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ELINKEINOELÄMÄN TUTKIMUSLAITOS
THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
Lönnrotinkatu 4 B 00120 Helsinki Finland Tel. 358-9-609 900
Telefax 358-9-601 753 World Wide Web: http://www.etla.fi/

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Aija Leiponen*

IS SERVICE INNOVATION DIFFERENT?

* Cornell University, Department of Applied Economics and Management
aija.leiponen@cornell.edu, 251 Warren Hall, Ithaca, NY 14853-7801, United States

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ABSTRACT: This exploratory empirical study compares the determinants of innovation in manufacturing and services through descriptive and regression analyses of sales from innovative products and services. The results suggest that, contrary to earlier research, R&D investments play a positive and significant role in both services and manufacturing. Service firms also benefit from broad strategies of sourcing external information. In contrast, strategic breadth in terms of pursuing multiple different innovation objectives or cooperating with different types of partners appears to have detrimental effects on service innovation. We interpret the latter results through reference to service firms' R&D and alliance management capabilities: Managing multiple innovation projects or multiple cooperative arrangements is challenging, and some service firms may not have accumulated the requisite managerial capabilities to benefit from these strategies. The available data provide partial support for this conjecture.

JEL: O31, O32, L8

1. INTRODUCTION

Most scholarly studies of innovation continue to focus on manufacturing firms and industries. Several arguments suggest that a much greater attention on innovation in services is appropriate. Around 75% of GDP in industrialized economies is now produced in the service sector. The economic importance of the sector is thus already clear, yet we don't understand very well how the sector works and, in particular, how it renews itself. Some service industries are lagging in terms of productivity growth and this is feared to slow down economic dynamism as an ever-increasing share of the economy consists of service activities. At the same time, services are expected to be the engine of employment growth in industrialized economies in the coming decades. While innovation in many traditional manufacturing industries involves technologies and processes to increase labor productivity (and often reduce headcount), the potential to reduce service employees in many service activities is limited, hence the prospects for continued employment growth in the sector. Finally, the boundaries between services and manufacturing are getting blurred (Christensen & Drejer, 2007). Much innovation in the manufacturing sector actually involves service activities. Then, analyses of service innovation may also illuminate relevant aspects of innovation processes in the manufacturing sector.

To better understand the implications of service growth for economic dynamism, it is useful to start by asking whether innovation in service activities is different from that in manufacturing activities. There are various answers to this question in the literature. Some scholars highlight the unique characteristics of services (Gallouj, 1997; Miles, 1994; Miles & Boden, 2000) and argue that the conceptual frameworks originally developed for manufacturing industries do not necessarily apply in the service sector. Others (Evangelista, 2000; Leiponen & Drejer, 2007; Tether, 2005) using broad-based innovation surveys do not find very dramatic differences between the two sectors. Generally speaking, European innovation surveys seem to suggest that there are greater differences within each sector than there are between the two sectors. In particular, and against expectations of some observers, many service firms are very innovative and invest highly in R&D. These “high-tech” services appear to innovate largely in the same ways high-tech manufacturing firms do. However, the reason why we find this is the case may be the survey questionnaires that were developed with the manufacturing sector in mind. More nuanced data collection efforts and empirical analyses are thus called for.

To identify some of these subtler differences between the two main sectors, it is useful to recall that the fundamental distinctions between services and manufacturing products are that services are largely intangible and often co-produced with clients (Miles et al., 1995). These characteristics presumably influence the organization of service development activities. Sundbo (1997) argued that service development projects are typically carried out by informal ad hoc committees or project teams rather than institutionalized R&D organizations. In interviews with knowledge-intensive business service (KIBS) executives, Leiponen (2001) found that some KIBS firms intentionally resist institutionalization of new service development, because it is important that employees engaged in innovation activities also interact directly with clients. Here, the co-production aspect arguably comes into play. At least thus far, KIBS managers feel that cross-functional teams cannot replace direct contact between clients and employees active in new service development. Leiponen’s results elsewhere (2005) also align with the notion that business service innovation is often ad hoc in nature. R&D investments or permanent R&D teams are not very strongly statistically associated with the introduction of new services. In the manufacturing sector, in contrast, R&D investments are very closely correlated with measures of innovation output. As relevant capabilities in services reside to a very large degree in individuals and teams as opposed to equipment or blueprints, in-house training may compensate for formal R&D activities in many service firms (Leiponen, 2000).

Additional areas of differences found between the two sectors include the sources of knowledge for innovation and the use of intellectual property rights to protect the returns on investments in innovation. For example, based on the European CIS data, Arundel et al. (2007) document that universities and research institutes are on average less valued as sources of information or as collaboration partners. However, a much more diverse picture hides behind these statistics: firms in KIBS industries value public science much more than firms in the manufacturing sector do. Other studies also have documented that based on the CIS data, service firms tend to rely more than manufacturing firms on consulting companies as sources of inputs for innovation (add citation). Finally, both Arundel et al. (2007) and Tether and Massini (2007) also find that service innovators utilize formal intellectual property rights much less intensively than goods innovators do. The intriguing result is that service firms also use informal (or strategic) forms of protection such as secrecy, lead time, or less frequently than do manufacturing firms. Nevertheless, as one would expect, service firms tend to rely on confidentiality agreements, lead time, trademarks, and secrecy, rather than patents, which are the second most important method of protection for manufacturing firms and only the sixth most important for services (Tether & Massini, 2007: 164).

Considering that differences have been identified, in what ways, then, have processes of service and manufacturing innovation been found to be similar? In the Schumpeterian literature, innovation is often conceptualized as a process of combination—of ideas, technologies, or capabilities (e.g., Schumpeter, 1942; Fleming & Sorenson, 2001; Mowery, Oxley, & Silverman, 1996). One can argue that innovation activities in both services and manufacturing are similarly about creating or sourcing relevant knowledge and combining it in new and valuable ways. Directly comparing the knowledge-sourcing patterns of samples of service and manufacturing industries, the Finnish CIS datasets indicate that both manufacturing and service firms value customers as the most important source of information and ideas for innovation, followed by suppliers of equipment, technology and software, competitors, and consulting firms. In terms of knowledge sourcing patterns, there are thus few differences between the sectors.

More generally, when comparing the CIS responses of service firms and manufacturing firms, apart from the aforementioned specific differences, the two sectors look fundamentally alike, not distinct. This was statistically documented in factor and cluster analyses by Leiponen and Drejer (2007). When Finnish and Danish firms were clustered based on their scores in a factor analysis of innovation activities, knowledge sources, and objectives for innovation, first, similar factors were found in services and manufacturing when the analyses were carried out separately for the two sectors, and second, when the analyses were carried out for the combined sample, service firms were found in all clusters alongside manufacturing firms and were not found particularly likely to cluster together. The differences found were a matter of degree: relatively fewer service firms were found in the "scale and science based" cluster dominated by large firms that source information from and collaborate with universities and use formal intellectual property rights, while relatively more service firms were found in the "market driven" cluster where they source information from clients with the objective of opening new markets and extending old ones.

The novelty in the current paper is to shed new light on service innovation by using the Finnish community innovation survey dataset combined with the subsequent R&D survey. The special focus of this study is to examine whether the roles of strategic and geographic breadth in innovation activities differ between services and manufacturing, and between different subsectors within services manufacturing. The sub-sector level analyses enable the identification of more fine-grained distinctions. We have data of 121 service innovating firms (firms with some innovation activities or investments) and 414 manufacturing innovators for the 1994-96 community innovation survey and the 1998 R&D survey. These two sources of information enable us to construct a dataset where independent variables are lagged by two years.

The conceptual tack is to compare innovation in service and manufacturing industries with respect to “breadth” of innovation approach. An earlier study investigated the effects of the breadth of innovation objectives and information sourcing strategies on innovation outcomes using data on the manufacturing sector only (Leiponen & Helfat, 2005). Here we examine breadth both in terms of objectives and information sources and in terms of domestic and foreign R&D collaboration. There are a few reasons why breadth of innovation strategies may be associated with innovation success. First, by engaging in multiple simultaneous innovation objectives, firms increase the probability that at least one of them will succeed (Evenson & Kislev, 1976). Multiple sources of information might also be useful from this “sampling” perspective. Additionally, as innovation is often conceptualized as a process of knowledge combination, the diversity of information available to a firm might be more conducive to success in its innovation processes. Of course, there are costs to breadth, and firms should increase breadth until the marginal benefit equals marginal cost. However, in practice this optimal point may be difficult to identify or achieve, which enables us to estimate the effects of breadth. Moreover, the benefits of breadth may depend on firms’ R&D capabilities. Managing multiple R&D objectives and knowledge sources requires managerial experience and organizational processes. We test for the moderating effect of institutionalized (regular) R&D activities in benefiting from breadth.

External sources of information have been found to be essential for innovation (Laursen & Salter, 2006) and to vary across different types of firms and industries. For example, the so-called Pavitt taxonomy (1984) of innovation in different industries had patterns of information sourcing as one of the fundamental distinctions between sectors. Pavitt also characterized the different sectors in terms of their broad innovation objectives: creation of new products or markets vs. process efficiency. Knowledge sources and innovation objectives are thus central elements of innovation strategy.

Finally, there is a large and growing literature focusing on the role of inter-firm cooperation in innovation. Although Pavitt was essentially silent about cooperation when he wrote about sectoral patterns in early 1980s, cooperative activities have blossomed in the subsequent two decades. Here I characterize the types of partners chosen by firms in each sector and the breadth of cooperation approach. A particular focus is on firms' international orientation – whether they collaborate with domestic or foreign partners. One might hypothesize that services are more domestically oriented because of the need for co-location to deliver the services. However, the evolution of communication technologies has made it much more feasible to deliver even highly knowledge-intensive services over communication networks, as we have learned in the case of offshoring.

2. DATA

The Finnish 1994-96 CIS dataset combined with 1998 R&D survey has 533 observations in total when we retain firms with some innovation activity (any innovation investments, collaboration, or innovation output); of these 121 are service firms in a subset of service industries. Most importantly, all personal services are excluded. Table 1 displays the industry distribution in this combined sample. With 121 observations it is difficult to achieve great statistical significance, particularly with sub-sample analyses. We will therefore interpret these data as the basis of discussion and hypothesis formation rather than as conclusive evidence.

Descriptive statistics for the service sample are provided in table 2. In general terms, the service firms sampled are quite R&D intensive (4.4% of sales) and innovative—almost 10% of these firms' sales were derived from any new services introduced by the firm within the previous 3 year, and over 4% of sales derived from service innovations that were "novel" (new to the market). More than half of the firms also are engaged in R&D cooperation with domestic or foreign partners.

Table 1 Industry distribution

NACE	Industry	N	Share %	Subsample group
15-16	Food, beverages and tobacco	33	*6.4%*	Discrete manufacturing
17-19	Textiles, wearing apparel and leather	19	*3.7%*	Discrete manufacturing
20-22	Wood, pulp, paper, printing and publishing	54	*10.5%*	Discrete manufacturing
23-25	Petroleum, chemicals, rubber and plastic products	57	*11.1%*	Discrete manufacturing
26-28	Metals, metallic and non-metallic min. products	59	*11.5%*	Discrete manufacturing
29	Machinery and equipment n.e.c.,	70	*13.6%*	Complex manufacturing
30-33	Electrical and optical equipment	73	*14.2%*	Complex manufacturing
34-35	Transportation equipment	20	*3.9%*	Complex manufacturing
36-37	Manufacturing n.e.c.	9	*1.8%*	NA
40-41	Electricity, gas and water supply	15	*2.9%*	Network service
51	Wholesale trade and commission trade, except of motor vehicles and motorcycles	21	*4.1%*	Network service
60-62	Land, water and air transport	19	*3.7%*	Network service
64.2	Telecommunications	21	*4.1%*	Network service
72	Computer and related activities	24	*4.7%*	Knowledge-intensive business service
74.2	Architectural and engineering activities and related technical consultancy	20	*3.9%*	Knowledge-intensive business service
	Total	*514*	*100.0%*	

Table 2 Descriptive statistics of the service subsample (N=121)

Variable	Mean	Std Dev	Minimum	Maximum
Employees	462.545	1653.470	10	10533
Finnish parent	0.322	0.469	0	1
Foreign parent	0.132	0.340	0	1
Export share	0.070	0.167	0	0.910
Higher technical skills	0.121	0.159	0	0.737
Any service innovations (1998)	0.455	0.500	0	1
% of sales from service innovations (1998)	9.959	19.792	0	90
% of sales from novel service innovations (1998)	4.165	10.190	0	60
Training expenditure/sales	0.002	0.008	0	0.063
R&D expenditure/sales	0.044	0.116	0	0.753
Any patents	0.107	0.311	0	1
Any domestic R&D cooperation	0.653	0.478	0	1
Any foreign R&D cooperation	0.355	0.481	0	1
Types of domestic cooperation partners	1.851	1.896	0	6
Types of foreign cooperation partners	0.835	1.428	0	6

We divide the combined sample into four different groups. Services are split into "network" industries (electricity, gas & water; transportation; telecommunications) and knowledge-intensive business services (computer services and technical services). There are

44 firms in the business service group, and 76 firms in the network service group. The manufacturing sample is split into discrete and complex industries, following Cohen et al. (2000). Discrete industries include chemical, food, paper, and metals, and the group of complex industries consists of machines and equipment, electronics, and transportation equipment.

Table 3 Means for service and manufacturing subsectors

Variable	Business service	Network service	Complex manufacturing	Discrete manufacturing
Employees	135.977	649.156	309.574	519.480
Finnish parent	0.386	0.286	0.306	0.462
Foreign parent	0.091	0.156	0.175	0.157
Export share	0.153	0.023	0.400	0.286
Higher technical skills	0.222	0.048	0.064	0.061
Any innovations (1998)	0.591	0.377	0.760	0.601
% of sales from product innovations (1998)	18.727	4.948	21.273	9.466
% of sales from novel product innovations (1998)	7.045	2.519	9.503	4.045
Training expenditure/sales	0.005	0.001	0.001	0.001
R&D expenditure/sales	0.092	0.017	0.058	0.014
Any patents	0.159	0.078	0.508	0.350
Any domestic R&D cooperation	0.773	0.584	0.683	0.717
Any foreign R&D cooperation	0.523	0.260	0.552	0.543
Types of domestic cooperation partners	2.318	1.584	1.896	2.013
Types of foreign cooperation partners	1.295	0.571	1.361	1.305

When we compare across the four subsectors (see table 3), we find that services are rarely outliers; there is substantial variation within each main sector. For example, business services have the most highly trained technical staff of all four groups, and network service firms have the least highly trained staff. Similarly, business services are the most R&D intensive group, while network services are about as R&D intensive as discrete manufacturing. Network services are also the least export intensive and the least innovative group, and the least likely to be engaged in R&D collaboration. Nevertheless, with their emphasis on process efficiency, network services are in many ways similar to the manufacturing sector in terms of their objectives for innovation.

Aligned with other CIS studies, a clear difference between manufacturing and services is the frequency of patenting. While over half of innovating complex manufacturing firms have applied for at least one patent in the previous three years, only 16% of business service firms and 8% of network service firms have applied for any patents. Patents are not useful as a source of knowledge, either. However, although this would seem to suggest that appropriability of returns to innovation is a problem for service innovators, according to the knowledge sourcing indicators in table 4, service firms obtain less knowledge for innovation from their competitors than either of the manufacturing subsectors. Horizontal knowledge flows thus appear to be less prominent in services than in manufacturing, perhaps against expectations.

The CIS questionnaire of 1994-96 asked about R&D cooperation in two different dimensions: types of partners and location of partners. In table 3, we summarized the information from the dataset in these two dimensions: the number of different types of domestic partners and the number of different types of foreign partners. Types of partners include own business group (parents, siblings, subsidiaries); clients; suppliers of equipment, materials, software etc; competitors; consulting firms; universities; and non-profit research institutes. Business services are the most active domestic collaborator, while discrete manufacturing is the best networked internationally. Table 4 enables comparisons across the four subsectors in terms of specific types of collaboration partners. Compared to the manufacturing groups, business services are relatively more active in cooperation arrangements with competitors and consulting firms. In absolute terms, however, their most important partners are domestic customers, suppliers, and universities, as is the case for both manufacturing groups. Network services, on the other hand, is the only subsector that collaborates more with domestic consulting firms than with universities. As a supplier-dominated group, these firms also are rather unlikely to cooperate with any other foreign partners than suppliers.

Table 4 Elements of innovation breadth for the subsamples

Means	Business service	Network service	Complex manufacturing	Discrete manufacturing
Objectives (0/1):				
1. Replace outdated products	0.773	0.766	0.699	0.574
2. Improve product quality	0.909	0.896	0.836	0.834
3. Expand product assortment	0.750	0.727	0.639	0.587
4. Enter new markets or increase market share	0.864	0.688	0.776	0.807
5. Increase flexibility of production	0.227	0.455	0.432	0.350
6. Reduce labor costs	0.591	0.688	0.607	0.682
7. Reduce use of materials	0.409	0.558	0.536	0.556
8. Reduce use of energy	0.227	0.286	0.464	0.556
9. Fulfill government regulation or standards requirements	0.205	0.260	0.257	0.345
10. Mitigate environmental damage	0.273	0.390	0.344	0.422
Knowledge sources (0/1):				
1. Own firm	0.932	0.792	0.918	0.843
2. Business group	0.341	0.325	0.251	0.372
3. Competitors	0.341	0.455	0.574	0.552
4. Customers	0.886	0.740	0.902	0.798
5. Consulting firms	0.250	0.273	0.153	0.166
6. Suppliers of equipment, materials, components, or software	0.341	0.558	0.454	0.502
7. Universities	0.341	0.221	0.383	0.381
8. Public or private non-profit research institutes	0.205	0.130	0.213	0.291
9. Patents	0.000	0.013	0.148	0.126
10. Conferences, scientific/trade publications	0.250	0.506	0.393	0.462
11. Databases (e.g. Internet)	0.295	0.338	0.153	0.117
12. Trade fairs, exhibitions	0.295	0.299	0.481	0.498
R&D cooperation with (0/1):				
1. Domestic customers	0.591	0.390	0.448	0.430
2. Domestic suppliers	0.409	0.364	0.404	0.395
3. Domestic competitors	0.182	0.169	0.060	0.166
4. Domestic universities	0.477	0.234	0.579	0.547
5. Domestic consulting firms	0.318	0.273	0.240	0.220
6. Foreign customers	0.341	0.078	0.415	0.300
7. Foreign suppliers	0.273	0.195	0.311	0.323
8. Foreign competitors	0.182	0.078	0.142	0.143
9. Foreign universities	0.136	0.091	0.158	0.220
10. Foreign consulting firms	0.227	0.065	0.104	0.099
Observations	44	77	183	223

Knowledge sourcing statistics are highly aligned with the collaboration numbers. Although services are thought to be less actively engaged with university research, this only applies to network services; knowledge-intensive business services are almost as likely to source information from universities or research institutes as are firms in manufacturing industries. In contrast, both service groups more actively source information from consulting firms and databases than do the two manufacturing groups.

3. REGRESSION ANALYSES

In this section we use the Finnish data to test some commonly suggested hypotheses about service innovation activities using simple regression analyses. First, we examine the role played by R&D investments and institutionalized (regular) R&D – do they matter or not. Then, we explore the roles of clients, suppliers, universities, and competitors as sources of information and as collaboration partners. Finally, we assess the role of "breadth" in firms' innovation strategies: how many different types of partners firms cooperate with; how many different sources of information they utilize; and how many different objectives for innovation do they pursue. For manufacturing industries, these factors were found to improve innovation outcomes, but we don't know how they play out in services.

Descriptive statistics in table 3 indicated that the service sample here is rather highly R&D intensive, particularly the group of knowledge-intensive business services. The Frascati manual definition of R&D has been criticized by service scholars as being too focused on technical artifacts (Howells, 2007). The CIS questionnaire is based on the Frascati definition of R&D and hence asks respondents to report expenditures related to "systematic activities, the purpose of which is to increase knowledge or to develop new applications based on existing capabilities." The questionnaire goes on to define the development of prototypes as a central element in R&D and to include software development when software is significantly improved or when software development is part of an R&D project.

The first set of estimation models for the service firm sample in table 5 includes the natural logarithm of sales from innovative services as the dependent variable and a standard set of control variables. Firm size is included as the natural logarithm of employees; business group (whether the firm has a domestic or foreign parent) controls for organization structure and possible knowledge flows from the parent; export intensity controls for incentives for innovation from international competition; and the binary variable "any R&D cooperation" controls for the organization of firms' R&D activities. The investment variables included are the natural logarithms of R&D and training expenditures. Training is included as earlier research on knowledge-intensive business services suggested that in-house training may compensate for R&D activities in smaller service firms that rely on employees' skills to a large extent (Leiponen 2005).

Table 5 Does R&D matter for service innovation?

Service subsample

	Log(ALL INNOVATION SALES)			Log(NOVEL INNOVATION SALES)		
	Coeff.	SE	p	Coeff.	SE	p
Intercept	-5.913	6.320	0.349	-4.388	5.583	0.432
Log(employees)	0.771	0.472	0.102	0.542	0.417	0.194
Business group	-0.908	1.376	0.509	-2.020	1.216	0.097
Exports/sales	5.613	3.851	0.145	3.450	3.402	0.311
Any R&D cooperation	-2.673	1.338	0.046	-1.848	1.182	0.118
Log(R&D expenditure)	0.751	0.230	0.001	0.522	0.203	0.010
Log(training expenditure)	0.334	0.254	0.188	0.668	0.224	0.003
Sigma	5.967	0.387	<.0001	5.271	0.342	<.0001
Log likelihood	-381.41			-366.66		

Notes: Tobit ML models include 2-digit industry dummies. 119 observations.

Services and manufacturing combined

	Log(ALL INNOVATION SALES)			Log(NOVEL INNOVATION SALES)		
	Coeff.	SE	p	Coeff.	SE	p
Intercept	-3.072	1.512	0.042	-1.883	1.485	0.205
Log(employees)	0.943	0.233	<.0001	0.675	0.229	0.003
Business group	-0.554	0.650	0.394	-1.292	0.639	0.043
Exports/sales	0.935	1.038	0.368	0.749	1.019	0.462
Any R&D cooperation	1.311	0.720	0.069	1.143	0.707	0.106
Institutionalized R&D	2.835	0.717	<.0001	2.093	0.704	0.003
Log(R&D expenditure)	0.274	0.171	0.108	0.019	0.167	0.910
Log(training expenditure)	0.327	0.126	0.009	0.589	0.123	<.0001
Service*Log(R&D)	0.158	0.232	0.496	0.274	0.228	0.229
Service*Any R&D cooperation	-4.222	1.477	0.004	-3.256	1.450	0.025
Sigma	5.887	0.180	<.0001	5.782	0.177	<.0001
Log likelihood	-1701.00			-1692.00		

Notes: Tobit ML models include 2-digit industry dummies. 533 observations.

R&D investments are found to significantly explain both sales resulting from any type of service innovation and those resulting from novel (new-to-the-market) service innovations. The coefficient of training investments is positive in the model for novel service innovation sales, but in the first model for all innovation sales, it is positive but statistically insignificant. We thus have evidence that both R&D investments and training related to innovation matter for service innovation performance. A possible reason why some earlier studies have failed to find the connection between R&D and innovation outcomes is that most studies have used cross-sectional and simultaneous dependent and explanatory variables. However, time lags can be important, particularly for service firms that do not necessarily carry out R&D on a continuous basis. For example, with the current sample, there is no concurrent connection between R&D investments and service innovation output. The time lag of two years used here is thus important.

An intriguing result is the negative and significant effect of R&D cooperation on sales from service innovations. This seems to suggest that successful service innovation processes tend to be substantially less “open” than those in the manufacturing sector, where cooperation is strongly positively associated with innovation output. When the same dependent variables are regressed on different types of domestic and foreign partners (not reported in the table), foreign competitors and universities do show up as positive and significant factors. Moreover, subsector analyses suggest that foreign suppliers and universities are particularly relevant for novel service innovation in network services. Hence, cooperation is not necessarily detrimental to innovation in these service industries, but not all service firms appear to benefit from it.

The lower panel of table 5 estimates the same model for the combined sample of service and manufacturing firms but with separate coefficients for R&D cooperation and R&D expenditures for service firms. This provides additional evidence that R&D doesn’t matter any less for service innovation. For both types of innovation output, the coefficient of the interaction between service dummy and R&D expenditures is positive but not statistically different from zero. These results also demonstrate the differential effect of R&D cooperation for services and manufacturing. The interaction coefficient of cooperation for service firms is significantly negative and larger in magnitude than the coefficient of the original R&D cooperation variable suggesting that cooperation can indeed hamper innovation in services. We also include a dummy variable for firms that carry out R&D on a regular basis as an additional control for R&D activity. It is not significantly different for service and manufacturing firms.

However, when analyzing the two manufacturing subsamples (not reported in the table), we find that the general benefits of cooperation mainly apply to discrete manufacturing firms. In separate analyses using the types of collaboration partners, none of the domestic or foreign types of partners are statistically significantly associated with innovation by complex manufacturing firms, while innovating discrete manufacturing firms statistically significantly benefit from domestic universities and consulting firms and foreign customers as collaboration partners. Cooperation thus has different implications for innovation in different types of manufacturing industries, too.

Additional subsample analyses of business and network services (available from the author on request) confirm the results concerning the role of R&D investments in service innovation in table 5, although, for novel service innovations, the results from small subsamples are slightly less precise. Hence, we conclude that R&D investments are an integral element of both manufacturing and non-personal service innovation.

The next set of analyses compares the two sectors in terms of their utilization of information from or collaborating with customers, suppliers, universities, and competitors. Other studies have suggested that as in-house R&D activities play a lesser role in service innovation, firms in service industries engage in a highly interactive pattern of innovation with their environments. We are thus interested in how service firms tap into relevant information outside of their boundaries and, to examine this, we form four new variables: customer_info, competitor_info, supplier_info, and university_info, each of which are sums of three binary variables: information source, domestic collaboration, and foreign collaboration. In other words, customer_info equals three if a firm indicates that (1) customers are an important or very important source of information for innovation, (2) it collaborates in innovation activities with domestic customers, and (3) it collaborates in innovation activities with foreign customers. Competitor_info, supplier_info, and university_info are formed in similar ways. Each new variable thus ranges between zero and three. The purpose of these variables is to assess the importance of these information sources and at the same time reduce the multicollinearity among the information source and collaboration variables.

Table 6 displays the estimation results using these new variables. The same set of control variables is included as in table 5. The results for the sales from all service innovations dependent variable indicate that service innovators do not benefit from any particular source of information. However, for sales of novel (new to the market) services, information from universities turns statistically significant. Subsample analyses suggest that this result is largely driven by the group of network services. None of the information sources significantly affects business service innovation—not even clients.

In contrast, manufacturing firms benefit from customer information both in terms of sales from new to the firm (all innovation) and new to the market (novel innovation) products. Additionally, universities show up as a significant and positive source for the former type of innovation. In all samples, intensive sourcing of supplier information is negatively (though not significantly) associated firm innovativeness—firms that rely on suppliers tend not to innovate that much themselves. Finally, from manufacturing subsamples (not reported here) we learn that the results obtained are largely driven by the discrete manufacturing group.

Table 6 Importance of different sources of knowledge utilized in innovation

Dependent variable: Log(all innovation sales)

	Services			Manufacturing		
	Coeff.	SE	p	Coeff.	SE	P
Intercept	-1.275	2.092	0.542	-0.788	0.952	0.408
Log(employees)	0.567	0.450	0.208	0.476	0.258	0.065
Business group	-1.352	1.261	0.284	-0.545	0.748	0.467
Exports/sales	4.331	3.924	0.270	1.301	1.007	0.197
Log(R&D expenditure)	0.682	0.242	0.005	0.660	0.155	<.0001
Log(training expenditure)	0.361	0.265	0.173	0.204	0.145	0.159
Customer_info	0.082	0.829	0.921	1.269	0.368	0.001
Supplier_info	-0.462	0.667	0.488	-0.305	0.328	0.353
University_info	0.153	0.673	0.820	0.843	0.346	0.015
Competitor_info	1.097	0.889	0.217	0.112	0.415	0.787
Sigma	6.253	0.402	<.0001	6.061	0.210	<.0001
Log likelihood	-393.49			-1340.00		
Observations	121			416		

Notes: Tobit ML models include 2-digit industry dummies.

Dependent variable: Log(novel innovation sales)

	Services			Manufacturing		
	Coeff.	SE	p	Coeff.	SE	p
Intercept	-1.366	1.775	0.441	-1.204	0.969	0.214
Log(employees)	0.351	0.382	0.358	0.301	0.262	0.251
Business group	-1.918	1.070	0.073	-1.046	0.762	0.170
Exports/sales	2.116	3.329	0.525	1.081	1.026	0.292
Log(R&D expenditure)	0.480	0.205	0.019	0.349	0.158	0.027
Log(training expenditure)	0.802	0.225	0.000	0.524	0.147	0.000
Customer_info	-0.141	0.703	0.841	1.245	0.375	0.001
Supplier_info	-0.568	0.566	0.316	-0.620	0.334	0.063
University_info	1.217	0.571	0.033	0.489	0.353	0.165
Competitor_info	-0.220	0.754	0.770	0.381	0.423	0.368
Sigma	5.305	0.341	<.0001	6.171	0.214	<.0001
Log likelihood	-373.61			-1347.00		
Observations	121			416		

Notes: Tobit ML models include 2-digit industry dummies.

Next we explore the effects of breadth in innovation objectives and knowledge sources. Leiponen and Helfat (2005) explained in detail why breadth might be valuable for innovating firms. A priori there doesn't seem to be any reason why breadth might affect service and manufacturing innovation differently. Table 7 shows results for the combined sample estimating separate coefficients for service firms. The variables of interest are the sum of important innovation objectives and the sum of important sources of knowledge (see table

2 and 4 for the raw scores of sources and objectives). As reported in Leiponen and Helfat (2005), when these variables are used to explain sales of innovative products in the manufacturing sector, both are positive and statistically significant. Here, we find that breadth in knowledge sources is again positively and significantly associated with sales of innovative products, and that the coefficient is no different for service firms. If anything, knowledge sources are slightly more important for service firms.

Table 7 Breadth of innovation objectives and knowledge sources

Dependent variable: Log(all innovation sales)

	(1)			(2)		
	Coeff.	SE	p	Coeff.	SE	p
Intercept	-5.192	1.635	0.002	-3.273	1.667	0.050
Log(employees)	0.803	0.238	0.001	0.880	0.233	0.000
Business group	-0.479	0.665	0.471	-0.208	0.652	0.750
Exports/sales	0.879	1.047	0.402	1.044	1.029	0.311
Any R&D cooperation	0.161	0.651	0.805	0.265	0.632	0.675
Log(R&D expenditure)	0.589	0.133	<.0001	0.360	0.147	0.014
Log(training expenditure)	0.303	0.127	0.017	0.337	0.126	0.008
Sum of important objectives	0.229	0.145	0.115	0.109	0.155	0.482
Service*sum of objectives	-0.550	0.332	0.097	-0.635	0.328	0.053
Sum of important knowledge sources	0.350	0.169	0.038			
Service* Sum of important knowledge sources	0.097	0.315	0.758			
Institutionalized R&D*sum of important objectives				0.372	0.123	0.003
Institutionalized R&D*sum of objectives*service firm				0.293	0.223	0.190
Sigma	5.945	0.182	<.0001	5.885	0.180	<.0001
Log likelihood	-1706.00			-1701.00		

Notes: Tobit ML models include 2-digit industry dummies.

In contrast, the result on breadth in objectives is different. The coefficient of the sum of objectives is positive, although not quite statistically significant (multicollinearity with the sum of knowledge sources may play a role—objectives are significant when knowledge sources are excluded). However, the coefficient of objectives interacted with the service dummy is strongly negative and significant at the 90% level of confidence. Similar results were obtained when we estimate separately for the service sample only (not reported in the table): the coefficient of knowledge sources is positive and significant while that of objectives is negative although insignificant. Service firms thus experience difficulties benefiting from breadth in objectives.

One possible explanation for this is that managing multiple simultaneous objectives requires more sophisticated R&D project management capabilities. With an R&D organization that is often ad hoc in nature, service firms may not have as solid R&D management capabilities as manufacturing firms do. To test this idea, in the second specification of table 7, we estimate the coefficient for objectives and the coefficient for services interacted with objectives separately for firms that had institutionalized R&D activities. These results support the idea that R&D management capability is the prerequisite for benefiting from broad innovation objectives—for both service and manufacturing firms.

Our last regression results are displayed in table 8. Here, we further explore the negative coefficient for R&D cooperation obtained in table 5. To examine the effect of breadth in cooperation strategies, we sum up all the different types of cooperation partners listed in table 4, plus units of the domestic or foreign business group. This variable thus ranges from 0 to 12. For manufacturing firms, broader cooperation strategies pay off in the form of greater sales of innovative products. For service firms, the coefficient is much smaller, however, although the interaction term is not statistically significant. Perhaps service firms have started to utilize cooperation strategies more recently than manufacturing firms and have not accumulated sufficient "alliance capabilities" (Kale, Dyer, & Singh, 2002). Unfortunately, the CIS data do not include information about firms' previous cooperation activities. Instead, we interacted the cooperation breadth variable with the institutionalized R&D dummy and with R&D expenditures to gauge the moderating effect of R&D capability. These interaction terms were positive but not statistically significant. Additional analyses showed that the insignificance of broad cooperation for service innovation applies for both domestic and foreign partners and for both business and network service firms. The only exception is the positive and significant impact of breadth in cooperation with foreign partners on novel innovation sales in network services—service firms that cooperate with foreign partners the least.

Table 8 Breadth of cooperation

Dependent variable: Log(all innovation sales)

	Coeff.	SE	p
Intercept	-2.051	1.474	0.164
Log(employees)	0.601	0.231	0.009
Business group	-1.382	0.648	0.033
Exports/sales	0.545	1.012	0.590
Log(R&D expenditure)	0.274	0.132	0.038
Log(training expenditure)	0.561	0.123	<.0001
Sum of types of domestic and foreign R&D collaboration partners	0.281	0.118	0.017
Service*sum of types of R&D partners	-0.183	0.215	0.394
Sigma	5.824	0.178	<.0001
Log likelihood	-1708.00		

Notes: Tobit ML models include 2-digit industry dummies. 533 observations.

4. CONCLUSIONS

This exploratory empirical study uses Finnish CIS data combined with national R&D survey data to analyze differences in the determinants of innovation between the service and manufacturing sectors. The descriptive analyses of the service and manufacturing samples are largely aligned with earlier survey studies, most of which use CIS datasets for other European countries. The novelty of this study is in the results of the regression analyses that use dependent variables that are observed two years later than the independent variables. We find that R&D activities are very important for service innovation, at least in the network and business service industries covered by the Finnish CIS sample. Moreover, broad information sourcing strategies are also relevant for service innovators, although few of the individual sources of external information show up as significant determinants of innovation. Interestingly, service customers are not a distinguishing source of knowledge for innovation but universities are. Hence, although few service firms source knowledge from universities, those who do greatly benefit from it.

In contrast, the effects of breadth of innovation objectives and R&D cooperation are different for service innovators and manufacturing innovators. Broad innovation objectives and cooperation strategies are highly significant and positive factors behind innovation in manufacturing industries. For service innovators, these variables are either insignificant or negative and significant. We further explore these results with moderating factors of institutionalized R&D activities and R&D expenditures. We find a weakly significant effect of institutionalized R&D moderating the benefits of broad objectives. In other words, service firms that carry out R&D on a regular basis probably benefit from broad innovation objectives. We do not find a statistically significant moderator for the negative results on R&D cooperation. We hypothesize that service firms lack the alliance capabilities necessary to make cooperative activities work. Future work could further explore this issue by utilizing longitudinal information on cooperation experience from earlier CIS surveys.

The empirical analyses conducted in this study utilized a cross-sectional dataset where explanatory variables were lagged by two years. Although this research design reduces the problems with simultaneity that have plagued most of extant research, the results may still be biased because of unobserved heterogeneity. For example, there may be unobserved factors that make some firms likely to adopt multiple innovation objectives and be highly innovative, although there is either no causal relationship or a less pronounced causal relationship between the two variables. Research designs utilizing longitudinal datasets or natural experiments created by policy changes would mitigate these types of endogeneity issues. It is thus important to interpret the results as evidence of strong multiple correlation rather than causality.

Many of the extant studies of service innovation discuss the fact that CIS questionnaires were developed with manufacturing innovation in mind and might miss some important elements of service innovation. One aspect missing from the survey dataset used here is organizational innovation, which Tether (2005) found to be very relevant for service firms. Moreover, looking at the service and manufacturing subsamples, we found that our models were able to explain innovation in discrete manufacturing and network services—traditional industries—much better than in complex manufacturing and knowledge-intensive business services. More detailed research efforts should focus on these high tech industries and develop more appropriate datasets and empirical models to better understand their innovation activities.

Finally, unresolved and largely unstudied questions regarding service innovation involve the role played by information and communication technologies (ICTs). An early conceptual framework by Barras (1986 and 1990) argued that ICTs are a key driver of process innovation in services, particularly financial services, and that process innovations tend to precede product innovations in the service innovation life cycle, in contrast to the product life cycle identified in manufacturing industries (Abernathy & Utterback, 1978). It is clear that ICT adoption is crucial for continued productivity growth in service industries. Moreover, ICT adoption may reduce the degrees of intangibility and co-production identified earlier as critical characteristics of service activities. However, as far as innovation processes are concerned, it is not known to what degree service innovation and client interactions can be carried out using communication technologies rather than face-to-face interaction. Important future research questions thus involve the human and social dimensions of ICT adoption and ICT-based innovation in service industries.

At the same time, there is a major service transformation going on in the information technology industries. Technology giants such as IBM are trying to figure out how to downsize basic research on IT components and gear up activities that improve the dynamism and success of service operations (Spohrer et al., 2007). While, conceptually, the Schumpeterian idea of innovation through combination of relevant knowledge in new ways may still apply, it is highly likely that the types of knowledge that need to be combined have changed dramatically for the likes of IBM. Interactions with people—clients, complementors, suppliers, even competitors—are in a key role, in contrast to research scientists' interactions with technical artifacts or materials. R&D based on science and engineering may need to give way to applied social science research, and scholarly research projects on service innovation should reflect this.

To conclude, we find that the determinants of service innovation are in most ways similar to those of manufacturing innovation, and that broad strategies of information sourcing and juggling multiple objectives are beneficial for innovating service firms, provided they have the in-house managerial capabilities. We also found one clear area where service innovation appears to operate differently: R&D cooperation. More research on cooperative activities of service firms is thus called for. For example, one could start by exploring the initial hypothesis that many service firms lack sufficient alliance capabilities.

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