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Service Innovation in Philippine Industries

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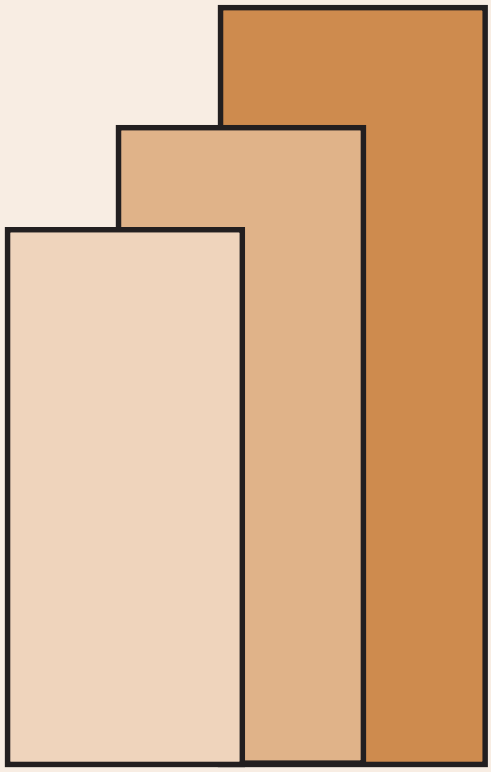

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Service innovation in Philippine industries

by Ramonette B. Serafica[1]

Abstract

This paper examines the evidence on service innovation using the 2012 Census of Philippine Business and Industry and the 2009 Pilot Survey of Innovation Activities. It reveals the wide variation in R&D intensities and differences in innovation behavior between the manufacturing and services sectors, for example with respect to information sources and innovation activities. Many similarities were also detected in terms of service product innovation, the popularity of organizational innovation, and the preference for training activities, among others. Looking at structural factors, the probit regression analyses indicate that the size of the firm is a good determinant for all types of innovation. Ownership and age were also significant for certain innovation outputs, which could help inform policies on FDI and entrepreneurship. The results of this paper reveal the importance of service innovation not only for the services sector but for the manufacturing sector as well consistent with servicification. In general, different types of innovation are undertaken by industries for various reasons and the technological and non-technological forms of innovation complement each other. If the government aims to promote economy-wide upgrading, support for innovation should not favor only one type of innovation output or activity. Further research on innovation behavior to cover more industries will be useful in developing a comprehensive and more nuanced approach to innovation policy.

Key words: innovation, services, manufacturing, R&D, servicification

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Table of contents

Introduction

The Philippines is a service economy. Thus, service innovation is necessary for sustained growth. Moreover, since services are used as intermediate inputs in the goods sector, service innovation will contribute to further industrial upgrading and value adding in other sectors of the economy.

Although critical to the productivity of all sectors, service innovation is not easy to grasp and empirical work particularly in the context of developing economies is scant. Thus, the aim of this paper is to gain some insights and contribute to a better understanding of this issue. In the next section a brief review of the theoretical and empirical literature is presented followed by an analysis of the innovation behavior of Philippine industries. The paper concludes with recommendations for policy and further research.

Review of the literature

The innovation process is essentially a service activity. For this reason, the linkage between services and innovation is not easy to characterize. Service innovation could be understood to mean the innovation that occurs in service firms or in terms of manufacturing firms producing new services. At the same time, a firm whether in manufacturing or in service industries can be thought of as innovating through service activities and functions (e.g. R&D, training, and marketing). As industries evolve, these distinctions will likely become less important. Nonetheless, identifying innovation in service industries presents difficulties (Toivonen and Touminen 2009). *First*, specific resources in the form of R&D departments are often missing in service companies. In many cases service innovations are not the results of a deliberate activity at all but emerge in the process of service provision on the basis of clients' needs. They are recognized as innovations only after they have been provided. *Secondly*, the common classification into product, process and organizational innovations is difficult to apply in services, as services are simultaneously both products and processes. *Thirdly*, due to the 'fuzzy' nature of the output of services it is much more difficult to detect a change or improvement in a service than to recognize an industrial product as a new one. Service companies often cannot tell whether they have produced innovations. Moreover, innovations are either underestimated or every service act is regarded as an innovation due to its unique nature. It is also common that service firms do not use innovation terminology, but speak about customer satisfaction, quality improvement, etc., when they are actually seeking to renew their products. In trying to explain how service firms innovate, the conceptual frameworks that have emerged to date can be grouped into three perspectives (Toivonen and Touminen 2009; Howells 2010; Gallouj and Savona 2010; and Morrar 2014):

Technologist approach – Also called the **assimilation** approach, it borrows from manufacturing-centered frameworks and considers innovation in services as resulting from the adoption and use of technologies and systems (in particular, computers and other information and technology equipment) by service firms and organizations. The non-technological aspects of the process of creating novelty are overlooked in this approach. The model of the '*reverse innovation cycle'* by Barras (1986), considered the first innovation theory that concentrated specifically on services, is an example. According to this view, the innovation cycle in service sectors takes the form that is the converse of the traditional industrial cycle where product innovation precedes process innovation. In contrast, service firms initially adopt new technologies developed in manufacturing to increase the

efficiency of their processes. Later, more radical process innovations are introduced to improve the quality of service. At the final stage, wholly new service products are developed.

Service-oriented approach – Also referred to as the **demarcation** approach, it emphasizes the peculiarities of services and innovation processes in relation to service activity. The unique qualities of services include intangibility and simultaneity of production and consumption (i.e. produced and consumed at the same time) often with direct involvement of the consumer (i.e. services are co-made or co-produced by the provider and user working together). Thus, the focus of this approach is on non-technological and invisible innovation output such as service customization, problem solving, new solutions, and organizational innovation. Studies which focus on this approach have sought to identify distinctive innovation practices and patterns and have typically looked at knowledge-intensive business services.

Integrative approach – A synthesis of the two perspectives described above, this approach favors a similar analytical treatment of innovation for manufacturing and services (i.e. one that is manufacturing-compatible and also able to account for the non-technological nature of the innovation activities that may occur in service companies). The integrative view is justified by the increasing convergence of goods and services in both their production and consumption and the increasing recognition that there are other forms of innovation aside from a technological one. Howells (2006) as cited in Morrar (2014) describe manufacturing as becoming more like services and services becoming more like manufacturing. In the former case, manufacturing firms produce more service products related to the main industrial products such that higher portions of their revenues are from selling services, a process of "servitization" of manufacturing or "servicification" as coined by the National Board of Trade (2012, 2013). In the latter case, service firms become more innovative and increasingly adopt traditional technological innovation in manufacturing (i.e. services are becoming more manufacturing-like in innovation). The synthesis approach therefore "highlights the increasing complex and multidimensional character of modern services and manufacturing, including the increasing bundling of services and manufacturing into solutions" (Morrar 2014 citing Salter & Tether 2006). This approach is now more commonly applied in empirical work using national innovation surveys.

Castro et al. (2011) compare the innovation behavior of 11,330 Spanish service companies and manufacturing companies. The study first analyzes whether there are different innovative behaviors followed by manufacturing and service companies. Next, the tendency to innovate of companies in each sector is determined using logistic regression models. Finally, factors which hinder innovation in each sector are also presented.

Their results indicate that both service companies and manufacturing companies are innovative, although they display different (behavior preferences) depending on the type of innovation. Companies belonging to the manufacturing sector are more likely to innovate in product, processes, work organization and product design and packaging. Companies in the service sector, on the other hand, are more likely to innovate in relations with other companies and in sales and distribution methods. Innovation in management systems shows no differences in the behavior of companies in these sectors.

It was also observed that the differences in innovative behavior also occur within their subsectors. With regard to services, the financial subsector stands out in all types of innovation except for

improving product design and packaging. Companies belonging to the financial sector have a greater tendency to innovate in processes, in contrast to those belonging to the retail and hotels and restaurants sectors. In manufacturing, all subsectors except recycling, tend towards product innovation and are more inclined to implement process innovations.

Pires, et al. (2008) analyze the innovation behavior of the manufacturing and services sectors in the case of Portugal using data from the third Community Innovation Survey. This survey covers data for the period 1998–2000 and it includes all manufacturing enterprises and most service firms except hotels and restaurants, some support services, public services and services provided by non-profit organizations. The study reveals that external knowledge sources are more important for product innovation, whereas internal sources are more relevant for process innovation. They also show that technology adoption through machinery acquisition plays an important role both in product and process innovation, but the effect is particularly strong in the case of process innovations.

They find that while manufacturing leads in some items (intramural R&D, machinery acquisition, pioneer innovators and process innovators), the service sector has more innovative behavior in other activities (extramural R&D, R&D cooperation, training activities and product innovation). Thus, as a whole there is no evidence that one sector clearly dominates the other in terms of innovation. There are however substantial differences in innovative activity across manufacturing and service subsectors.

In services, knowledge adoption activities are not as important as in manufacturing; however, technology adoption has a clearly positive impact on services innovation. The effect of the firm's absorptive capacity is positive for process innovation in manufacturing firms while for service firms its effect is positive both for product and process innovations. This shows that human capital is an essential resource for innovation in general and even more so for service innovations. Results also confirm that size has a positive impact on the probability of innovation; however, innovation in service firms is less sensitive to size than in manufacturing ones.

An unexpected result of the study is that being part of a multinational group, for a given size and level of R&D engagement, has a positive effect on the probability of process innovation but a negative impact on product innovation. Since the introduction of a new product requires a good knowledge of the local market and the use of advertising and distribution strategies adapted to the local market, locally based firms may have an advantage in these activities, which explains why locally based firms are more successful in product innovations.

Finally, young firms have a relatively higher propensity for pioneer innovations, but the reverse is true for process innovations in service firms. This shows that while the Schumpeterian perspective of a strong link between entrepreneurship and innovation applies well to pioneer product innovations, the importance of continuous improvement and learning-by-doing is dominant in service firms' process innovations.

In summary, there are four key insights that can be derived from the study:

- First, for a firm wanting to innovate, the optimal mix between internal and external knowledge sources depends on the type of innovation they want to achieve.

- Second, human capital is a very important resource for innovation, especially in the service sector.
- Third, for multinational firms to be more successful with regard to product innovations they should use their subsidiaries to learn about the diverse local environments; use this knowledge to design products so as to satisfy customers in the various environments and give their subsidiaries autonomy in adapting the new product and market strategy to the local market.
- Finally, encouraging entrepreneurship may lead to an increase in pioneer product innovations.

Iacovone, et al. (2013) used the micro level data from the 2007 Technological Innovation Survey in Chile to evaluate the differences between the manufacturing and services sectors and between exporters and non-exporters. They also looked inputs and outputs, outward orientation, and the (joint) decision to export and innovate. The following are the key findings from their study:

- First, services firms have a much lower propensity to export than manufacturing firms but the exporter size premium for the services sector is significantly lower than for the manufacturing sector. This means that fewer services firms export but those that do are not necessarily much larger than non-exporters. This could be due to the relatively greater importance of skills rather than scale in services exports. The study finds that while all exporters tend to be more skill-intensive than non-exporters, the "export skills premium" is greater in services than in manufacturing.
- Second, services firms appear to be as innovative as manufacturing firms, in terms of inputs in and outputs of innovative activity, measured using both subjective and objective indicators. However, services firms tend to rely relatively more on non-technological forms of innovation than manufacturing firms. This includes innovations in product design and organizational management in production, work environment or management structure of the firm, as opposed to "technological" innovation, which refers to introduction of new products or processes in the market, and expenditure related to R&D, physical equipment acquisition and training related to them.
- Third, exporters tend to be significantly more innovative than non-exporters, both in manufacturing and services. The gap in innovation between exporters and non-exporters increases for innovations that are closer to the global technological frontier. However, for both exporters and non-exporters services firms show a higher propensity to innovate than manufacturing.

In contrast to the previous studies which cover more than one sector, Bascavusoglu-Moreau and Tether (2010) focus on the manufacturing sector in the United Kingdom. The authors note that introducing and innovating services is encouraged as a means by which manufacturing firms in advanced economies can retain or enhance their competitiveness. However, little is known about how manufacturers innovate services. The primary objective of their paper is to examine the determinants of service innovations in manufacturing firms and to what extent the factors influencing service innovation are different from those influencing goods and process innovations. . Using the UK Innovation Survey, the empirical analysis is based on multivariate probit model with three equations that jointly estimate the factors associated with engaging in the three types of innovation: goods, process and services.

They find that manufacturing firms tend to innovate services differently from the way in which they innovate in material products (i.e., goods) and production process. Furthermore, the results support the servitization literature which identifies internal training and marketing as significant activities for the development of new services. The most striking finding refers to the influence of close engagement with customers (particularly for goods and service product innovation) and suppliers (particularly for process innovation). Although the literature emphasizes the importance of engaging with users (and suppliers) for innovation, and the service innovation literature indicates this is even more important when developing services they did not find evidence that close engagement with customers (and suppliers) enhanced the likelihood of innovation. A final insight from this study is that the three types of innovation do not appear to occur independently within firms. If firms innovate one, they are more likely than otherwise similar firms to also innovate in the others. The strongest correlation was found between product and process innovations which is consistent with previous research that find an increasing number of firms to be implementing both product and process innovations.

Santamaria, et al. (2012) also focused on manufacturing firms. Using the synthesis approach, they analyzed Spanish manufacturing firms to measure the impact of different factors traditionally linked to service innovation and determine whether they differ from those of product or process innovations. They found that that almost 20 percent of the manufacturing firms in the sample have introduced service innovation and that important differences exist between service and goods product innovations. They noted the importance of 'service related' factors in service innovations in manufacturing firms, which include employee training activities, the use of advanced technologies and close collaboration with customers. This suggests that service innovation by manufacturers has much in common with the innovation patterns detected in service sector firms. Moreover, other activities with low importance for innovation in service firms (such as R&D activities) have a positive impact on the achievement of service innovations in manufacturing firms. With respect to other types of innovation, the study found that the use of advanced technology has a positive impact on product and process innovations in servitised firms, and that training activities are particularly important for achieving process innovations.

In the Philippines, Albert, et al. (2013) studied the innovation behavior of establishments using the 2009 pilot survey of innovation activities commissioned by Department of Science and Technology (DOST) and the International Development Research Centre (IDRC). The questionnaire was adapted from the European Union's Community Innovation Survey Version 4 with some refinements to consider the Philippine setting. It involved the targeting of 500 establishments across four study areas: Quezon City, Metro Cebu (Cebu City, Lapu-lapu City, and Mandaue City), Davao City, and the Philippine Economic Zone Authority (PEZA) areas in Cavite and Laguna. The choice of these study areas was purposive and meant to provide a semblance of a national picture. The survey covered three sectors: (a) food manufacturing; (b) electronics manufacturing; and (c) information and communication technology (ICT) and the reference period was from January 2009 to June 2010.

Establishments were defined by Albert, et al. (2013) as innovation active if they are product innovators, process innovators, have innovation projects or engaged in expenditure of innovation activities (page 17). Based on this definition, more than half (54%) of the sampled establishments were classified as being innovation active during the period. Both medium and large establishments were observed to be more likely to engage in some sort of innovation activity, with about two-thirds

being innovation active, as compared to a third for micro establishments, and half for small establishments. Forty percent of all establishments had some innovation-related expenditure in 2009. The most commonly reported activities were in investment in training, followed by acquisition of computer software and hardware, in-house R&D, and other preparations. Innovative behavior varied across the size and age of the establishments. Among large firms, those that have been established within 21 to 30 years are the most innovative, while among the SMEs, those fairly young (established in the last ten years or so) appear to be the most innovative. Across the three sectors, establishments in electronics manufacturing and IT are the most innovation active. With respect to study areas, establishments located in the export processing zone lead in innovation activity. The following results were also obtained using a probit model:

- Having knowledge management practices is a good determinant of product innovation, process innovation and being an innovator, in general.
- Employment size matters, rather significantly for process innovation. The larger the firm, the more likely it is a process innovator.
- Location matters as firms in PEZA, all other things equal, are more likely to be innovators than firms in other areas.

While it seems that having a geographic market limited to the local market puts the firm at risk of not being a product innovator and innovator in general, the evidence is rather weak. A gender disparity indicator such as the share of women employees to total employment likewise does not contribute to explaining innovative behavior. All other things being equal, firms across the three sectors appear to be equally likely to innovate. Age of the firm also does not matter as far as innovative behavior is concerned. Neither does it appear that the share of foreign capital participation significantly explains the propensity to innovate.

Service innovation in Philippine industries

The previous section presented the findings on service innovation from the empirical work in other countries. Albert, et al. (2013) studied innovation behavior in the Philippines but did not differentiate between services and manufacturing. In this section, two sets of data are examined using the integrative framework discussed earlier to gain insights on service innovation in the Philippines. A comparison of the R&D performance of the two sectors is presented first followed by an analysis of the 2009 innovation survey.

R&D performance

Research and experimental development (R&D) is a service activity and the outcome a service product (OECD 2015, page 125). It involves "creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge." To be considered R&D, the activity must be *novel* (always aimed at new findings), *creative* (based on original concepts and their interpretation or hypotheses), *uncertain* (about its final outcome or at least about the quantity of time and resources needed to achieve it), *systematic* (it is planned for and budgeted even when carried out by individuals), and *transferable and/or reproducible* (aimed at producing results that could be either freely transferred or traded in a marketplace). The five core criteria need to be met, at least in

principle, every time an R&D activity is undertaken whether on a continuous or occasional basis. OECD (2015, pages 44-45). R&D activity is considered an input to the innovation process.

Based on the 2012 Census of Philippine Business and Industry (CPBI), nearly PhP 5.5 Billion was spent on R&D in the manufacturing and services sectors with the former accounting for nearly two-thirds. Its share in the combined stock of R&D personnel is nearly the same (see Table 1).

Table 1. R&D Costs (2012)

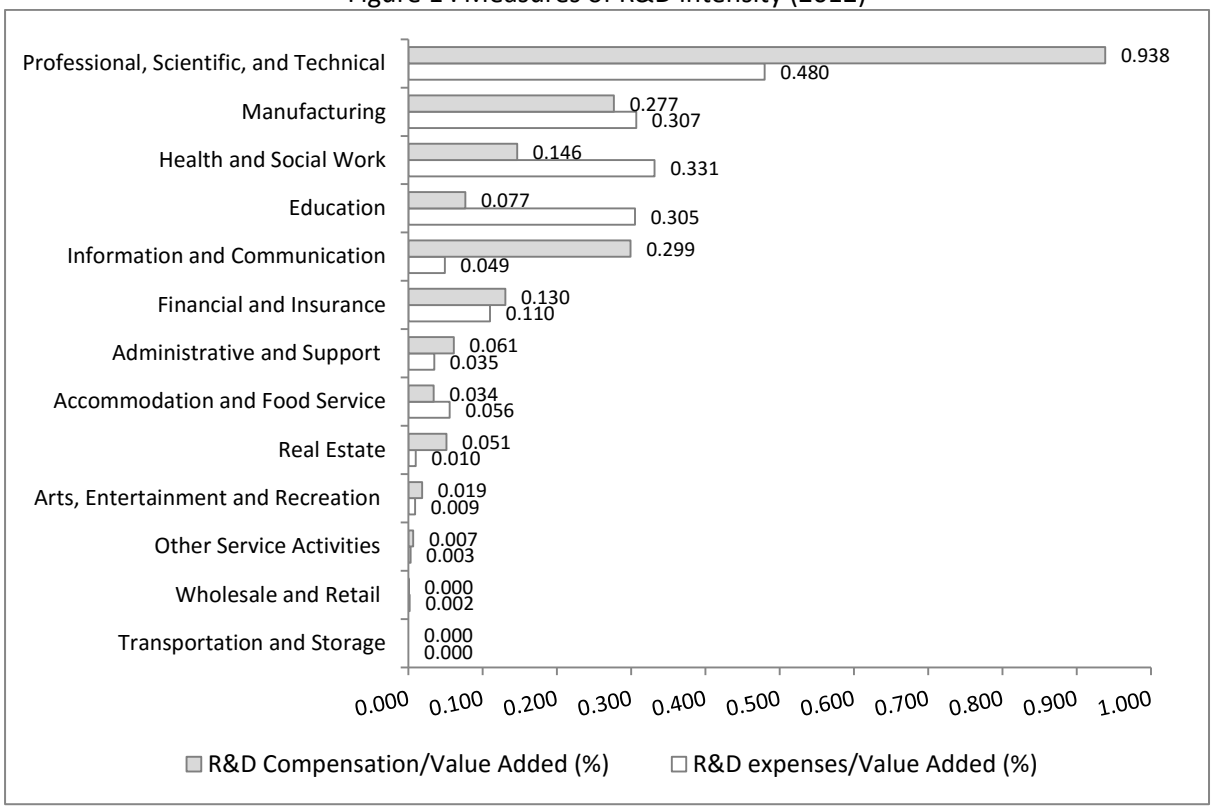
Sector	R&D Expenses*		R&D Personnel**	
	Value (in Thousand Pesos)	Share (%)	Quantity	Share (%)
Manufacturing	3,552,909	64.74	13,450	64.04
Services	1,934,916	35.26	7,551	35.96
Total	5,487,825	100.00	21,001	100.00

Note:
*Research and development (R&D) expense is the amount spent on any systematic, scientific and creative work undertaken to increase the stock of knowledge and the use of this knowledge to create new or improved products, processes, services, and other applications.
**R&D personnel are all persons employed directly on R&D as well as those providing direct services such as R&D Managers, administrators and clerical staff. R&D personnel are classified into three categories: researchers, technicians and auxiliary personnel.
Source of data: CPBI 2012

To have a better picture of the extent of R&D undertaken by industry, the R&D expenses and cost of R&D personnel must be considered (OECD 2015 page 207). Since the total cost for R&D personnel was not reported, it is estimated using the average industry compensation. Figure 1 shows two measures of R&D intensity (the ratio of an R&D-related cost to value added) by sector[2]. Appendix A presents the top performing industries in manufacturing and in services sectors Since Professional, Scientific, and Technical activities include industries dedicated to providing R&D services, it is not surprising that they would also engage in R&D resulting in R&D intensities higher than in Manufacturing. In some industries, the share of R&D expenses is higher than the share of R&D personnel cost (e.g. Manufacture of other electrical equipment, R&D in social science) while the reverse is true for others (e.g. Manufacture of domestic appliances, R&D in health sciences) which may reflect preference for internal or in-house R&D capacity. The wide range of R&D intensities across service industries is also evident.

[2] The Services Sector is composed of 13 sectors as shown in Figure 1. Since this covers Business and Industry only, Public Administration is not included.

Figure 1 . Measures of R&D intensity (2012)



Note: R&D Compensation calculated using average industry compensation x R&D personnel
Source of data: CPBI 2012

In contrast to the manufacturing sector where almost all industries spent on R&D (or employed R&D personnel), only half the industries in the services sector reported the same resulting in low to zero R&D intensities at the sectoral level as can be seen in the Figure 1 above.[3] This could indicate no interest or commitment to innovation on the part of the industries or other forms of innovation activity were undertaken.

As mentioned earlier, Toivonen and Touminen (2009) have noted the absence of R&D departments in many service companies. Hipp and Grupp (2005) explained that these companies usually do not pursue "classical" R&D and the innovation process usually involves more departments and project teams compared to the manufacturing sector. They add that since internal science and technology-based R&D play only a minor role in services compared to manufacturing, service companies have to focus on other forms of knowledge generation. Given the heterogeneity of services, there are considerable differences in R&D activity across individual industries. For example, looking at a 2000 survey of the German economy, Hipp and Grupp (2005) found little R&D activity occurring in trade and transport while the more technology-oriented industries such as technical service providers and telecommunication companies were found to be much more active in R&D.

While not all industries could be expected to engage in R&D, it is important to understand R&D behavior in Philippine industries especially for key sectors such as Transport and Storage where R&D

[3] These are based on aggregate establishment figures. A positive figure at the industry level indicates that at least one establishment engaged in R&D.

spending has been lacking[4]. With new and emerging technologies (e.g. e-commerce, Internet of Things, big data and data analytics) all industries, especially service industries, can be "technology-based" and benefit from technological forms of innovation created through R&D.

Patterns of innovation

As discussed, the 2009 pilot survey covered three major sectors: (1) food manufacturing; (2) electronics manufacturing; and (3) information and communication technology (ICT). The ICT sector industry includes IT manufacturing, ICT trade, software publishing, telecommunications services, hardware consultancy, other software and consultancy supply, other computer-related activities, data processing, hosting and related activities, database activities and online distribution of electronic content, repair of computers and communication equipment, publishing activities, animated film and cartoons production, motion picture, video and television program production, sound recording and music publishing activities, call center, and medical transcription activities. Instead of comparing three sectors as Albert, et al. (2013) did, the establishments are grouped into two sectors only - manufacturing and services. Table 2 shows the frequency distribution of the establishments grouped by sector.

Table 2 Frequency Distribution by Sector

	Manufacturing	Services	Total
Description (Frequency)	Food and drinks (191) Electronics (42) and IT (108)	ICT Services (60) Publishing activities and motion picture video and television production (33) Business process outsourcing (40)	
Frequency	341	133	474
Share (%)	71.94	28.06	100

Appendix B presents the characteristics of the sample.

A descriptive analysis is conducted using frequency tables and the Chi-Square test for independence to determine if there is a significant relationship between two categorical variables (i.e. sector and a measure of innovation).

Overall innovation output

As defined in the OSLO manual (OECD 2005 p. 46), an **innovation** is "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations." Note that the innovation need not be new to the market, country or the world. As Table 2 shows, close to 70 percent of the establishments implemented some form of innovation during the period with organizational innovation being the most common type of innovation undertaken both in

[4] In both the 2012 Census of Philippine Business and Industry and in the 2010 Annual Survey of Philippine Business and Industry none of the industries belonging to the Transport and Storage Sector reported any R&D expense or personnel (note that information on R&D personnel started in 2012).

manufacturing and services[5]. It could also be observed that there is no difference in the overall innovation pattern between manufacturing and services.

Table 3. Innovation Pattern

Innovation	Manufacturing		Services		Total		Pearson Chi Square
	#	%	#	%	#	%	
Innovator	238	*69.79*	91	*68.42*	329	*69.41*	0.0850
Product Innovator	135	*39.59*	43	*32.33*	178	*37.55*	2.1497
Process Innovator	155	*45.45*	53	*39.85*	208	*43.88*	1.2206
Organizational Innovator	196	*57.48*	80	*60.15*	276	*58.23*	0.2809
Marketing Innovator	172	*50.44*	67	*50.38*	239	*50.42*	0.0002

Note: Covers full sample of establishments

The overall pattern of innovation outputs do not follow the pattern observed in other countries where one type of innovation dominates in a particular sector. For example, in Spain (Castro, et al. 2011) manufacturing companies tend to do more product and process innovation while those in service industries tend to do more organizational and marketing innovations while in Chile (Iacovone, et al 2013) services firms tend to do more non-technological forms of innovation such as organizational innovation compared to the technological innovation done in manufacturing, which include the introduction of new products or processes. Although the differences in proportions are consistent with the results of these studies (i.e. the proportion of product innovators and process innovators in manufacturing is higher than in services while the proportion of organizational innovators is higher in services), it cannot be concluded that the differences are statistically significant. This could be due to the very limited set of service industries represented in the in the 2009 survey sample. Being intensive users of technology, ICT-related services may have more similarities with manufacturing than with other service industries.

Product Innovation

A **product innovation** is "the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics" (OECD 2005 p. 48*).* Examples are shown in Table 4.

Table 4 Examples of Product Innovation

Goods	Services
• Global positioning systems (GPS) in transport equipment. • Cameras in mobile telephones. • Food products with new functional characteristics (margarine that reduces blood cholesterol levels, yoghurts produced using new types of cultures, etc.).	• New services that significantly improve customers' access to goods or services, such as home pick-up and drop-off service for rental cars. • Video on demand via broadband Internet. • Internet services for banking or bill payment systems. • New types of loans (for example, variable rate

[5] Here an establishment is considered an "innovator" if it has engaged in any of the four types of innovation. In Albert, et al. (2013) instead of "innovator" they used "innovation active" establishments "if they are product innovators, process innovators, have innovation projects or engaged in expenditure of innovation activities".

loans with a fixed rate ceiling).

(OECD 2005 pp 149-150)

Establishments in both manufacturing and services introduced new or significantly improved goods and services. There was a greater proportion of manufacturing establishments that introduced new or significantly improved goods as could be expected and the difference in behavior is statistically significant. In terms of product innovation in services, around a quarter of the establishments introduced new or significantly improved services but interestingly, there is no relationship between service product innovation and the sector. Manufacturing establishments are as likely to introduce new or significantly improved services as establishments in services**.** See Table 5.

Table 5. Product Innovation

Types of Product Innovation	Manufacturing (%)	Services (%)	Total (%)	Pearson Chi Square
New or significantly improved goods	*36.36*	*17.29*	*31.01*	16.2644 ***
New or significantly improved services	*22.58*	*27.07*	*23.84*	1.0610

Note: Covers full sample of establishments
Significant at 1%(***), 5%(**), 10%(*)

The importance of service offerings in manufacturing could also be seen in Table 6. Among the establishments that introduced product innovation, there was a higher proportion of manufacturing establishments that innovated *in goods only* and *in both goods and services* while there is higher proportion of establishments in services that introduced product innovation in services only. The Chi-square test show that there is a relationship between the product innovation pattern and the categories used (i.e. manufacturing vs. services). This and the previous result confirm that manufacturing establishments are also engaged in service innovation. As discussed previously, it has been observed that goods producing companies increasingly buy, produce, sell and export services. Labelled as *servicification* (also, *servitization*), the provision of services by manufacturers allows them to differentiate and customize goods (National Board of Trade 2012, 2013).

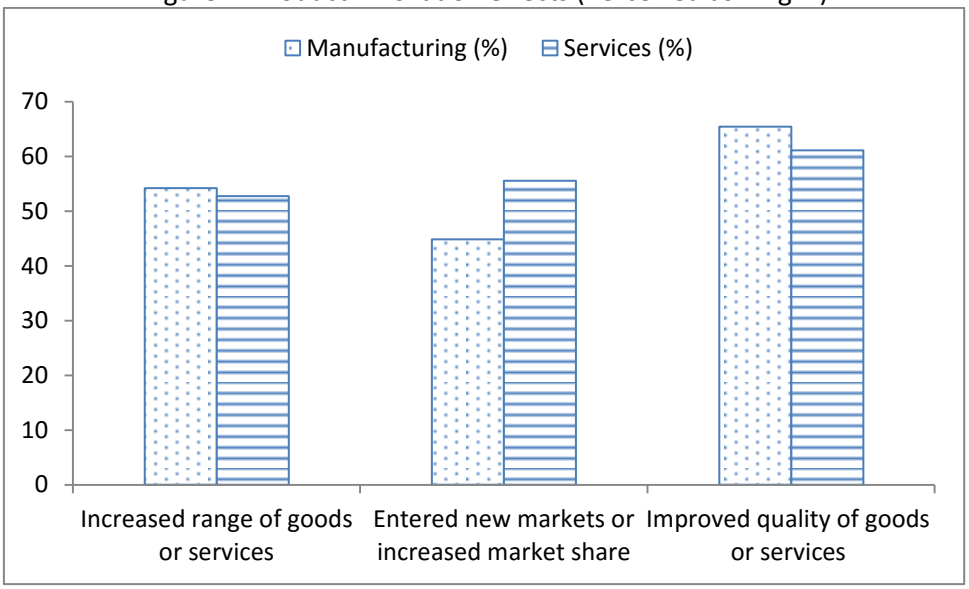
Table 6. Product innovation patterns

Types of Product Innovation	Manufacturing (%)	Services (%)	Total (%)
Innovation in goods only	*42.96*	*16.28*	*36.52*
Innovation in services only	*8.15*	*46.51*	*17.42*
Innovation in both goods and services	*48.89*	*37.21*	*46.07*
Total	*100*	*100*	*100*
Pearson chi2(2) = 34.8845 Pr = 0.000			

Note: Covers product innovators only

Among the establishments that introduced a new or significantly improved product, Figure 2 shows that "improved quality" had the biggest proportion of establishments which considered the effect as "High". Moreover, there was no difference between manufacturing and services in their assessment. See Appendix C Table A for the Chi-Square statistics.

Figure 2. Product innovation effects (Perceived as "High")



Note: Covers product innovators only

Process Innovation

A **process innovation** is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software (OECD 2005 p 49). See Table 7 for examples.

Table 7. Examples of process innovation

Production	Delivery and operations
• Installation of new or improved manufacturing technology, such as automation equipment or real-time sensors that can adjust processes. • New equipment required for new or improved products. • Laser cutting tools.	• Portable scanners/computers for registering goods and inventory. • Introduction of bar coding or passive radio frequency identification (RFID) chips to track materials through the supply chain. • GPS tracking systems for transport equipment. • Introduction of software to identify optimal delivery routes. • Introduction of automated voice-response system.

(OECD 2005 pages 151-152)

In service industries process innovations include new or significantly improved methods for the creation and provision of services, which can involve significant changes in the equipment and software used or in the procedures or techniques that are employed to deliver services. Examples are the introduction of GPS tracking devices for transport services, the implementation of a new reservation system in a travel agency, and the development of new techniques for managing projects in a consultancy firm (OECD 2005, p 49).

Table 8 reveals the pattern of process innovation indicating that the most common type of innovation involved "new or significantly improved methods of manufacturing or producing goods and services". Moreover, process innovation behavior is independent of the sector for all types.

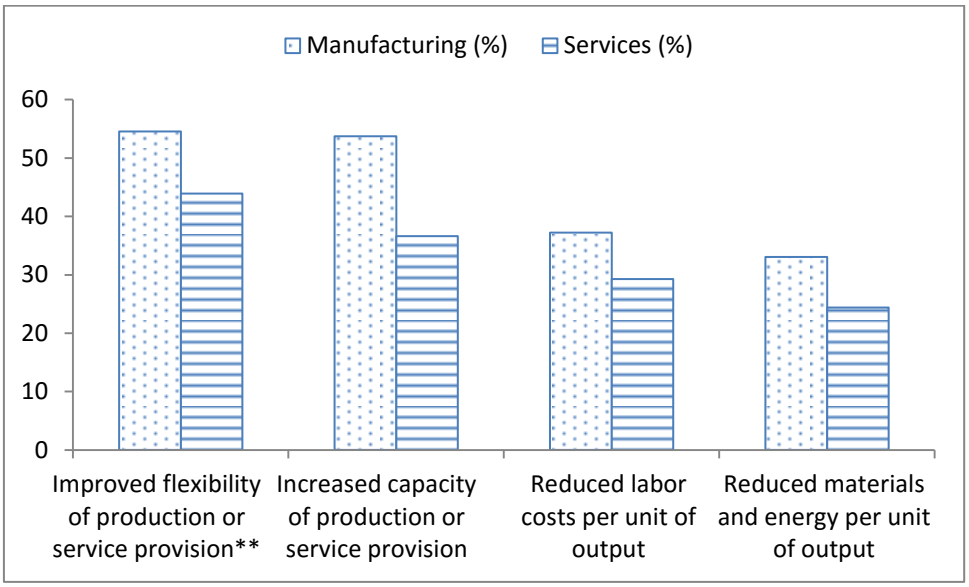
Table 8. Type of process innovation introduced

Types of Process Innovation	Manufacturing (%)	Services (%)	Total (%)	Pearson Chi Square
New or significantly improved methods of manufacturing or producing goods and/or services	*40.18*	*33.83*	*38.40*	1.6267
New or significantly improved logistics, delivery or distribution methods for your inputs, goods and/or services	*27.27*	*21.05*	*25.53*	1.9472
New or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing	*32.26*	*27.82*	*31.01*	0.8810

Note: Covers full sample of establishments

For the establishments that introduced some form of process innovation, Figure 3 shows the percentage which indicated the perceived effect as "High". Among the effects identified, it is only in "improved flexibility" where there is difference in behavior between manufacturing and services. See Appendix C Table B for the Chi-Square statistics.

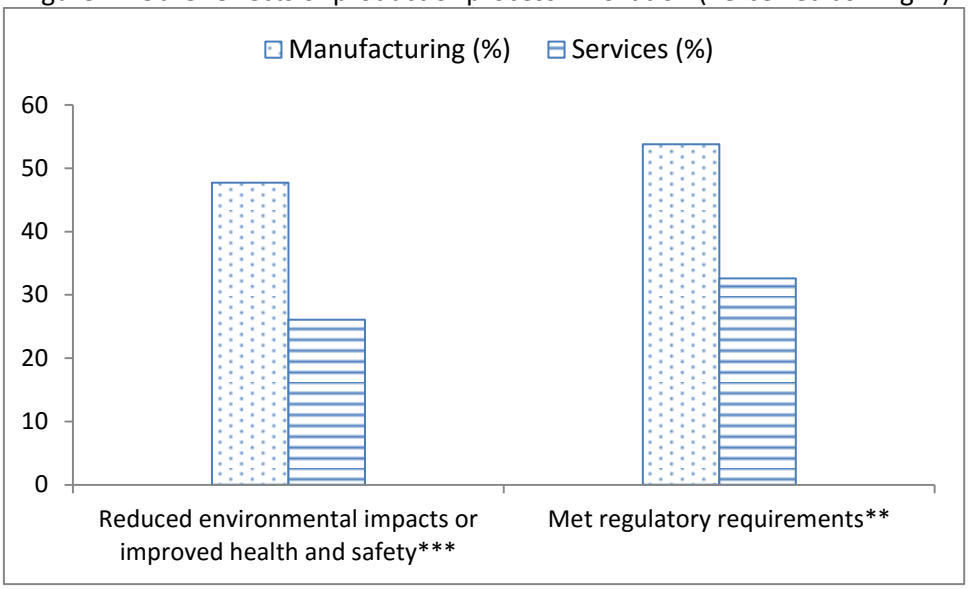
Figure 3. Process innovation effects (Perceived as "High")



Note: Covers process innovators only
Significant at 1%(***), 5%(**), 10%(*)

In terms of other effects, among the establishments that introduced some form of either product or process innovation, Figure 4 shows the percentage which indicated the perceived effect as "High". In both cases, the proportion of manufacturing establishments is higher than the proportion of establishments in services and the difference is statistically significant. See Appendix C Table C for the Chi-Square statistics.

Figure 4. Other effects of product or process innovation (Perceived as "High")



Note: Covers product and process innovators only
Significant at 1%(***), 5%(**), 10%(*)

Organizational Innovation

An **organizational innovation** is the implementation of a new organizational method in the firm's business practices, workplace organization or external relations (OECD 2015, p. 51). It is noted that mergers with, or the acquisition of, other firms are *not* considered organizational innovations unless the firm develops or adopts new organization methods in the course of the merger or acquisition (OECD 2015, p. 52). Examples of organizational innovation include the following being introduced (OECD 2015, pp 153-154):

- **Business practices**
  - Establishing a new database of best practices, lessons and other knowledge
  - First-time introduction of an integrated monitoring system for firm activities
  - First-time introduction of management systems for general production or supply operations
- **Workplace organization**
  - First-time implementation of decentralized job responsibility for the firm's workers
  - First-time establishment of formal or informal work teams to improve the access and sharing of knowledge from different departments
  - First-time implementation of an anonymous incident reporting system
- **External relations**
  - First-time introduction of quality control standards for suppliers and subcontractors
  - First-time use of outsourcing of research or production
  - First-time entering into research collaboration with universities or other research organizations

Table 9 shows the pattern of organizational innovation. "Significant changes to the organization of work in your establishment that increased employee decision making…" was the most common type of organizational innovation introduced. Except in the case of "new management systems for the production and/or supply operations of your establishment" there is no difference between the two sectors for this type of organizational behavior.

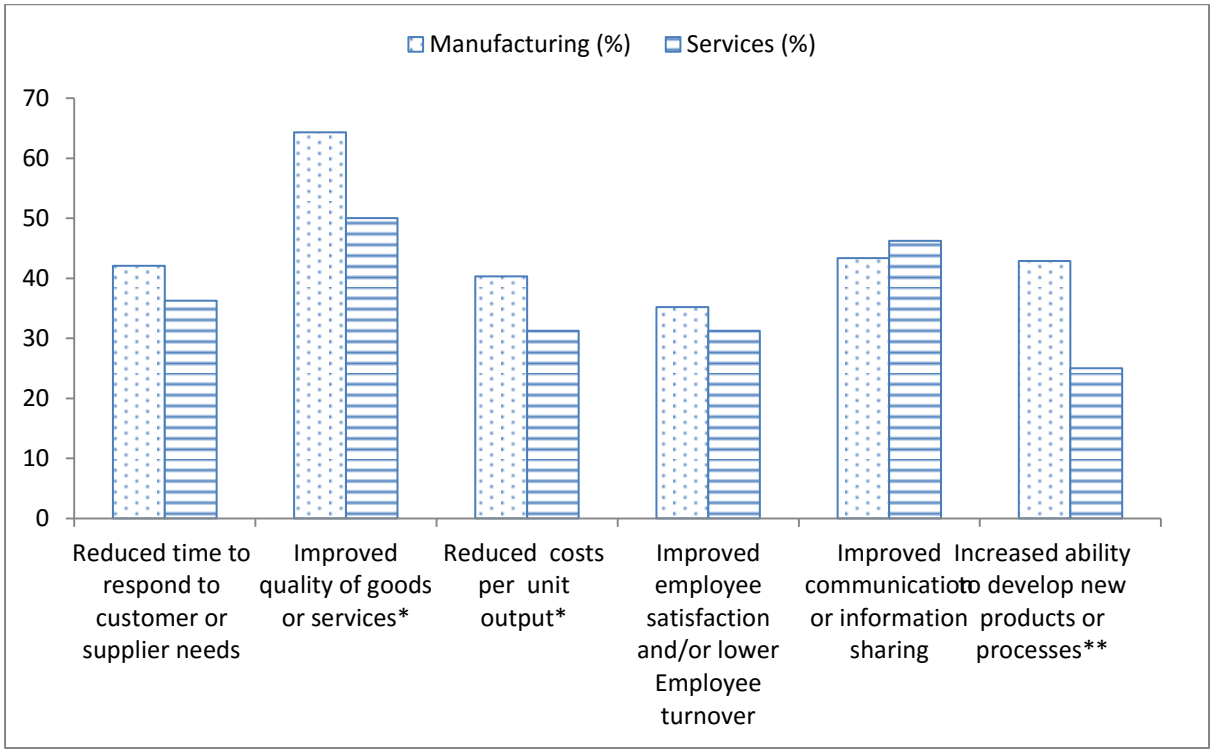
Table 9. Types of Organizational Innovation

Types of Organizational Innovation	Manufacturing (%)	Services (%)	Total (%)	Pearson Chi Square
New or significantly improved knowledge management systems to better use or exchange information, knowledge and skills within your establishment	*41.64*	*45.11*	*42.62*	0.4713
New management systems for the production and/or supply operations of your establishment	*42.52*	*33.83*	*40.08*	3.0067*
Significant changes to the organization of work in your establishment that ***increased*** employee decision making and responsibility for their work	*48.09*	*47.37*	*47.89*	0.0202
Significant changes to the organization of work in your establishment that ***decreased*** employee decision making and responsibility for their work	*2.93*	*2.26*	*2.74*	0.1644
Significant changes to the organization of work in your establishment that ***had no effect*** employee decision making and responsibility	*6.45*	*8.27*	*6.96*	0.4888
A significant change to the management structure of your enterprise such as creating new divisions or department, integrating different departments or activities, adoption or a networked structure, etc.	*34.6*	*36.84*	*35.23*	0.2100
New or significant changes in your relations with other firms or public institutions, such as through alliances, partnerships, outsourcing or sub-contracting	*24.93*	*26.32*	*25.32*	0.0976

Note: Covers full sample of establishments
Significant at 1%(***), 5%(**), 10%(*)

Among the establishments that introduced some form of organizational innovation, Figure 5 shows the percentage that indicated the perceived effect as "High" with "improved quality" having the highest proportion in both sectors. For three of the effects identified (i.e. increased ability to develop new products or processes, improved quality, and reduced per unit), the ratings are related to whether the establishment is in manufacturing or in services but for the other effects the sector does not matter. See Appendix C Table D for Chi-Square statistics.

Figure 5. Effects of organizational innovation (Perceived as "High")



Note: Covers organizational innovators only
Significant at 1%(***), 5%(**), 10%(*)

In many cases, organizational innovation was necessary for other types of innovation being undertaken by the establishment (see Table 10). Jointly engaging in organizational innovation with goods product innovation is more common in manufacturing than in services.

Table 10. Type of innovation which required organizational innovation

	Manufacturing (%)	Services (%)	Total (%)	Pearson Chi Square
Product innovation for a new or improved good	55.1	26.25	46.74	19.2240***
Product innovation for a new or improved service	46.94	57.50	50	2.6275
Process innovation	64.29	55	61.59	2.3764

Note: Covers organizational innovators only
Significant at 1%(***), 5%(**), 10%(*)

Marketing Innovation

A **marketing innovation** is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing. The objective of such innovations are to better address customer needs, open up new markets, or newly position a firm's product on the market, with the aim of increasing the firm's sales (OECD 2005, p. 50). Examples of marketing innovation include the following (OECD 2005, pp. 152-153):

- **Design and packaging**
  - Implementation of a significant change in the design of a furniture line
  - Implementation of a fundamentally new design of bottles for a body lotion

- **Promotion**
  - First-time use of trademarks
  - First-time use of product placement in movies or television programs
- **Placement (sales channels)**
  - First-time introduction of product licensing.
  - First-time introduction of direct selling or exclusive retailing.
  - Implementation of a new concept for product presentation such as sales rooms
- **Pricing**
  - Introduction of a new method that allows customers to choose desired product specifications on the firm's website
  - First-time use of a method for varying the price of a good or service according to demand

Implementing a new promotion strategy was the most common form of marketing innovation introduced in the services sector while in manufacturing the most popular was a new pricing method. A higher proportion of establishments in manufacturing introduced new design (specifically in terms of packaging) while a higher proportion of establishments in services used new promotion techniques (specifically using new media techniques). In both cases, there was a significant difference in behavior between the two sectors. See Table 11.

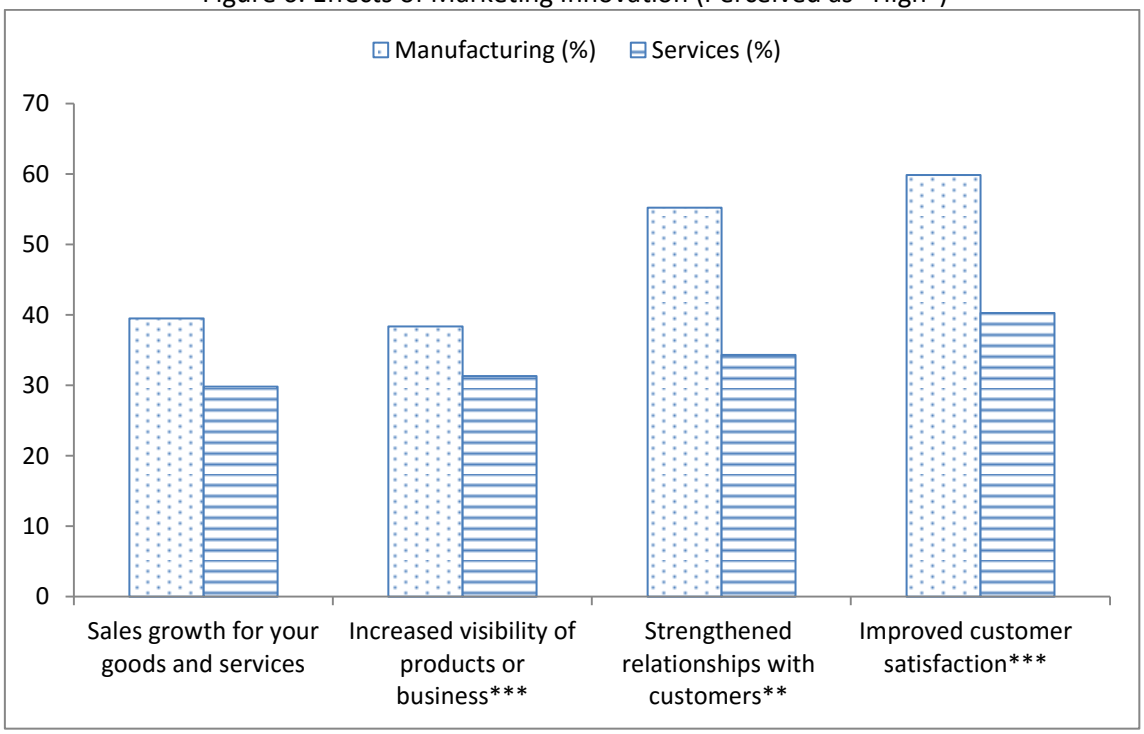
Table 11. Marketing Innovation

Types of Marketing Innovation		Manufacturing (%)	Services (%)	Total (%)	Pearson Chi Square
Design	Introduce significant changes to the design of a good or service	27.35	25.56	26.85	0.1558
	Introduce significant changes to the packaging of the good	30.00	12.78	25.16	15.0525***
Promotion	Implement a new marketing strategy to target new customer groups or market segments	36.47	38.35	37.00	0.1442
	New media techniques to promote products	23.53	31.58	25.79	3.2364*
Placement	Use new sales channels such as direct selling, internet sales outlets (e.g. sales rooms, websites, other types of outlets)	21.76	15.79	20.08	2.1266
	Introduce new concepts for product presentation in sales outlets (e.g. sales rooms, websites, other types of outlets)	23.82	30.83	25.79	2.4500
Pricing	Use new pricing methods to market goods or services	36.76	30.08	34.88	1.8834

Note: Covers full sample of establishments
Significant at 1%(***), 5%(**), 10%(*)

Figure 6 shows the percentage which indicated the perceived effect of a marketing innovation as "High". Except for "sales growth" the proportion of establishments in manufacturing was significantly higher than in services. See Appendix C Table E for Chi-Square statistics.

Figure 6. Effects of Marketing Innovation (Perceived as "High")



Note: Covers marketing innovators only
Significant at 1%(***), 5%(**), 10%(*)

Intellectual Property Rights

Among the innovators, Table 12 shows type of Intellectual Property Rights (IPR) used. "Registered a trademark" was the most common IPR for all establishments although "applied for a patent" was as popular among innovators in services. The proportion of establishments in services that "claimed a copyright" is higher than in manufacturing and the difference is significant. This shows that copyright as a form of IP protection is more important to the services sector than to the manufacturing sector especially for the service industries included in the sample.

Table 12. Intellectual Property Rights

	Manufacturing (%)	Services (%)	Total (%)	Pearson Chi Square
Applied for a patent	7.98	12.09	9.12	1.3384
Registered an industrial design	5.88	10.99	7.29	2.5385
Registered a trademark	14.71	12.09	13.98	0.3751
Claimed a copyright	4.2	9.89	5.78	3.9146 **

Note: Covers innovators (product, process, organizational, and marketing) only
Significant at 1%(***), 5%(**), 10%(*)

Knowledge management

"Regular updates of internal databases or manuals" was the most common knowledge management practice while "A policy to bring in external experts" was the least common. There is no difference between the behavior or manufacturing and services firms in terms of knowledge management practices adopted. See Table 13.

Table 13. Knowledge Management Practices

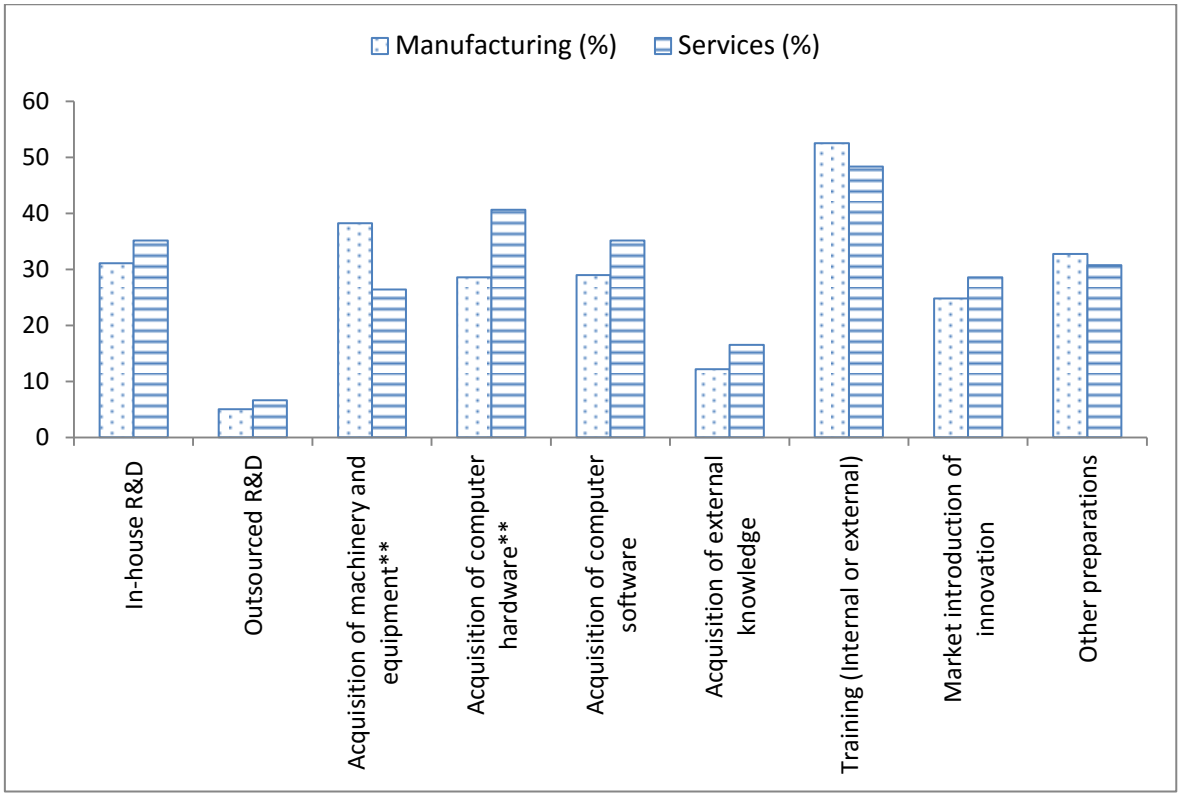
	Manufacturing (%)	Services (%)	Total (%)	Pearson Chi Square
A written knowledge management policy	40.18	37.59	39.45	0.2670
Incentives for employees to share knowledge within your establishment	44.57	41.35	43.67	0.4036
Dedicated resources to monitor and obtain knowledge from outside your establishment	30.79	25.56	29.32	1.2618
A policy to bring in external experts from universities, research institutes, or other establishments to participate in project teams as needed	18.18	19.55	18.57	0.1183
Regular updates of internal databases or manuals of good work practices, lessons learned, or expert advice	46.04	54.14	48.31	2.5104

Note: Covers full sample of establishments

Innovation activities and expenditures

Figure 7 reveals the proportion of innovating establishments that engaged in a particular type of innovation activity. There was a significantly higher share of manufacturing establishments that acquired machinery and equipment while the proportion that acquired computer hardware was significantly higher in services. This is not surprising given the service industries included in the sample. For the rest, there was no relationship between the sector and innovation activities (i.e. no significant difference between manufacturing and services in their behavior). In both sectors, training was the most common type of innovation activity. See Appendix C Table F for Chi-Square statistics.

Figure 7. Innovation Activities

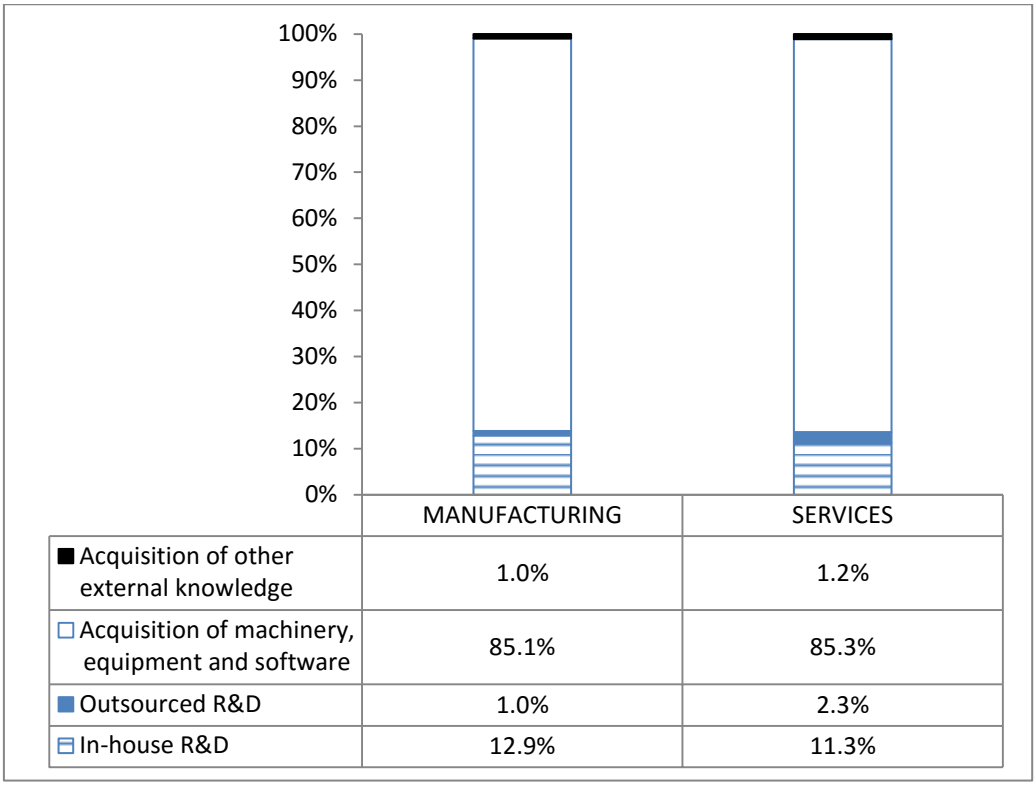


Note: Covers innovators (product, process, organizational, and marketing) only
Significant at 1%(***), 5%(**), 10%(*)

Out of 329 innovators in the sample, 41.94 percent reported innovation-related expenditures. Figure 8 shows the distribution of innovation expenditures which shows that the acquisition of machinery, equipment and software is the most significant cost item.[6]

[6] Expenditures for training and other innovation activities were not included in the 2009 questionnaire.

Figure 8. Composition of Innovation Expenditures

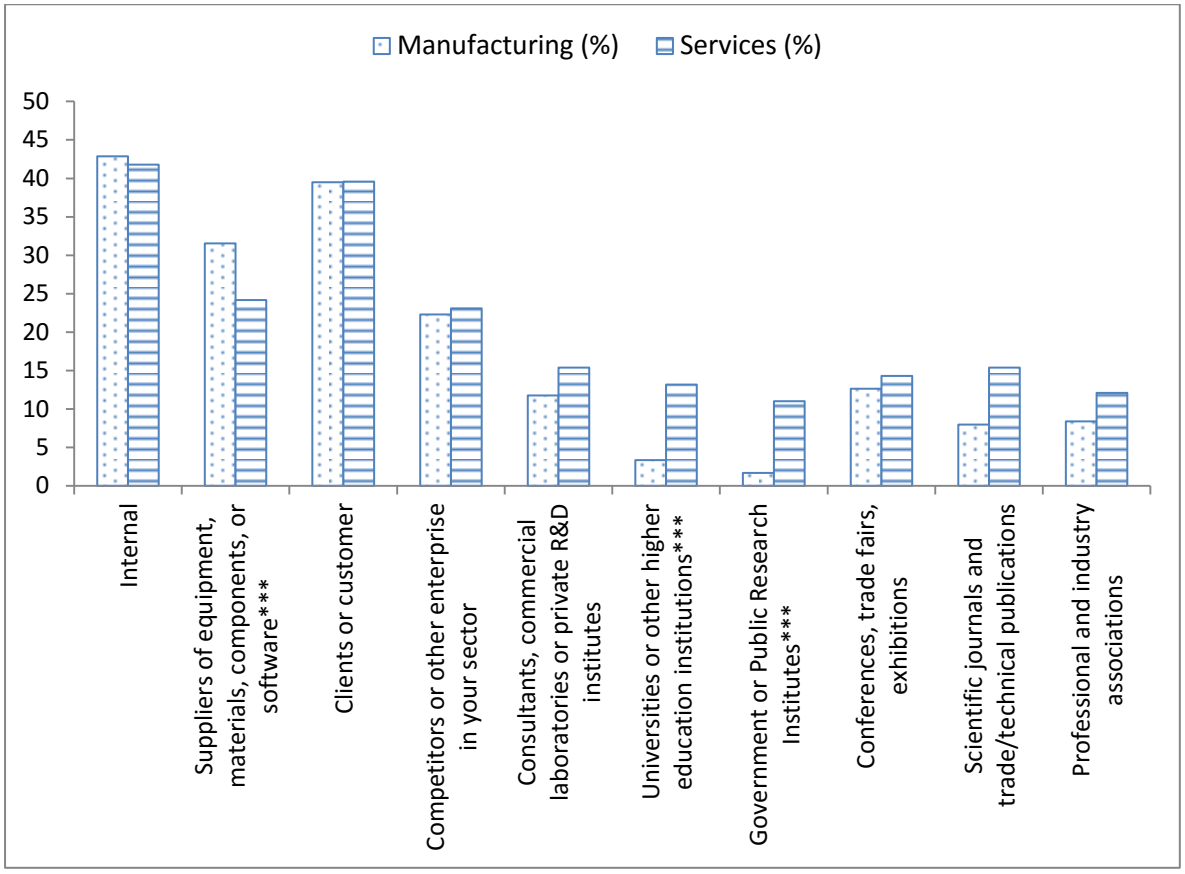


	MANUFACTURING	SERVICES
Acquisition of other external knowledge	1.0%	1.2%
Acquisition of machinery, equipment and software	85.1%	85.3%
Outsourced R&D	1.0%	2.3%
In-house R&D	12.9%	11.3%

Information sources

Figure 9 reveals the proportion of innovating establishments that considered the importance of a particular source of information as "High". There was a bigger proportion of innovating manufacturing establishments that valued suppliers whereas a bigger proportion of innovating services establishments favored institutional sources such as universities and public research institutes. The differences in the importance of the other information sources were not significant and both sectors relied on internal sources the most. See Appendix C Table G for Chi-Square statistics.

Figure 9. Importance of information sources for innovation activities ("High")

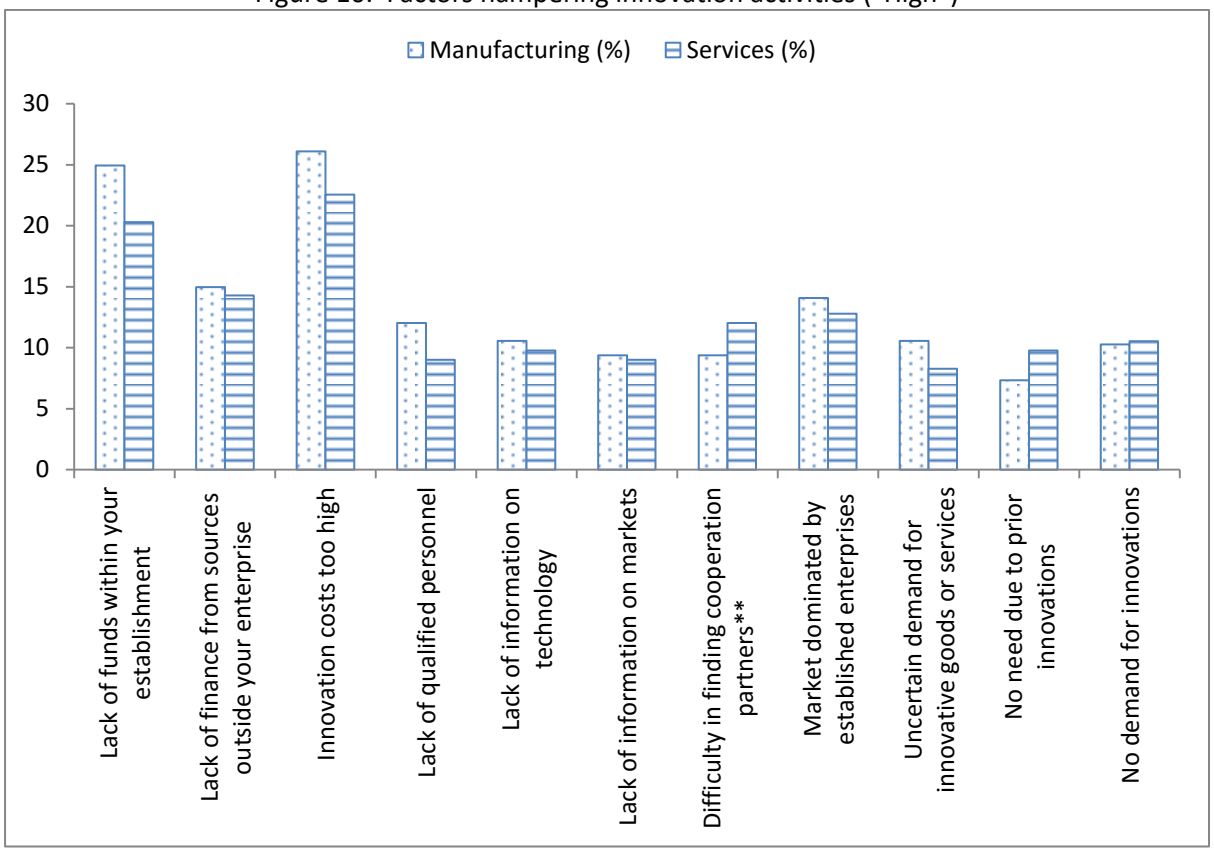


Note: Covers innovators (product, process, organizational, and marketing) only
Significant at 1%(***), 5%(**), 10%(*)

Factors hampering innovation activities

Of the various factors that may impede innovation, "innovation costs too high" had the highest proportion of establishments that deemed its importance as "High" (See Figure 10). Except for one case ("difficulty in finding cooperation partners") the rating of the inhibiting factor and the sector are not related. See Appendix C for Chi-Square statistics.

Figure 10. Factors hampering innovation activities ("High")



Note: Covers full sample of establishments
Significant at 1%(***), 5%(**), 10%(*)

Summary

A descriptive analysis of the survey results reveals that establishments in the services sector do not innovate less than manufacturing. Except for goods product innovation, there was no significant difference in the innovation outputs of the two sectors. Moreover, organizational innovation was the most popular type of innovation undertaken and the perceived effect of such innovation which was most rated "High" was "Improved quality of goods and services". For a significant number of establishments, organizational innovation was introduced to complement product and/or process innovation.

There were other similarities between the two sectors with regard to innovation outputs:

- There was no significant difference between the two sectors in terms of service product innovation. That manufacturing establishments introduce new or significantly improved services provides evidence of servicification.

- In terms of process innovation, "new or significantly improved method of manufacturing or producing goods and/or service" was the most common type adopted.

- The most popular organizational innovation undertaken was "Significant changes to the organization of work in your establishment that ***increased*** employee decision making and responsibility for their work".

- For marketing innovation, “new pricing method” was the most popular in manufacturing closely followed by “implementing a new marketing strategy”. This was also the most common type of marketing innovation in the services sector.

For other aspects of innovation behavior, the similarities between the two sectors are as follows:

- “Regular updates of internal databases or manuals of good practices, lessons learned, or expert advice” was the most prevalent knowledge management practice.

- “Registered a trademark” was the most common IPR for all establishments although “applied for a patent” was as popular among innovators in services.

- “Cost of innovation” had the highest proportion of establishments which rated its importance in hampering innovation activities as “High”.

- “Internal sources” had the highest proportion of establishments which rated its importance as a source of information for innovation as “High”.

- “Training of personnel for the development and/or introduction of a new product or process” was the most common innovation activity undertaken.

- “Acquisition of machinery, equipment and software” was the largest cost item incurred.

Differences between the two sectors were also observed as highlighted in Table 14 below:

Table 14. Summary of differences between manufacturing and services sectors

	Significantly higher proportion of establishments in the manufacturing sector	Significantly higher proportion of establishments in the services sector
Product innovation	Introduced goods product innovation	-
Organizational innovation	Introduced new management systems for production and/or supply operations	-
Marketing innovation	Introduced significant changes to packaging of the good	Employed new media techniques to promote products
Intellectual Property Rights	-	Claimed a copyright
Information sources	Relied on suppliers	Relied on institutional sources (public institutions and universities)
Innovation activity	Acquired machinery and equipment.	Acquired computer software.

A larger sample of establishments representing greater variety of service industries could better reveal the differences in innovation behavior between manufacturing and services sectors as well as difference within the services sector.

Determinants of innovation

In this section, the 2009 pilot survey results are analyzed using probit regression. Unlike Albert, et al. (2013), the analysis focuses only structural factors (characteristics of the establishment) and their impact on various innovation outputs. As can be seen in Table 15, tests of association indicate that of the five factors included, the sector and age of the establishment are not related to being an innovator. In contrast, capital participation, market orientation, and size of the establishment matter. The impact of each factor however cannot be determined from this simple test. Moreover, the results are based on individual analysis of each variable. As explained in Albert, et al. (2013) it is important to account for the effects of these factors in the presence of other factors. Thus, a probit model is employed to explain the probability of an establishment being an innovator given certain characteristics.

Table 15. Structural determinants of Innovation

	Not Innovator (%)	Innovator (%)	Total (%)	Pearson Chi Square
Sector (Services)	28.97	27.66	28.06	0.0850
Capital participation (Foreign Majority-Owned)	22.07	40.43	34.81	14.9445***
Market Orientation (Exporter)	29.66	47.42	41.98	13.0348***
Age of establishments (1 to 10 years)	44.14	47.72	46.62	2.8255
Size of establishments (Micro)	33.10	17.63	22.36	17.6940***

Before presenting the results of the probit regression, the expected impact of these factors are reviewed first based on existing literature. With respect to **sectoral** impact, as discussed previously, evidence in other countries indicates differences in the innovation patterns between manufacturing and services. Manufacturing firms tend to innovate more in terms of product and process while services firms tend to do more organizational and marketing innovation. Pires, et al. (2008, pages 1346-1348) explain the expected impacts on innovation of the other factors.

A firm belonging to a **multinational** group is expected to have a higher probability of being an innovator. Multinational firms learn from the diverse local environments where they operate and the existence of internal networks facilitate the spread of knowledge within the company. The organizational structure of a firm and the degree of autonomy enjoyed by the subsidiaries are relevant to the learning and diffusion process (Frenz et al., 2003, p. 5 as cited by Pires, et al. 2008). In this paper, ownership and market orientation are used as proxies for multinationality.

In terms of **age**, Pires, et al. (2008) note that the effect of the firm's youth on the probability of being an innovator is a priori ambiguous. Young firms could be expected to be more innovative following the Schumpeterian view of a strong link between entrepreneurship and innovation. However, an older firm may benefit from its established name and reputation to enter a new market and/or to obtain finance for its more innovative and riskier projects. In addition, there are some types of innovation that are more likely to occur with the passage of time. Process innovations, for example, are the consequence of continuous improvement and learning-by-doing.

With respect to **size**, there are factors that favor innovation in both large and smaller firms. Due to the costs and risks involved, larger firms are in a better position to manage the innovation process. However, smaller firms have management structures that are more flexible, less bureaucratic and

with less inertia, which are all conducive to innovation (Scherer 1991 as cited in Pires, et al. 2008). Based on a review of various studies, the cumulative evidence suggests a positive correlation between firm size and innovativeness particularly in the manufacturing sector (Pires, et al 2008 citing Becheikh et al. 2006).

Two sets of probit regression analyses are conducted to determine the impacts of these structural variables. The difference in the two approaches lies in how the sector dummy is introduced to compare establishments in manufacturing and services sectors.

Probit model with a separate Sector dummy variable

Table 16 below presents the results of the Probit Regression for various types of innovation outputs. Four of the structural factors are represented as a dummy variable including the sector variable.

In general, the size of the establishment is a good determinant of innovation in each regression and the result is consistent with the expected impact. The probability of being an innovator increases with firm size and this is true for all types of innovation.

Additional factors matter for particular types of innovation. For product innovation, the impact of the factors differs depending on whether new goods or new services are being introduced. While service establishments are less likely to undertake goods product innovation, the sector does not matter in terms of services product innovation. This result further confirms the observation from the descriptive analysis presented earlier that service innovation is also important to manufacturing. In addition, the age of the establishment is statistically significant and positive. Younger establishment are more likely to engage in service product innovation.

For organizational innovation, ownership and age matters. The positive relationship between ownership and organizational innovation could be due the same reasons given earlier on the impact of multinationality. In this case, firms that are foreign majority-owned either learn new business practices and other organizational methods from its affiliates or foreign-owners have better exposure to good international practices and are able to introduce these domestically. In terms of age, a possible explanation is that being relatively new, these younger establishments are still in the process of developing or adopting various organizational systems.

Table 16. Results of Probit Model (with separate Sector dummy variable)

Variable	Innovator (Any type)	Goods Product	Service Product	Process	Organizational	Marketing
Sector Dummy (Services=1)	*-.087076*	***-.6474461******	.0285427	-.2047742	.0311473	-.0308463
Majority Ownership Dummy (Foreign=1)	.2350374	-.0817784	-.094926	.0893156	***.4515713*****	-.1469295
Market orientation Dummy (Exporter=1)	.1152216	-.0979195	-.2191678	-.0029936	-.0164675	-.1153456
Age Dummy (1-10 Years=1)	.159327	.1138256	***.4188343*****	.1628605	***.2405868****	.065323
Size (Log of employment)	***.083959****	***.1312856*****	***.1353475*****	***.1630559*****	***.1078492*****	***.0844037****
Constant	-.0192338	-.9079952***	-1.413366	-.9317674***	-.5202874***	-.28296
Num of observations	474	474	474	474	474	474
LR chi2(5)	23.71	30.43	18.42	38.02	42.56	5.12
Prob > chi2	0.0002	0.0000	0.0025	0.0000	0.0000	0.4015
Pseudo R2	0.0406	0.0518	0.0354	0.0585	0.0661	0.0078

Correctly classified	69.83%	69.20%	75.74%	61.60%	61.81%	53.38%

Significant at 1%(***), 5%(**), 10%(*)

Since the coefficients in probit models do not reflect the magnitude of the impacts, the marginal effects of the independent variables are calculated and presented below. As Table 17 shows, the probability of introducing a goods product is lower for service firms by 22 percentage points. Relative to its older counterparts, a young establishment is more likely to be a services product and an organizational innovator by 12 and 9 percentage points, respectively. On the impact of capital participation, the probability of being an organizational innovation is higher by 16 percentage points for foreign majority-owned establishments. For the continuous independent variable, size, which is consistently significant and positive for all types of innovation, the probability is highest in process innovation at 6 percentage points for every 1 percentage point increase in employee size. This is understandable given the need to improve production or distribution methods as a firm grows.

Table 17. Average Marginal Effects (Probit model with separate Sector dummy variable)

Variable	Innovator (Any type)	Goods Product	Service Product	Process	Organizational	Marketing
Sector Dummy (Services=1)	-.0292632	***-.2162166***	.0084995	-.0756065	.0113102	-.0122007
Majority Ownership Dummy (Foreign=1)	.078988	-.0273102	-.0282673	.032977	***.1639744***	-.0581155
Market orientation Dummy (Exporter=1)	.038722	-.0327005	-.0652644	-.0011053	-.0059797	-.045623
Age Dummy (1 to 10 Years=1)	.0535443	.0380124	***.1247216***	.0601312	***.0873618***	.0258374
Size (Log of employment)	***.0282157***	***.0438432***	***.0403041***	***.0602033***	***.0391622***	***.0333844***

Probit model with interaction terms

In this section, the approach of Pires, et al. (2008, pages 1348-1351) to determine the significance of the sector is employed. Instead of using a standalone dummy variable for the sector, an interaction term is used. The dummy variable Sector, which is equal to 1 when the establishment belongs to the services sector and equal to 0 otherwise, is combined with the other structural variables. This allows the integration of both manufacturing and service establishments in the regression without imposing that the effects of the various explanatory variables are the same in both sectors. In the models presented below, the first group involves the structural determinants of innovation output (minus the sector dummy) while the second group is formed by the interaction variables which captures whether the impact of a particular structural variable is different for establishments in the services sector. For example, the coefficient for the variable "Owner*Services" indicates the difference of the impact of foreign majority-owned firms on the probability of being an innovator between a service and a manufacturing firm. If the impact of the explanatory variables on the probability of the firm being an innovator is the same for manufacturing and service firms, the coefficient of "Owner*Services" should be equal to zero. Otherwise, it should be statistically significant.

As Table 18 shows, the size of the establishment is the one variable that is statistically significant across all types of innovation and the sign is positive except in two cases. Goods product innovation and process innovation by service establishments are less sensitive to size compared to manufacturing establishments similar to the results of Pires, et al. (2008).

In terms of producing new and significantly improved services, younger firms whether in the manufacturing or the services sector are more likely to innovate than older firms consistent with the results of the previous approach. This could be attributed to the Schumpeterian perspective mentioned earlier. The probability of becoming a service product innovator is also higher for foreign majority-owned establishments in the services sector. With respect to organizational innovation, foreign ownership matters regardless of whether the firm is in the manufacturing or services sector.

Table 18. Results of Probit Model (with interaction terms)

Variable	Innovator (Any type)	Goods Product	Service Product	Process	Organizational	Marketing
Majority Ownership Dummy (Foreign=1)	.065495	-.1626854	-.3120747	-.092074	***.3475531****	-.2735071
Market orientation Dummy (Exporter=1)	.2473409	-.0205545	-.1927313	.0181713	.0868993	-.0577005
Age Dummy (1-10 Years=1)	.1571535	.1470999	***.396686****	.144924	.2156001	.0710511
Size (Log of employment)	***.1128225****	***.1750789****	***.1489316****	***.2072138****	***.1216398****	***.1033368****
Owner*Services	.5250561	.2877118	***.8337797****	.5789247	.3529729	.4233103
Market*Services	-.5929587	-.4755225	-.2623088	-.2213936	-.5312015	-.2900198
Age*Services	.2296395	.1281996	.0004191	.1879411	.2798271	.0867849
Size*Services	-.0502085	***-.1322167****	-.028317	***-.1072787****	-.0159179	-.0388176
Constant	-.1061673	-1.124655***	-1.397832***	-1.041269***	-.5584994***	-.323012**
Num of observations	474	474	474	474	474	474
LR chi2(5)	29.36	36.22	23.19	44.40	45.68	7.52
Prob > chi2	0.0003	0.0000	0.0031	0.0000	0.0000	0.4813
Pseudo R2	0.0503	0.0617	0.0445	0.0683	0.0709	0.0115
Correctly classified	68.99%	69.20%	76.37%	63.50%	62.87%	54.43%

Significant at 1%(***), 5%(**), 10%(*)

The marginal effects of the statistically significant variables could be interpreted in the same way as the previous approach but now taking into account the interaction terms to determine the differences in the impact depending on the sector (see Table 19). For example, the impact of size is weaker in the services sector in the case of goods product and process innovation with lower probabilities of 1.41 (5.77 – 4.36) and 3.65 (7.56 -3.92), respectively. For service product innovation, ownership is not significant except in the services sector where the probability is 24.57 percentage points higher for foreign majority-owned firms compared to Filipino majority-owned firms.

Table 19. Average Marginal Effects (Probit model with interaction terms)

Variable	Innovator (Any type)	Goods Product	Service Product	Process	Organizational	Marketing
Majority Ownership Dummy (Foreign=1)	.0217616	-.0536115	-.0919777	-.0336039	***.125458***	-.1077521
Market orientation Dummy (Exporter=1)	.0821823	-.0067735	-.0568037	.0066319	.0313685	-.022732
Age Dummy (1-10 Years=1)	.0522163	.0484754	***.1169152***	.0528924	.0778263	.0279916
Size (Log of employment)	***.0374868****	***.0576956****	***.0438946****	***.0756261****	***.0439089****	***.040711****
Owner*Services	.1744569	.0948128	***.2457398****	.2112882	.1274145	.1667693
Market*Services	-.1970184	-.1567041	-.0773102	-.0808013	-.1917506	-.1142575
Age*Services	.0763008	.042247	.0001235	.0685922	.1010106	.0341902
Size*Services	-.0166824	-***.0435708***	-.0083459	-***.0391532***	-.005746	-.0152928

Summary

Based on the results of the two approaches, the following key insights can be derived:

- As the size of the establishment increases, the probability of being an innovator increases. This is especially true for manufacturing establishments.

- The impact of size on goods product innovation and on process innovation is weaker for establishments in the services sector.

- The impact of age is significant for service product innovation. Younger firms whether in the manufacturing or the services sector are more likely to introduce new or significantly improved services than older firms.

- Foreign ownership is a good determinant of service product innovation and organizational innovation. In particular, foreign majority-owned firms are more likely to engage in service product innovation compared to those that are Filipino majority-owned but this applies to those in service industries only. For organizational innovation, foreign ownership matters regardless of whether the firm is in the manufacturing or services sectors.

- Although the test of association indicates a relationship between being an exporter and being an innovator, when combined with other factors, the impact of market orientation is not significant.

- That the sector per se is not relevant to the probability that an establishment will engage in service product innovation (whereas the sector matters for goods product innovation) provides evidence of servicification in Philippine manufacturing.

While some of the individual factors are statistically significant, in general the predictive power of the probit models is not high indicating the need to consider other explanatory factors. Expanding the sample size to include other service industries could also better capture any differences in the innovation behavior between the manufacturing and services sectors and within services which have been detected in other studies.

Conclusion

Understanding services and innovation requires an integrative approach that captures different types of innovation and adopts a common analytical treatment for the manufacturing and services sectors. This paper examined the patterns and determinants of innovation in Philippines industries and found that technological and non-technological forms of innovation occur in both manufacturing and services sectors with varying perceived effects of these innovations.

The integrative approach is also applicable for developing policy. The results suggest that government should have an innovation policy that does not favor only one type of innovation output (e.g. goods product innovation), or one type of innovation activity (e.g. R&D), or one type of innovation expenditure (e.g. investment in capital equipment). Moreover, with the increasing convergence of goods and services, industry targeting may be a blunt and inadequate instrument for industrial upgrading compared to a strategy that focuses instead on encouraging innovation (or incentivizing innovation activities) regardless of the sector. Another implication of servicification is that policies and regulations directed at service industries could affect the competitiveness of manufacturing industries apart from the traditional channel (i.e. services as inputs to production). Restrictions to supply a service, for example, will hurt manufacturing firms if these affect their ability to incorporate services as part of their overall product offerings.

On the role of structural factors on innovation output, the significant and positive impact of foreign majority-owned establishments on organizational innovation is interesting. This suggests that given the perceived effects of organizational innovation as rated by the establishments themselves, there could be additional benefits and positive spillover effects from encouraging foreign ownership. Its significance for service product innovation in the services sector is also instructive. These results should be useful inputs for evaluating Philippine FDI policy and promotion.

Entrepreneurship is another area that is relevant for generating innovation. Given that younger firms, whether in the manufacturing or the services sector, are more likely to produce new or significantly improved service products highlights the importance of a policy and regulatory environment conducive to creating startups.

Further study is needed to explain the low to non-existent R&D activity in various industries. Related to this, understanding the innovation behavior of various services is another area for future research. A key limitation of the survey used for this paper is the limited sample of service industries included. Given that the sector is so diverse, expanding the coverage to include other services will provide more insights on innovation patterns and determinants. Inclusion of more service industries in future surveys could reveal not only differences between manufacturing and services but also differences with various service industries. This will contribute to a deeper understanding of the differences and similarities which will help in developing more appropriate government support, if any. Apart from surveys, case studies of the innovation process in specific industries and/or locations will also be useful.

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Appendix A. Business expenditures in R&D (BERD)

Definitions from PSBI Questionnaire:

Research and Development (R&D) refers to creative work undertaken as a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.

R&D personnel are all persons employed directly on R&D as well as those providing direct services such as R&D Managers, administrators and clerical staff. R&D personnel are classified into three categories: researchers, technicians and auxiliary personnel.

Research and development (R&D) expense is the amount spent on any systematic, scientific and creative work undertaken to increase the stock of knowledge and the use of this knowledge to create new or improved products, processes, services, and other applications.

Top BERD performing industries in Manufacturing sector (from highest to lowest in terms of Total R&D Cost/Value Added)

PSIC code	Industry	R&D Expenses/Value Added (%)	R&D Compensation/ Value Added (%)	Total R&D Cost/Value Added (%)
C279	Manufacture of other electrical equipment	6.7316	0.0992	6.8308
C275	Manufacture of domestic appliances	2.0357	3.7868	5.8225
C263	Manufacture of communication equipment	5.1983	0.2002	5.3985
C274	Manufacture of electric lighting equipment	4.1800	0.6273	4.8073
C321	Manufacture of jewelry, bijouterie and related articles	1.8563	1.7002	3.5565
C210	Manufacture of pharmaceuticals, medicinal chemical and botanical products	0.2371	2.6295	2.8667
C325	Manufacture of medical and dental instruments and supplies	0.9052	1.4899	2.3952
C310	Manufacture of furniture	1.2309	1.1260	2.3569
C323	Manufacture of sports goods	0.5683	1.4766	2.0449
C103	Processing and preserving of fruits and vegetables	1.1416	0.8744	2.0160

Note: R&D compensation estimated using average industry compensation x R&D personnel. Total R&D cost is equal to R&D expenses and R&D compensation.

Top BERD performing industries in Services sector (from highest to lowest in terms of Total R&D Cost/Value Added)

PSIC code	Industry	R&D Expenses/Value Added (%)	R&D Compensation/ Value Added (%)	Total R&D Cost/Value Added (%)
M72103	Research and experimental development in health sciences	10.8561	27.3304	38.1865
M72102	Research and experimental development in engineering and technology	0.1375	27.6438	27.7813
M72300	Research and experimental development in information technology	6.9832	11.5105	18.4937
M72101	Research and experimental development in natural sciences	5.8897	7.8310	13.7207
M702	Management consultancy activities	1.6931	3.0634	4.7565
J61209	Other wireless telecommunication services, n.e.c.	0.3048	3.5606	3.8654
M72200	Research and experimental development on social sciences and humanities	3.0147	0.3611	3.3758
K651	Insurance	0.4100	2.8734	3.2834
Q889	Other social work activities without accommodation, n.e.c.	2.6832	0.0701	2.7532
J62010	Computer programming activities	0.2905	2.4310	2.7216

Note: R&D compensation estimated using average industry compensation x R&D personnel. Total R&D cost is equal to R&D expenses and R&D compensation.

Appendix B. Profile of sample

Characteristics		Manufacturing (%)	Services (%)	Total (%)
Legal Organization	Single Proprietorship	*15.84*	*6.77*	*13.29*
	Partnership	*1.47*	*0.75*	*1.27*
	Government Corporation	*0*	*2.26*	*0.63*
	Stock Corporation	*80.35*	*86.47*	*82.07*
	Non-stock Corporation	*2.05*	*3.76*	*2.53*
	Cooperative	*0.29*	*0*	*0.21*
	Total	*100*	*100*	*100*
Economic Organization	Single establishment	*70.67*	*64.66*	*68.99*
	Branch only	*22.58*	*19.55*	*21.73*
	Establishment and main office	*6.74*	*15.79*	*9.28*
	Total	*100*	*100*	*100*
Capital participation	Filipino majority-owned (at least 50%)	*63.64*	*69.17*	*65.19*
	Foreign majority-owned (more than 50%)	*36.36*	*30.83*	*34.81*
	Total	*100*	*100*	*100*
Market Orientation	Non-exporter	*59.53*	*54.14*	*58.02*
	Exporter	*40.47*	*45.86*	*41.98*
	Total	*100*	*100*	*100*
Age (years)	0-10	*39.88*	*63.91*	*46.62*
	11-20	*43.7*	*21.8*	*37.55*
	21-30	*7.04*	*5.26*	*6.54*
	31 above	*9.38*	*9.02*	*9.28*
	Total	*100*	*100*	*100*
Size (number of employees)	Micro (0-10)	*22.87*	*21.05*	*22.36*
	Small (11-20)	*21.99*	*24.06*	*22.57*
	Medium (21-30)	*18.18*	*13.53*	*16.88*
	Large (31 above)	*36.95*	*41.35*	*38.19*
	Total	*100*	*100*	*100*

Appendix C. Other tables

Table A. Product innovation effects (Perceived as "High")

Effect	Manufacturing (%)	Services (%)	Total (%)	Pearson Chi Square
Increased range of goods or services	**54.21**	**52.78**	**53.85**	0.2232
Entered new markets or increased market share	**44.86**	**55.56**	**47.55**	1.8279
Improved quality of goods or services	**65.42**	**61.11**	**64.34**	3.3385

Note: Covers product innovators only

Table B. Process innovation effects (Perceived as "High")

Effect	Manufacturing (%)	Services (%)	Total (%)	Pearson Chi Square
Improved flexibility of production or service provision	54.55	43.9	51.85	8.7665**
Increased capacity of production or service provision	53.72	36.59	49.38	4.1178
Reduced labor costs per unit of output	37.19	29.27	35.19	3.2246
Reduced materials and energy per unit of output	33.06	24.39	30.86	4.6493

Note: Covers process innovators only

Significant at 1%(***), 5%(**), 10%(*)

Table C. Other Effects (Perceived as "High")

Effect	Manufacturing (%)	Services (%)	Total (%)	Pearson Chi Square
Reduced environmental impacts or improved health and safety	47.73	26.09	42.13	14.4956***
Met regulatory requirements	53.79	32.61	48.31	11.0822**

Note: Covers product or process innovators only

Significant at 1%(***), 5%(**), 10%(*)

Table D. Effects of organizational innovation (Perceived as "High")

	Manufacturing (%)	Services (%)	Total (%)	Pearson Chi Square
Reduced time to respond to customer or supplier needs	42.05	36.25	40.36	2.6647
Improved quality of goods or services	64.29	50	60.14	6.1837*
Reduced costs per unit output	40.31	31.25	37.68	6.2332*
Improved employee satisfaction and/or lower Employee turnover	35.2	31.25	34.06	2.5815

Improved communication or information sharing	43.37	46.25	44.20	0.4001
Increased ability to develop new products or processes	42.86	25	37.68	8.7722**

Note: Covers organizational innovators only

Significant at 1%(***), 5%(**), 10%(*)

Table E. Effects of Marketing Innovation (Perceived as "High")

	Manufacturing (%)	**Services (%)**	**Total (%)**	**Pearson Chi Square**
Sales growth for your goods and services	39.53	29.85	36.82	2.1458
Increased visibility of products or business	38.37	31.34	36.4	15.8955***
Strengthened relationships with customers	55.23	34.33	49.37	10.1389 **
Improved customer satisfaction	59.88	40.3	54.39	18.0347***

Note: Covers marketing innovators only

Significant at 1%(***), 5%(**), 10%(*)

Table F. Innovation Activity

	Manufacturing (%)	**Services (%)**	**Total (%)**	**Pearson Chi Square**
In-house R&D	31.09	35.16	32.22	0.4999
Outsourced R&D	5.04	6.59	5.47	0.3064
Acquisition of machinery and equipment	38.24	26.37	34.95	4.0737**
Acquisition of computer hardware	28.57	40.66	31.91	4.4267**
Acquisition of computer software	28.99	35.16	30.70	1.1792
Acquisition of external knowledge	12.18	16.48	13.37	1.0500
Training (Internal or external)	52.52	48.35	51.37	0.4581
Market introduction of innovation	24.79	28.57	25.84	0.4913
Other preparations	32.77	30.77	32.22	0.1210

Note: Covers innovators (product, process, organizational, and marketing) only

Significant at 1%(***), 5%(**), 10%(*)

Table G. Information Sources for Innovation Activities

		Manufacturing (%)	Services (%)	Total (%)	Pearson Chi Square
Internal	Internal	42.86	41.76	42.55	0.1852
Market sources	Suppliers of equipment, materials, components, or software	31.51	24.18	29.48	11.6707***
	Clients or customer	39.50	39.56	39.51	1.1117
	Competitors or other enterprise in your sector	22.27	23.08	22.49	1.7773
	Consultants, commercial laboratories or private R&D institutes	11.76	15.38	12.77	0.8054
Institutional Source	Universities or other higher education institutions	3.36	13.19	6.08	12.2366***
	Government or Public Research Institutes	1.68	10.99	4.26	14.0552***
Other sources	Conferences, trade fairs, exhibitions	12.61	14.29	13.07	1.0513
	Scientific journals and trade/technical publications	7.98	15.38	10.03	4.1592
	Professional and industry associations	8.40	12.09	9.42	1.2268

Note: Covers innovators (product, process, organizational, and marketing) only
Significant at 1%(***), 5%(**), 10%(*)

Table H. Factors hampering innovation activities (Considered as "High")

		Manufacturing (%)	Services (%)	Total (%)	Pearson Chi Square
Cost factors	Lack of funds within your establishment or enterprise	24.93	20.3	23.63	1.9630
	Lack of finance from sources outside your enterprise	14.96	14.29	14.77	3.5362
	Innovation costs too high	26.1	22.56	25.11	5.3468
Knowledge factors	Lack of qualified personnel	12.02	9.02	11.18	1.2485
	Lack of information on technology	10.56	9.77	10.34	3.7598
	Lack of information on markets	9.38	9.02	9.28	4.0715

	Difficulty in finding cooperation partners for innovation	9.38	12.03	10.13	7.8786**
Market factors	Market dominated by established Enterprises	14.08	12.78	13.71	3.4579
	Uncertain demand for innovative goods or services	10.56	8.272	9.9	1.3694
Reasons not to innovate	No need due to prior innovations	7.33	9.77	8.02	1.6115
	No demand for Innovations	10.26	10.53	10.34	0.4692

Note: Covers full sample of establishments

Significant at 1%(***), 5%(**), 10%(*)