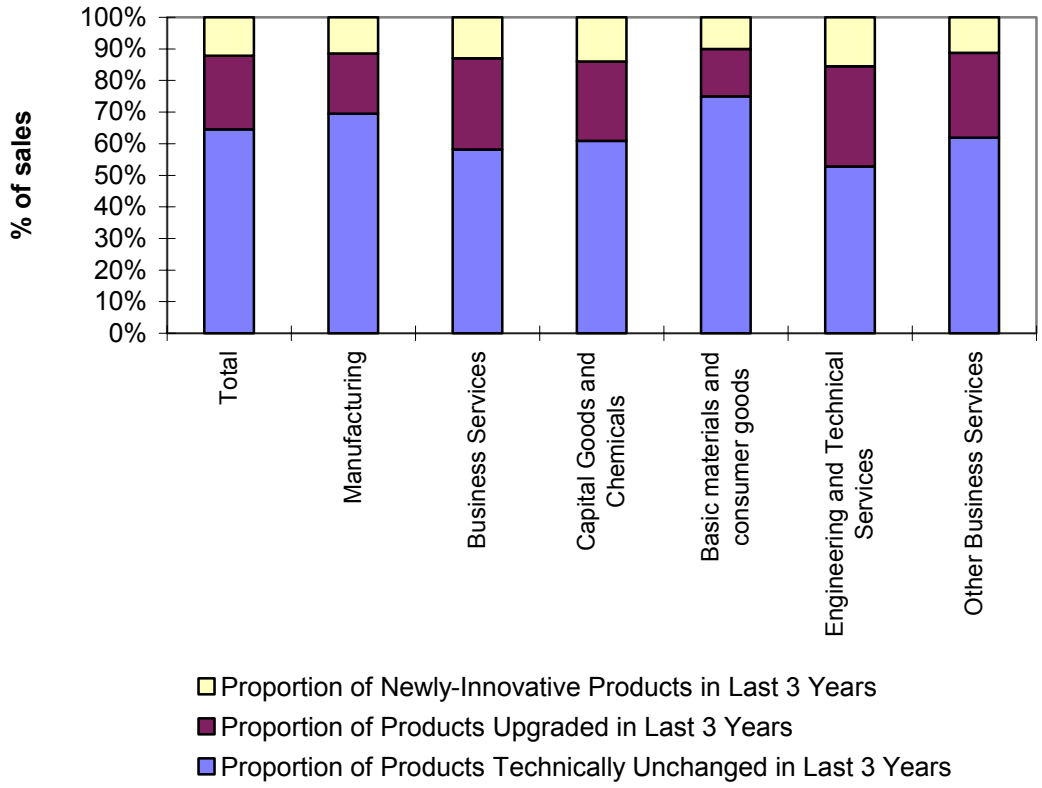

Figure 4 R & D Employment in UK SMEs 1992-95

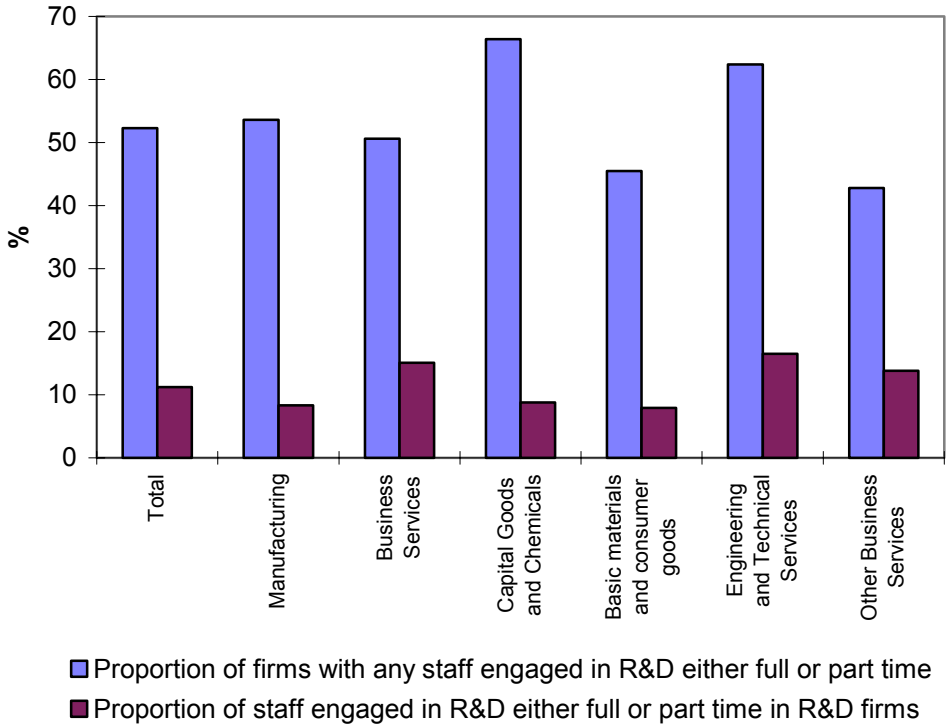

Figure 5 Technologists, Scientists and Higher Professionals as Proportion of Labour Force in UK SMEs 1995

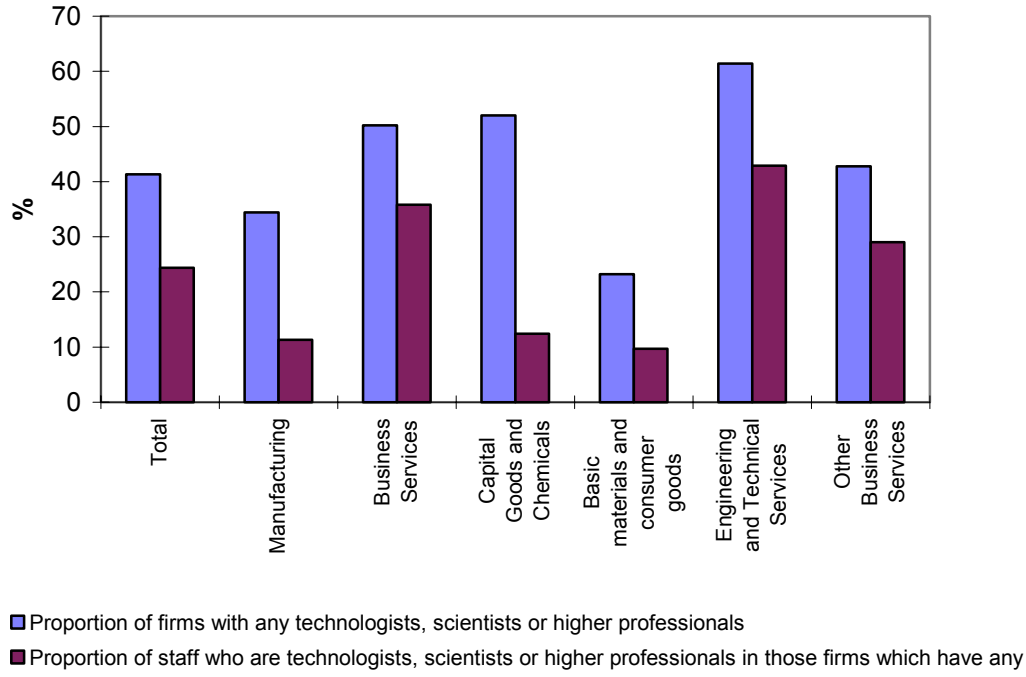

Table 3. Sources of Innovation Information in UK SMEs 1992-95

Mean Scores

	Total	Manufacturing	Business Services	Capital Goods & Chemicals	Basic materials & consumer goods	Engineering & technical services	Other Business Services
Industry groups		**A**	**B**	**a**	**b**	**c**	**d**
Internal sources:							
Within the firm	3.71	3.69	3.73	3.95[b]	3.49	3.83	3.67
Within the group	1.30	1.32	1.28	1.50	1.17	1.24	1.31
External sources:							
Suppliers of materials and components	2.48	2.69[B]	2.22	2.73[c]	2.65[d]	2.16	2.26
clients or customers	3.49	3.53	3.44	3.66	3.43	3.65	3.30
Competitors in your line of business	2.71	2.70	2.73	2.77	2.64	2.92	2.60
Consultancy firms	1.52	1.46	1.61	1.50	1.42	1.51	1.69
Universities/higher education institutes	1.38	1.36	1.40	1.46	1.28	1.41	1.39
Technical institutes	1.35	1.37	1.33	1.45	1.31	1.32	1.33
Patent disclosures	1.24	1.25	1.22	1.39[b]	1.15	1.29	1.16
Professional conferences, meetings, professional journals	1.81	1.61	2.06[A]	1.58	1.64	2.15[a]	2.00[b]
Fairs/exhibitions	2.09	2.21[B]	1.93	2.31[c]	2.13	1.97	1.91
Trade associations	1.68	1.74	1.59	1.66	1.80	1.60	1.58
Chambers of commerce	1.23	1.27	1.17	1.30	1.24	1.15	1.20

Means are of ranked scores on a scale 0-5 (0 insignificant, 5 crucial)

B – Score is significantly greater than that in column B at the 5% level
A – Score is significantly greater than that in column A at the 5% level
a – Score is significantly greater than that in column a at the 5% level
b – Score is significantly greater than that in column b at the 5% level
c – Score is significantly greater than that in column c at the 5% level
d – Score is significantly greater than that in column d at the 5% level

Mann – Whitney U non parametric test used.

Table 4. Barriers to Innovation in UK SMEs 1992-95

Mean Scores

	Total	Manufacturing	Business Services	Capital Goods & Chemicals	Basic materials & consumer goods	Engineering & technical services	Other Business Services
Industry groups		**A**	**B**	**A**	**b**	**C**	**d**
Economic factors:							
excessive perceived risk	2.46	2.40	2.53	2.22	2.52[a]	2.73[a]	2.40
Lack of appropriate sources of finance	2.51	2.44	2.61	2.47	2.42	3.06[ad]	2.31
innovation costs too high	2.63	2.67	2.58	2.73	2.63	2.63	2.54
pay-off period of innovation too long	2.38	2.37	2.40	2.40	2.34	2.61[d]	2.26
Firm level factors:							
Firm's innovation potential (eg. R&D, design, etc. too small)	2.41	2.49	2.31	2.53	2.47	2.40	2.26
lack of skilled personnel	2.29	2.42[B]	2.13	2.49	2.37[d]	2.3	2.02
lack of information on technologies	1.85	1.89	1.79	1.91	1.88	1.77	1.8
lack of information on markets	1.98	2.01	1.94	2.00	2.01[d]	2.17[d]	1.79
innovation costs hard to control	2.08	2.06	2.09	2.19	1.98	2.27[d]	1.97
resistance to change in the firm	1.69	1.72	1.66	1.76	1.69	1.57	1.71
deficiencies in the availability of external technical services	1.62	1.65	1.57	1.75	1.59	1.63	1.53
lack of opportunity for co-operation with other firms and technological institutions	1.70	1.70	1.70	1.61	1.76[d]	1.92[ad]	1.56
Other reasons							
Lack of technological opportunities	1.56	1.60	1.52	1.56	1.62	1.56	1.49
no need to innovate due to earlier innovations	1.55	1.60	1.49	1.47	1.68	1.46	1.51
innovation too easy to copy	1.68	1.76	1.58	1.66	1.82	1.54	1.61
legislation, norms, regulations, standards, taxation	1.79	1.80	1.78	1.82	1.78	1.88	1.72
lack of customer responsiveness to new products and processes	1.85	1.87	1.83	1.82	1.90	1.90	1.78
uncertainty in timing of innovation	1.76	1.68	1.85	1.78	1.62	1.98	1.76

Means are of ranked scores on a scale 0-5 (0 insignificant, 5 crucial)

B – Score is significantly greater than that in column B at the 5% level
A – Score is significantly greater than that in column A at the 5% level
a – Score is significantly greater than that in column a at the 5% level
b – Score is significantly greater than that in column b at the 5% level
c – Score is significantly greater than that in column c at the 5% level
d – Score is significantly greater than that in column d at the 5% level

Mann – Whitney U non parametric test used.

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Appendix

1995 CBR SURVEY INSTRUMENT

Section B: Innovative Activity

*In this section we would like you to tell us about your innovative activity. We are interested in innovation in products and processes which are **new to your firm**.*

*In answering the questions in this section, please count innovation as occurring when a new or changed product is introduced to the market (product innovation) or when a new or significantly improved production method is used commercially (process innovation), and when **changes** in knowledge or skills, routines, competence, equipment, or engineering practices are required to make the new product or to introduce the new process.*

*Please do **not** count as product innovation, changes which are purely aesthetic (such as changes in colour or decoration), or which simply involve product differentiation (that is minor design or presentation changes which differentiate the product while leaving it technically unchanged in construction or performance).*

B1. Has your firm introduced any innovations in products (goods or services) or processes during the last three years which were new to your firm? *(Please tick only **one** box in **each** row)*

	Yes	No
Products		
Processes		

If you ticked No for <u>both</u> products <u>and</u> processes please skip B2.

B2. If you introduced a product innovation, was it, to the best of your knowledge, already in use in other firms either in (a) your industry or (b) other industries? If you made more than one product innovation please answer with respect to your most important product innovation. *(Please tick only **one** box in **each** row)*

Product Innovation	Yes	No	Don't Know
(a) in use in your industry			
(b) in use in other industries			

B3. If you introduced a process innovation was it, to the best of your knowledge, already in use in other firms either in (a) your industry or (b) other industries? If you made more than one process innovation please answer with respect to your most important process innovation. *(Please tick only **one** box in **each** row)*

Process Innovation	Yes	No	Don't Know
(a) in use in your industry			
(b) in use in other industries			