ServINNo
Service innovation in
the Nordic countries:
Key Factors for
Policy Design

Blurring boundaries between manufacturing and services

Jesper Lindgaard Christensen and Ina Drejer
IKE Group, Department of Business Studies, Aalborg University
Mail-to: jlc@business.aau.dk; Ina.Drejer@ru.rm.dk

Abstract

The paper explores the extent to which the boundaries between manufacturing and services are blurred. Based on Danish data the paper shows that service firms by no means only generate their turnover from service activities, and that a considerable fraction of manufacturing firms also carry out service activities. The statistical classification of firms is thus not adequately covering the true state of affairs with respect to types of activities in the firms. In terms of innovative activities the findings of the paper indicate a high degree of complementarities between manufacturing and service activities. The findings are however somewhat ambiguous: On the one hand firms classified as belonging to one of the two main sector, often also carry out activities classified as belonging to the other main sector. On the other hand the majority of the firms in both sectors do appear to focus on either manufacturing or services when it comes to development activities. In terms of policy implications the findings indicate that sector-based policies to improve innovation in services will only 'hit the target' to a limited extent.

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1. Introduction[1]

The term 'service economy' was introduced in the mid-1960's by Fuchs (1965)[2] to illustrate that the service sector had been the dominating sector in the US from an employment perspective since the mid-1950's. But services did not receive much attention in innovation studies – or in economic studies in general - until the 1990's. This reflects that innovation theory has its roots in a time where manufacturing was still the major economic activity.

Studies of innovation in manufacturing were for a long time – and are partly still – dominated by a strong technology focus. This is reflected in the fact that R&D expenditures or -intensities and patenting have in many cases been used as approximations for innovative activity.[3] The first studies of innovation that broadened their scope to include services tended to maintain this technology-focused perception of innovation. For example, the first two rounds of the Community Innovation Survey based on the Oslo Manual excluded other types of innovations than so-called TPP-innovations (Technological Product and/or Processes) even if the second survey did cover the service sector in some countries. Innovation surveys such as the Community Innovation Survey have hence gradually shifted from a heavy focus on technological innovations and the manufacturing sector towards also incorporating other types of innovations and a broader range of industries. The first CIS in 1993-94 covered a (limited) number of service firms in surveys in Germany and The Netherlands. In the second round of CIS the questionnaire was partly adjusted in order to be understandable for service firms, which were covered in the majority of countries. Thereafter, CIS-questionnaires aimed at manufacturing and service firms have been almost identical. This approach to studies of service innovation has been labelled the assimilation approach (Barras, 1990). Studies using this approach see innovation in services as heavily influenced by technology and assimilating technology and modes of production from especially manufacturing. The studies within this tradition see few differences between manufacturing and services innovation[4].

Only recently innovation surveys have begun incorporating other types of innovation than new products and processes. Although these studies contributed to correct the misconception that services are only users and not producers of innovation, service researchers argued that a technology-focused perception of innovation underestimated the true extent of innovative activities going on in services in terms of new forms of organisation, new types of customer relations and delivery, new package solutions etc. As a reaction to this, service researchers developed new tools and concepts aimed specifically at studying

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[2] Other examples of studies of the emerging service economy, carried out in the United States under the auspices of the National Bureau of Economic Research in the 1950's and 1960's, are Stigler (1956) and Greenfield (1966).

[3] See Pavitt 1985 for a discussion of the use of patenting statistics as innovation indicators, and Kleinknecht et al. (2002) for a discussion of R&D and a general discussion of innovation indicators, also in relation to capturing innovation in services.

[4] For overviews of different 'service innovation schools' see Coombs and Miles (2000), Evangelista, (2006), de Vries, (2006), Howells, (2006)

innovation in services. This demarcation approach to service innovation (Coombs and Miles, 2000) argues that service innovation is distinctively different from manufacturing innovation, being characterised by the importance of clients, the multiplicity of possible actors involved in innovation, and the dominance of interactive models of innovation. Therefore new theories and instruments are claimed to be required in order to understand the dynamics of service innovation. Djellal and Gallouj[5] (2001) represent a demarcation approach to innovation, broadening the innovation concept to encompass not only product and process innovation, but also internal organisational innovation and external relational innovation.

It is however worth noticing that many of the peculiarities of service innovation pointed out by studies following the demarcation approach may be just as important in manufacturing, they have just not been studied very often in that context (Drejer, 2004). Innovative activities in services and manufacturing may thus not be that different, studies of innovation in the two main sectors may just have focussed on different things. The approach that suggests that studies of service innovation place attention on general aspects of the innovation process that have tended to be neglected in studies of manufacturing innovation, is labelled the synthesis approach (Coombs and Miles 2000). Additional factors that speak in favour of relaxing the sharp distinction between innovation activities in manufacturing and services are the widespread presence of service *activities* in non-service sectors (Nählinder, 2005), as well as empirical findings of a large similarity between at least some types of service industries and manufacturing industries (Preissl, 2000). Some studies point out that there has even been a convergence between services and manufacturing (Coombs and Miles, 2000, Gallouj and Weinstein, 1997) and that there is a lot interdependence between the two sectors. As mentioned by Sundbo (2001) the sales of manufacturing products are often combined with services (training, maintenance) and services are sold in packages that also include tangible goods.

The present paper explores the extent to which the boundaries between manufacturing and services are blurred, both the degree to which manufacturing and service activities are intertwined in general, and the extent to which elements of services and manufacturing are combined in innovations. The mapping is based on Danish data[6].

2. Boundaries between manufacturing and services – a brief introduction to the literature

It has been recognized for a while that the separation of industries in statistical accounts is not drawing clear boundaries between firms in terms of their activities. In reality most firms perform a range of activities that could be assigned to other industries than their primary NACE-code. In addition, many functions are of a generic character, which means that the strictly industry-related activities are reduced to a smaller share of the total activities of the

[5] French researchers, especially in Lille, played an important role in the process of increasing the awareness of the importance of innovation in services. See, in addition to Djellal and Gallouj (2001), e.g. Gadrey et al. (1995) and Gallouj and Weinstein (1997).

[6] Data from the Nordic Community Innovation Surveys are used to broaden the focus from the Danish to the Nordic level in another part of this *ServInno* workpackage.

firm. These arguments are only reinforced when it comes to innovation. The trend towards modularisation and still more complex and cross-disciplinary innovation processes means that both the knowledge base and the pure innovation activities of the firm spans across a range of different types of processes.

One of the early attempts to perhaps dismantle the statistical classifications of what is going on in the innovative firm is work carried out at IUI, Industriens UtredningsInstitut, in Sweden. Researchers at this institute produced in mid-1970s to mid-1980s what was denoted a micro-to-macro model, sometimes referred to as the MOSES data base. It was built on the basis of survey information on what today probably would have been denoted ABC – Activity Based Costs – in an effort to make an accounting of the real activities of the firm. One of the backgrounds for doing this was dissatisfaction with how the statistical classifications represented what was going on in the larger Swedish firms. This was noted early in the work with building the model, e.g. when Eliasson (1985, p.22) claimed that *"Contrary to standard beliefs, service production, consisting mostly of information processing, is the dominant production activity within a modern manufacturing corporation."*

More specifically it was e.g. found that in 1982, 36% of labor costs in manufacturing firms in Sweden could be assigned to other activities than factory production (Pousette and Lindberg, 1990). Additionally, firms use a substantial and increasing share of their turnover on the purchase of services from other firms.[7] This led the authors to state that "*At the macroeconomic level attention is directed to the blurred statistical borderline between the manufacturing sector and parts of the service sector."* (ibid., p.119)

Turning more specifically to the issue of innovation, most studies of innovation have been limited either to manufacturing industries, or to services. A main explanation for this, in particular in the most recent years, where the awareness of the economic importance of service industries has increased, may be the lack of comparable data between the two main sectors. But the statistical classifications of firms and industries as belonging to either manufacturing or services also make it difficult to focus on *activities*, in particular the extent to which service and manufacturing activities are intertwined.

Tether (2005) discusses the way that innovation is carried out in manufacturing and services, respectively. Based on an analysis of data from the European Innobarometer 2002, Tether finds that although services tend to be more oriented towards organisational change in their innovation activities than manufacturing, there is no distinctively different mode of innovation in services from that of manufacturing. In line with the synthesis perspective on innovation, Tether concludes that firms in services "*often innovate through means that are more subtle (including an emphasis on human skills and inter-firm cooperations) and that are easily overlooked by traditional indicators such as R&D expenditures. But importantly these approaches to innovation are not peculiar to services*." (ibid., p. 182). This is further emphasized by Hipp and Grupp (2005, p.532) who find that "*manufacturing and services*

[7] The decision to 'make-or-buy' the services involves not only classical transaction cost theoretical problems and trade-offs but also strategic problems on the building of unique, long-term capabilities.

should be analysed together, classified not according to industries, but to 'service products' regardless of the sector in which they were generated. This would also allow a better account of product-accompanying services". While this admittedly poses challenges to traditional statistics it seems to be recognised in theory, but all the same neglected in practice in most studies.

One reason for the similarity of innovation modes in manufacturing and services may be that manufacturing is becoming more like services, as already discussed by the IUI-researchers in the 1970's and 1980's. Some firms classified as manufacturing are generating high proportions of their turnover from selling services, as illustrated by Howells (2004), who reports that IBM and Siemens derive more than 50% of their turnover from service activities. Howells relates the increasing focus on service activities in manufacturing to a change in the perception of consumption, with a growing tendency to move from perceiving consumption as a one-off contact via a product sale, to a continuing process involving long-term customer contact through service delivery. Howells argues that the shift in selling and consumption can influence a firm's perception about innovation as well, making it more concerned about reliability and ease of servicing, since the firm eventually may have to bear the costs of these activities. For a company like Rolls Royce (manufacturer of aircraft engines) services in terms of instrumentation and electronics for monitoring and diagnostics have thus become a more central issue for the innovation strategy. Likewise, service firms have become aware of how physical products may be delivered as part of a service package, or support a service delivery (ibid.).

Based on the above discussion, the borders between service and manufacturing activities appear to become increasingly blurred because of an increased focus on selling solutions rather than products, paired with a similarity in methods for carrying out innovation in the two main sectors. Additionally, trends in service innovations are that such activities have become more interactive and based on still more complex constellations of collaboration. Moreover, the innovation activities tend to be still more based on, or supplemented with, knowledge from R&D, often in-house R&D (Howells, 2006). There is however another main trend, which may pull in the opposite direction. Following a period in the 1970's and 1980's where leading firms engaged in vertical integration, and 'Big is beautiful' was the mantra, we have, since the late 1980s, witnessed an increasing tendency to outsource and focus on core capabilities. Whereas this was earlier primarily confined to low-skill activities it is more recently a phenomenon that is also prevalent in more knowledge-intensive activities. Strategic sourcing (Venkatesan, 1992; Gottfredson et al., 2005) is the opposite of acquiring control over the value chain through ownership by vertical integration. An example of a company that has undergone a dramatic change through a shift from focussing on vertical integration to strategic sourcing is 7-Eleven. 7-Eleven went from being a vertically integrated company with control of most of the activities of its value chain through ownership - operating a distribution network, delivering its own gasoline, making candy and ice cream, and even owning the cows that produced the milk sold in the stores – to becoming a company focussing on a small set of capabilities considered strategically vital, including in-store merchandising, pricing, ordering, and customer data analysis (Gottfredson et al., 2005). A recent Danish

survey (Ledernes Hovedorganisation, 2005) shows that 29% of the participating firms in the survey – private manufacturing and service firms with more than 10 employees – have outsourced activities either to companies within the country or to foreign located companies within the 3-year period preceding the survey. The main motives for outsourcing was reducing labour costs and increasing focus on core activities. The survey does not indicate whether firms that mainly produce services outsource manufacturing activities, and firms that mainly produce physical products outsource service activities. But the finding that half of the outsourcing firms mention "focus on core activities" as a motive for the outsourcing is in line with the strategic sourcing trend. This points in the direction of a clearer division of labour between firms in the value chain, and therefore also possibly a clearer separation between manufacturing and service activities[8]. Furthermore, there is now a general consensus that the role of knowledge and information in innovation has increased, and that this has contributed to a range of new, specialised industries within the service sector. Moreover, there are extensive efforts to codify much information in order to facilitate easy and long-distance transfer. Knowledge and information is now increasingly seen as a commodity for which there is a market. In turn, this has rendered an increased trade with knowledge and information, the explosion in trade with licences and other intellectual property rights being just one indicator of this[9].

There are thus tendencies pointing towards an increasing as well as a decreasing blurring of boundaries between manufacturing and services. In the following a snapshot of the extent of blurredness of these boundaries is explored based on data from two Danish innovation surveys, supplemented with survey data for a Danish region, North Jutland. The extent to which firms classified as manufacturing develop new services, and new physical products are developed by firms classified as belonging to the service sector, is used as a main indication of the blurredness of the boundaries between specifically the innovation activities in the two industries, whereas the potential blurring of boundaries in general is investigated through using a combination of information on the share of activities classified as services and the NACE-codes attached to the firms.

3. Empirical indications of blurring boundaries between manufacturing and service innovation

3.1 The data

The empirical investigation is primarily based on data from two surveys of innovation carried out by the Department of Business Studies at Aalborg University. The first survey, carried out in 2004, aimed at mapping innovative activity, with a special emphasis on collaboration on

[8] It is possible that this clearer separation between activities is only one of a legal nature. The activities are to a higher extent separated in different entities but at the same time they interact and trade intensively and in complex ways.

[9] For example, The EU-Commission estimates the global trade to be EURO 100 billion, a 40-fold increase in the past 20 years. OECD (2004) also show that the IPR-market has grown substantially over the past 10 years. As an illustration of revenues in the manufacturing sector being generated from a range of diverse sources, Texas Instruments earn licensing revenues of $ 800 million annually.

innovation, in Danish manufacturing firms (NACE codes 15-37) with a minimum of 10 employees. The sample included 1783 relevant respondents, and 1318 firms participated in the survey, resulting in a 74% response rate.

The second survey was carried out in 2005. The questionnaire was very similar to the one used in the 2004 survey, but the industry focus was now on firms with at least 10 employees operating in knowledge intensive service industries[10]. This main survey only includes a subpart of the service sector, but we are also - albeit unfortunately to a limited extent only - able to include other data sources, which include a broader part of the service sector. Because the number of knowledge intensive service firms with at least 10 employees is limited, it was possible to carry out a census survey. Of the 1393 relevant firms contacted, 732 firms participated, leading to a 53% response rate. For further information about the two surveys (in Danish) see Drejer et al. (2004) and Drejer (2006). As mentioned, an additional regional survey on types of activities in firms supplements these two surveys.

3.2 Boundaries as displayed in NACE codes

A first indication of the extent to which the boundaries between manufacturing and services are dissolving is the percentage of the turnover in the firms identified as knowledge-intensive service firms (based on NACE codes), which is actually generated from the sales of services.

[10] Defined as Financial intermediation, excl. ; Computer and related activities; Research and development; Other business activities, excl. Industrial cleaning; Adult and other education n.e.c.; Motion picture and video production; Radio and television activities

Table 1 shows the participating service firms' own reporting of the percentage of turnover generated from services. In total 71% of the identified service firms generate between 76 and 100% of their turnover from services, and one out five firms characterised as service firms in the industry classifications generate less than half of their turnover from sales of services.

There are marked differences between sub-sectors: In IT-services 30% of the firms ascribe less than 50% of their turnover to sales of services, and it is only half of the firms that generate 76-100% of their turnover from services. In Other business services and Finance and insurance, between 78% and 81% of the firms generate the large majority of their turnover from services. This difference may be due to IT-services combining their services with different types of hardware, but this issue is not explored further in the survey.

In terms of firm sizes there are no significant differences between small and larger firms. This is notable since larger firms generally have more diverse activities than small firms.

Table 1: Percentage of turnover generated from services in the identified knowledge intensive service firms

	1-25%	26-50%	51-75%	76-100%	Do not know	N
Finance and insurance	7%	5%	0%	81%	7%	112
IT-services	12%	18%	17%	50%	3%	179
Other business services	10%	7%	3%	78%	2%	441
10-19 employees	8%	11%	7%	73%	2%	323
20-49 employees	13%	10%	6%	67%	5%	236
50-99 employees	13%	3%	7%	72%	5%	61
100-199 employees	7%	10%	5%	76%	2%	42
200+ employees	14%	7%	0%	75%	5%	44
Total	10%	9%	6%	71%	3%	732

Differences between industries are statistically significant (at the 5% level – unless anything else is stated, the significance level is 5% in all tests throughout the paper). Differences between firm sizes are not significant.

Unfortunately the manufacturing firms were not asked the question about which main sector their turnover is generated from. As an approximation of the extent to which manufacturing firms are engaged in service activities we have looked at the NACE-codes assigned to the firms. The firms in the data set are assigned at least one and maximum seven NACE-codes. In Table 2 we have identified the fraction of firms in the manufacturing data set that have assigned NACE-codes from service as well as manufacturing industries. 34% percent of the firms are assigned NACE-codes from both sectors, i.e. the remaining 66% of the firms are only assigned NACE-codes from manufacturing. The figures from Table 1 and 2 can not be compared, but both tables do – in each their own way - indicate that the boundaries between manufacturing and services have not been completely erased since it is only a minority – although a considerable number – of the firms that operate on the borderline. Unfortunately we are not able to determine whether the fraction of firms operating on the borderline between manufacturing and services is stable, increasing, or decreasing over time, since we only have data for one time period. As discussed in the literature review there are tendencies pushing in opposite directions: outsourcing and focussing on core activities may lead to a clearer distinction between manufacturing and services; whereas the tendency of increased trade with knowledge, and the trend to focus more on selling solutions and complementary products[11] rather than stand-alone, specific products speaks in favour of dissolution of the boundaries. Whether the two types of activities are separated may also be affected by

[11] Complementarities between tangible and service products may e.g. be the increased tendency to sell all-coverage insurance together with electronics or the service programme and (differentiated) guarantee offered with a new car.

business cycles, just as may innovation activities. It has been discussed intensively, though, *how* business cycles affect innovation activities, or in this case, the propensity to try out new activities. On the one hand, it may be argued that innovation is risky and costly; therefore innovation activities are high in upswings when firms can afford and dare pursue new avenues. On the other hand it may be argued that firms have no incentives to go into different types of business when they are doing well in what they are doing. Rather, they are pushed into doing something differently only when times get tough.

Turning to specific industries, firms in the Transport equipment industry, Manufacture of wood products, Furniture and other manufacturing, as well as Electronic components are least focussed on manufacturing, and in these industries more than 40% of the firms have assigned NACE-codes from both manufacturing and services. Contrary to the case of knowledge intensive services, size matters in the manufacturing sectors: firms with at least 200 employees are more likely to have NACE-codes assigned from both manufacturing and services than the smaller firms. Thereby the firms in the manufacturing survey display the expected relation between firm size and scope of activities, which may be due to manufacturing firms being more able to benefit from synergies between products than service firms.

Table 2: Percentage of manufacturing firms that have assigned NACE-codes from both services and manufacturing

		N
Food, beverages and tobacco	39%	114
Textiles	39%	54
Wood products	43%	68
Paper and printing	26%	153
Chemical industry	36%	39
Rubber and plastic products	30%	69
Other non-metallic mineral products	35%	43
Metal industry	24%	270
Machinery and equipment	37%	217
Electronic components	42%	176
Transport equipment	44%	25
Furniture and manufacturing n.e.c.	43%	90
10-19 employees	30%	437
20-49 employees	31%	457
50-99 employees	39%	194
100-199 employees	34%	117
200+ employees	55%	103
Total	34%	1318

The differences between industries and firm sizes are statistically significant.

Extending this approach to the total population of Danish firms appendix table A1 shows information on which industries are 'connected' in terms of firms in these industries having more than one NACE-code.

3.3 Blurring boundaries as reflected in the view of firms' own activities

A regional Danish survey complements the above-mentioned data. The data are based on telephone interviews with the management of 1007 private firms in North Jutland, Denmark. This data collection is part of a quarterly regional business cycle indicator established in 1998[12]. In the fall of 2006 the survey included a small set of questions on the type of activities of the firms. These questions were specially designed for the purpose of the present paper. Firms were asked to list the share of their activities that could be denoted services, manufacturing and other. These statements are compared with the assigned NACE codes.

The survey covers the private sector. We investigate the share of firms that assigned a percentage of their activities to 'services' and 'manufacturing' respectively. Results are displayed in table 2a and 2b.

Table 2a: The Share of activities listed as Services. By industries and size groups.

	No service	1% - 49%	50%-99%	100%	Don't know	Mean	Median	Number of cases
Agriculture, fisheries, raw materials	46	20	15	18		30	2	43
Industry	41	35	14	10	1	23	5	226
Building and Construction	7	18	30	41	4	65	84	153
Trade and restaurants	7	10	17	65	1	79	100	326
Transport and telecommunications	1		5	94		99	100	59
Finance, business services	3	6	16	72	2	84	100	200
below 10 empl	11	10	19	58	2	72	100	401
10-19 empl	13	17	19	49	2	65	99	279
20 - 49 empl	18	23	14	46		59	89	177
50-100 empl	31	22	11	33	2	44	20	91
101 – 199 empl	38	26	9	24	3	33	9	34
TOTAL	15	15	17	51	2	66	100	1007

[12] The results of the business cycle forecasts and further explanation of method etc. (in Danish) can be obtained from www.business.aau.dk/njk.

Table 2b: The Share of activities listed as manufacturing. By industries and size groups.

	No service	1% - 49%	50%-99%	100%	Don't know	Mean	Median	Number of cases
Agriculture, fisheries, raw materials	18	7	29	46		70	98	43
Industry	11	8	40	41	1	75	95	226
Building and Construction	46	19	24	7	4	27	1	153
Trade and restaurants	67	11	14	6	1	18	0	326
Transport and telecommunications	96	3		1		1	0	59
Finance, business services	73	8	14	3	2	13	0	200
Below 10 empl	59	11	17	10	2	24	0	401
10-19 empl	53	10	23	12	2	31	0	279
20 - 49 empl	47	9	25	18		39	5	177
50-100 empl	32	8	26	31	2	54	79	91
101 – 199 empl	24	6	29	38	3	64	91	34
TOTAL	53	11	21	14	2	31	0	1007

Table 2a shows that half of the firms in the survey are classified as pure services; two thirds (68%) have listed that the majority of their activity are services. Even 18% of firms in Agroindustries, fisheries, raw materials, and 10% of firms classified as Industry, characterise all of their activities as services. Thus, a large share of firms, 33%, 24% and 71% in Agroindustries, fisheries, raw materials, Industry, and Building and construction respectively, claim that more than half of their activities are services rather than manufacturing. The propensity to list the activities as pure services decreases with firm size, which may not be surprising as many large firms are multi-product firms covering either different, complementary products or more than one link in the value chain. The larger share of service activities in large firms may also reflect that these firms are often more complex organisations.

Moving to the propensity to list manufacturing as the main activity, Table 2b shows that firms in Industry and Agro-food industries are listing this more frequently than firms in other industries. But even within these industries there are 18% and 11% of firms respectively who list ‘no manufacturing’. 25% and 19% of firms respectively in these two sectors characterise more than half of their activities as being outside manufacturing. The reverse picture appears concerning firm size: the smaller firms are less ‘manufacturing intensive’. Again, Building and construction appears to be dominated by activities not regarded as manufacturing by the firms themselves. In 65% of firms in that industry activities are primarily outside manufacturing – an average of 27% of activities being manufacturing.

While the above discussion is mainly concerning shares of firms within catagories of activities, we are also interested in the share of economic activity ascribed to services and manufacturing respectively. Mean and median values for the share of activities characterised

by the firms as services (Table 2a) and manufacturing (Table 2b) are also displayed in the tables. From the mean and median values the size effect is clear. But also the industry break-down is showing results in line with those discussed above. It may be noted that firms in Industry claim that one fourth of their activities are services, and that Building and construction firms characterise two thirds of their activities as services. A large share of activities in Building and construction is not regarded as manufacturing by the firms themselves.

3.4 Blurring boundaries in innovation activities

The above figures refer to the main activities of the firms. In the remaining part of the paper we will take a closer look at product/service innovative firms.

44% of the manufacturing firms participating in the innovation survey had developed one or more new products within a two-year period. 26% of the firms that had developed a new manufacturing product had also – alone, or in collaboration with external partners – developed one or more new services which were delivered as part of the firms' product packages (see

Table 3).[13] The manufacturing industries with the highest frequencies of delivering new services as part of their product package were Machinery, Electronics, and Transport equipment, where 33% of the product innovative firms also had developed new services. This fits well with the findings by e.g. Sundbo (2001) that manufacturing products and services are often delivered in packages. It also corresponds with findings by Howells (2004) discussed in the previous section, that in manufacturing industries producing machinery and equipment, that can be used for performing a service, the service part of these products – including supporting the operation reliability – may receive a considerable innovation focus. The lowest frequencies were found in industries where the consumption may still be seen as a one-off event, such as Non-metallic mineral products (6%), Food, beverages and tobacco (13%), Metal industry (14%), and Wood products (18%). In terms of size, large firms, i.e. firms with more than 200 employees, are more likely to have introduced new services as part of the product package than smaller firms. This fits with the discussion above that large manufacturing firms are often more efficient in exploiting synergies between different products. Also it is likely that larger firms may to larger extent have sufficient volume in their complementary services to generate deep competences in these services. and hence innovative capabilities to renew and develop these services.

[13] Examples of services are free service checks or user training.

Table 3: Percentage of product-innovative manufacturing firms that – within the last two years – have developed one or more new services to be delivered as part of the product package

		N
Food, beverages and tobacco	13%	62
Textiles	24%	21
Wood products	18%	22
Paper and printing	32%	44
Chemical industry	32%	28
Rubber and plastic products	23%	30
Other non-metallic mineral products	6%	16
Metal industry	14%	76
Machinery and equipment	33%	117
Electronic components	33%	107
Transport equipment	33%	9
Furniture and manufacturing n.e.c.	29%	38
10-19 employees	17%	144
20-49 employees	27%	184
50-99 employees	28%	95
100-199 employees	21%	71
200+ employees	42%	74
Total	26%	570

The differences between firm sizes are statistically significant, whereas the differences between industries are not (unless the significance level is raised to 10%, i.e. the significance is weak).

Table 4 reveals that although firms in the manufacturing survey that are assigned NACE-codes for both manufacturing and services are more likely to have introduced new services as part of their product packages than firms with manufacturing NACE-codes only, the differences are not as outspoken as one might have expected: 33% of the firms with both service and manufacturing NACE-codes have developed new services, whereas 22% of the firms with manufacturing NACE-codes only have done so. Firms identified as manufacturing may thus develop and supply services without this necessarily being reflected in the industry codes. This illustrates that industry codes are not always very precise indicators of the actual activities going on in the firms. This as was also strongly reflected in the findings reported in Tables 2a and 2b.

Table 4: Relation between manufacturing firms having assigned NACE-codes for both manufacturing and services, and development of one or more new services to be delivered as part of the product package

	Percentage of product innovative firms that have developed one or more new services to be delivered as part of the product package	N
Only manufacturing-related NACE-codes	22%	368
Both service- and manufacturing-related NACE-codes	33%	202
Total	26%	570

Differences are statistically significant.

The survey of the service sector is limited to the most knowledge-intensive services. 77% of the participating service firms have developed one or more new services within a two-year period. 33% of the remaining firms that have *not* developed new services themselves report to have contributed to other firms' development activities. Of these non-developing, but contributing firms, 23% contributed to the development of new physical products, 54% participated in the development of new services, and 16% participated in the development of both physical products and services (7% were not able to specify whether the development concerned physical products and/or services).

Table 5 overleaf shows that 37% of the knowledge intensive service firms that had developed new services had also developed services that were delivered as part of a product package that included physical, tangible products. The product package combining services and physical products was most often supplied by the innovating service firm itself, but in more than one out of four cases the product package was supplied by another firm. The knowledge intensive service firms appear to be slightly more often involved in combining services with physical products, than manufacturing firms are involved in combining their physical products with services: 26% of manufacturing firms have developed services, opposed to the 37% of the service firms involved in product packages that include physical products. There is however a difference in the way that the questions are posed to the firms in the two main sectors: the manufacturing firms were asked whether they had developed new services, whereas the service firms were only asked whether their newly developed services were delivered in a product package that included a physical product – the service firms did not necessarily develop the physical product themselves. What the data do show is that at least one out of four product innovative firms in both manufacturing and knowledge intensive services have introduced innovations that combine physical products and services. This substantiates that even if there are still boundaries between manufacturing and services, then in a substantial share of the firms the boundaries are however erased to such a degree that innovative activities combine tangible and intangible products. This holds across size groups and sub-groups of the industry.

Table 5: Percentage of service-innovative knowledge intensive service firms that – within the last two years – have developed one or more new services to be delivered as part of a product package including physical products

	Package including physical products supplied by firm itself	Package including physical products supplied by another firm	N
Finance and	10%	6%	89
IT-services	46%	13%	155
Other business	22%	10%	321
10-19 employees	23%	12%	238
20-49 employees	30%	9%	186
50-99 employees	25%	6%	48
100-199 employees	27%	12%	33
200+ employees	28%	8%	40
Total	27%	10%	565

Only the differences between industries in percentage of firms having developed services delivered as part of packages including physical products supplied by the firm itself are statistically significant.

There is a strong relation between the focus of the knowledge intensive service firms, in terms of percentage of turnover generated from services, and the likelihood of having been involved in delivering product packages combining physical products with services (see

Table 6). 68% percent of the firms that generate 25% or less of their turnover from services have been involved in delivering product packages containing both physical products and services, whereas this is only the case for 27% of the firms that generate 76-100% of their turnover from services. This tells us that, as discussed in the literature review, 'pure' service firms may be highly specialised and not so prone to benefit from product synergies.

Table 6: Relation between percentages of turnover generated from services and development of one or more new services to be delivered as part of a product package including physical products

	Percentage of service innovative firms that have developed one or more new services to be delivered as part of a product package including physical products	N
1-25% of turnover generated from	68%	57
26-50% of turnover generated from	66%	56
51-75% of turnover generated from	56%	39
76-100% of turnover generated from	27%	401
Percentage of turnover generated from services unknown	67%	12
Total	37%	565

Differences are statistically significant.

66% of the manufacturing firms that have developed new products have in at least one occasion collaborated with partners external to the firm on one of their development projects. Most of these firms have collaborated with suppliers of knowledge intensive services: as illustrated in Table 7, 50% of all the product-innovative firms have collaborated with one or more service suppliers in the development process. The larger firms are more likely to have collaborated with service suppliers than the very small firms, but this is more likely to be a reflection of the overall collaboration structure, where larger firms have a higher collaboration frequency than small firms, than a reflection of service firms being less relevant as collaboration partners for small firms than other types of partners.

Table 7: Percentage of product-innovative manufacturing firms that have collaborated with suppliers of services[14] in the development process

		N
Food, beverages and tobacco	42%	62
Textiles	43%	21
Wood products	32%	22
Paper and printing	39%	44
Chemical industry	71%	28
Rubber and plastic products	40%	30
Other non-metallic mineral products	56%	16
Metal industry	45%	76
Machinery and equipment	23%	117
Electronic components	57%	107
Transport equipment	57%	9
Furniture and manufacturing n.e.c.	50%	38
10-19 employees	36%	144
20-49 employees	52%	184
50-99 employees	51%	95
100-199 employees	55%	71
200+ employees	65%	74
Total	50%	570

The differences between firm sizes are statistically significant, whereas the differences between industries are not (unless the significance level is raised to 10%, i.e. the significance is weak).

[14] Suppliers of private services are in the survey categorised in four groups: (i) institutes for testing, control, certification, standardisation; (ii) other authorised technological service institutes; (iii) other private technical laboratories or consultants; (iv) marketing, management, legal or other private consultants.

Although there also appears to be large differences in collaboration frequencies between manufacturing firms in different industries, these differences are only weakly significant because the number of observations in each industry is too low to strongly reject that the differences are more than statistical coincidences.

The overall collaboration frequency with partners external to the firm is with 63% at the same level for knowledge intensive service as was the case for manufacturing firms. The knowledge intensive service firms are however less likely to have collaborated with suppliers of physical products and equipment in the development process, than the manufacturing firms are to have collaborated with knowledge intensive services: only 23% of the knowledge intensive service firms that have developed new services have collaborated with suppliers of physical products during the development process (see Table 8). This difference may reflect that knowledge intensive services – in addition to being innovative themselves - to a considerable extent are aimed at supporting innovation in other sectors. This is in accordance with previous findings of knowledge intensive services as important contributors to innovation processes taking place in their client firms (den Hertog and Bilderbeek, 2000). This might be a consequence of manufacturing firms to a greater extent outsourcing service activities, such as design or testing (the survey does not inquire about outsourcing activities though, so this is just a proposed explanation).

Table 8: Percentage of service-innovative knowledge intensive service firms that have collaborated with suppliers of physical products/equipment in the development process

		N
Finance and insurance	18%	89
IT-services	25%	155
Other business services	23%	321
10-19 employees	25%	238
20-49 employees	22%	186
50-99 employees	10%	48
100-199 employees	21%	33
200+ employees	28%	40
Total	23%	565

Differences are not statistically significant.

As discussed in section 2, one sign of blurring boundaries between manufacturing and services can be that the ways that innovation is carried out in the two main sectors are similar. The organisation of innovation in services is explored further in other deliverables from the *ServInno* project, so in the present context we only look at one additional factor,

which has commonly been perceived as being very different between manufacturing and services: the extent to which innovation is based on research and development activities. Service innovation has traditionally been perceived as being less dependent on R&D activities than innovation in manufacturing, where innovation processes have been perceived as technologically driven to a much larger extent. Tether (2005) documents that R&D is used as a source of innovation in some service firms, although to a lesser extent than in manufacturing. It has also been discussed in the literature that when the range of services in a firm expands, the costs of R&D may increase, but in services relatively more than in manufacturing because synergies are not as outspoken (see other workpackage in the *ServInno* project for elaboration and documentation). The Danish data however illustrates that when services are limited to include knowledge intensive services only, the frequencies of firms that base their innovation activities on R&D are similar between manufacturing and services. Among the product innovative manufacturing firms, 42% base their innovative activities on in-house R&D activities, whereas the corresponding fraction is 39% among the knowledge intensive service firms (Table 9). 11% and 10% respectively in the two main sectors have not invested in R&D, but have considered this. Only when it comes to basing the innovative activities on externally acquired R&D services or patents/licenses there is a considerable difference between the two sectors: 16% of the product innovative manufacturing firms have acquired external R&D and/or patents or licenses in relation to their innovative activities, whereas this only applies for 8% of the service innovative firms. There is in particular a higher tendency amongst manufacturing firms to buy patents compared to services, which is in accordance with patenting being used less frequently as a means of protecting intellectual property rights in services (Andersen and Howells, 2000).

Table 9: Percentage of firms that have invested in R&D activities in relation to product/service development

	Product innovative manufacturing firms	Service innovative knowledge intensive service firms
In-house R&D activities	42%	39%
Externally acquired R&D services or patents/licenses	16%	8%
No R&D, but considered investing in R&D in relation to product/service development	11%	10%
N	570	565

The widespread use of R&D as a basis for innovation in services illustrates that although service innovation may draw more on “subtle” means, such as human skills and inter-firm cooperations than manufacturing innovation (Tether, 2005), “hard” knowledge based on R&D also plays a role in knowledge intensive services, thereby underlining that, based on this, it is not possible to draw a clear line between how things are done in manufacturing and services

respectively – just as it may sometimes be difficult to draw a clear line between what is a service and a manufacturing product.

4. Conclusions

The purpose of the present paper has been to provide a snapshot of the extent to which the boundaries between manufacturing and services are blurred. Although the boundaries between manufacturing and services are also discussed in general, the major emphasis is on innovation activities, in order to contribute to the major aim of the *ServInno* project, which is to add to our knowledge about service innovation as a basis for informed policy making.

Services have moved from being ignored in innovation studies, over being studied with what was characterised as a "manufacturing logic", to being treated as activities that require special tools and concepts in order to grasp the true nature of the innovative activities going on. Currently there is a debate about whether the "manufacturing logic" is in fact too narrow for understanding the extent of innovative activities in manufacturing as well as a debate about the appropriateness of industry codes as descriptions of the activities going on in firms. As a contribution to this debate, the current paper illustrates the extent to which firms that are categorised as belonging to *one* main sector in the economy carry out activities that, according to a strict distinction between manufacturing and services, actually "belong" in *another* main sector. In relation to innovation the focus is on the extent to which services and physical products are combined in new innovative offerings.

The analysis shows that service firms by no means only generate their turnover from service activities, and that a considerable fraction of manufacturing firms also carry out service activities. In fact, in industries such as Building and construction, Agroindustry and raw materials, and Industry a large share of activities are classified as services. In terms of innovative activities, one out of four innovative firms in manufacturing and 37% in knowledge intensive services has provided new product packages that combined manufacturing and service elements. This indicates a high degree of complementarity, one that seems to be pervasive across sub-industries. Our final answer to our research questions is hence somewhat ambiguous. On the one hand our analysis of what types of activities firms are engaged in showed that firms generally, even if classified as manufacturing, have a lot of other types of activities, in particular services. We showed that the statistical classification of firms is actually not adequately covering the true state of affairs with respect to types of activities in the firms. The shutters between manufacturing and services are by no means waterproof. On the other hand the majority of the firms in both sectors do however appear to focus on either manufacturing or services when it comes to development activities, without engaging in activities outside their main sector. So even though there does appear to be a grey zone between the two sectors, where the activities intertwine, currently this only involves a minority of firms in the two sectors. Service innovation activities are also carried out in many (one fourth) manufacturing firms, but despite the general assertion of service

firms being extremely interactive in their development activities, we also found indications of – if not an introvert mode of innovation – then at least a segmentation of firms where some are strongly related to other sectors, while other firms are not. This is supported by the finding that the share of knowledge intensive service firms that carry out R&D is equal to the share of manufacturing firms. The size of the firms explains the general activities, not the development activities.

In terms of drawing on knowledge from the other main sector in the innovation process, manufacturing firms are more likely to engage in collaborations with knowledge intensive service providers than service firms are likely to engage in collaborations with providers of physical inputs. Half of manufacturing firms had collaboration with service providers in their product innovation process, whereas 23% of knowledge intensive service firms had a manufacturing firm as a development partner. In line with a general trend towards increasing importance of R&D in services (Howells, 2006) the paper also demonstrates that R&D activities appear to be used equally frequent – by 4 out of 10 firms - as an innovation input in manufacturing and services, although service firms are less likely to acquire external R&D through patents and licenses than manufacturing firms.

Policies for promoting service innovation have only recently begun to emerge. Therefore policy learning is still limited, as only a few countries have had service innovation programmes for some time (e.g. Scotland, Netherlands, Denmark, Finland – for an overview see European Commission, 2006). With respect to policy implications of the present study we shall confine ourselves to general propositions (other parts of the *ServInno* project goes deeper into policy implications). Our first remark on implications concerns the question of horizontal versus vertical policies. We saw in our analyses that a vast proportion of service activities, and even service innovation activities, are going on outside the service sector. Therefore, it is questionable whether sector-based policies will 'hit the target'. This raises a question of eligibility, that is, to which extent should support programmes be sector-oriented, in particular if based upon industry code classifications, and should they only be confined to firms statistically classified as service firms?

Another implication is of a more indirect character. The basis for sound policies should be knowledge of a high validity. The present study showed that the statistical foundation of analysis of services is shaky. To pursue knowledge based policies the statistics of service activities need to be improved.

Finally, we will point to a research implication of the study. The blurring boundaries and complementarities between services and manufacturing were deliberately not given a clear normative dimension above. It may be questioned if complementarity between the sectors is necessarily positive in terms of the performance of firms (even if it may be argued that it is beneficial from a societal perspective as it stimulates knowledge dissemination). The counter-hypothesis that specialisation and a clearly divided practise is good for performance cannot be rejected a priori. Future research needs to address this issue.

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APPENDIX

In addition to the survey information on primary and secondary NACE-codes, we obtained information on which industries are 'connected' in terms of having more than one NACE-code from a register of all Danish firms. Out of 617,369 firms, 577,612 (94%) assigned only one NACE-code, almost all the rest of the cases contains information on 2 NACE-codes; less than 1% (4500 firms) have more than two NACE-codes. Focusing upon the 39,757 firms who assigned more than 1 NACE-code, Table A1 shows how these firms list their secondary NACE-code.

Table A1: Secondary industry codes by industries. Firms who list minimum 2 NACE codes

Percentages horizontally		Secondary industry									
		Agri	F&B	Iron	Elec	Other	B&C	Trade	Trans	Finance	**Total**
PRIMARY INDUSTRY	Agriculture, fisheries, raw materials	26,07	0,29	1,50	0,16	0,86	15,87	10,53	1,50	43,21	5128
	Food and beverages	2,79	35,41			1,93	0,43	51,93	0,43	7,08	466
	Iron and metal	6,55	0,13	35,86	3,69	5,91	7,25	29,24	0,51	10,87	1573
	Electronics	1,74		10,00	19,57	5,43	3,91	42,61	0,22	16,52	460
	Other Industry	3,70	0,77	3,10	1,03	37,28	2,93	31,64	0,69	18,85	2323
	Building and Construction	12,54	0,03	3,67	0,95	2,42	33,66	17,12	2,80	26,80	3675
	Trade and restaurants	4,33	0,89	2,05	0,80	3,36	3,09	57,74	2,16	25,58	10259
	Transport and telecommunications	9,20	0,21	0,90	0,48	0,83	6,85	27,46	25,31	28,77	1446
	Finance, business services	6,56	0,15	0,64	0,41	3,70	4,23	22,13	1,95	60,23	14427
Total		**8,88**	**0,80**	**3,04**	**0,91**	**5,07**	**8,25**	**30,98**	**2,71**	**39,36**	**39757**

From the table it is clear that not only is it a small share (6%) of firms that have a secondary NACE-code, the majority of these firms also list secondary codes within their main industry. Two other results stand out. First, Finance/business services is frequently referred to as secondary code. This is probably explained by the way some firms are structured legally, as a substantial part are organised as holding companies. Second, Trade and restaurants is likewise frequently listed as the secondary industry. This may have to do with the fact that some of the trading activities are separated in a special department that in many cases engage in trading even beyond the narrow needs of the company.