Innovation and Productivity in the Service Sector

The Case of Mexico

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Abstract[1]

An extensive literature analyzes the determinants of research and development (R&D) and the impacts of R&D on firms' innovation performance and productivity. Because most available studies focus on manufacturing firms, very little is known about firms in the service sector. The gap is even more noticeable in the case of service firms in developing countries. Based on data from the latest available Mexican innovation survey, we explore the determinants of—including the barriers to—technological innovation and the impact of innovation on service firms' productivity in Mexico. Results from a three-stage econometric model indicate that firms' structural and behavioral factors, such as size, openness strategy, use of public funds, and exporting behavior, increase the propensity to invest in innovation. The results also show that firms with higher learning and innovation intensity tend to show superior innovation performance compared to firms that invest poorly in learning and innovation. Moreover, innovation output has a positive impact on firm productivity. In terms of policy implications, this study highlights the importance of promoting learning and innovation as the basis for improved productivity of service firms in Mexico. Specifically, policy interventions need to enhance both the number of service firms that innovate and the intensity of those innovation activities.

JEL classifications: L8, O12, O14, O31, O33, O40

Keywords: Innovation, Productivity, Innovation in services, Innovation survey, Barriers to innovation, Mexico

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1 Introduction

This study is part of a larger research project intended to understand the determinants of innovation in service firms and the linkages between innovation and productivity in the service sector in Latin America. The study endorses the growing interest in challenging traditional conceptualizations of services as users of technology and characterized by slow productivity growth, from an already low productivity base relative to other sectors of the economy (Pavitt, 1984; Miozzo and Soete, 2001). Rather, the authors endorse recent contributions to the literature calling for new conceptualizations of services and a deeper understanding of their heterogeneity, dynamics, and interactions with other sectors of economic activity (DTI 2007; Rubalcaba and Gago, 2006; Tacsir and Guaipatin, 2011). Expanding on the seminal work of Barras (1990), services are considered to be innovative and, in the case of knowledge-intensive business services (KIBS), at levels comparable to those of manufacturing (Evangelista and Savona, 2003; Bogliacino, Lucchese and Pianta, 2007). The evidence, however, remains scant and inconclusive.

The current study is a contribution to the debate from a developing-country perspective. Based on data about service firms in Mexico, we study the determinants of innovation in the sector and of learning and innovation intensity and, finally, we analyze if and how innovation sways firms' performance, measured in terms of labor productivity. For comprehensiveness, we also perform a comparative analysis of manufacturing firms in Mexico. We build our analysis on a conventional taxonomy of firms, which distinguishes between high-technology (high-tech) and low-technology (low-tech) manufacturing industries on the one hand, and knowledge-intensive business services (KIBS) and traditional services, on the other. Based on Crépon, Duguet, and Mairesse (1998), we perform a three-stage econometric model across the different sectors. An additional contribution of this study is the inclusion in the CDM model of the barriers to innovation, as perceived by firms, as determinant of both the decision to innovate and actual investment in innovation by firms in Mexico. [2]

Three main hypotheses are elaborated throughout this paper. The first addresses the component that firms in the service sector engage in learning and innovation activities and they

[2] The accompanying study in Appendix 1 provides a broader discussion and analysis of the barriers to innovation for both manufacturing and service firms in Mexico.

invest in those learning and innovation activities. We address that hypothesis in equations 1 and 1.1 in our econometric model. The second hypothesis relevant to this study is that firms in the service sector innovate differently than firms in the manufacturing sector. An important number of studies have addressed innovation in the manufacturing sector; however, just a few have focused on the analysis of innovation in services and the specificities of innovation between high-tech and low-tech manufacturing, and KIBS and traditional services. This study seeks to identify the differences between service and manufacturing sectors regarding the decision to innovate and the decision to invest in innovation and learning activities. For example, we test the particular impact on manufacturing and services of structural variables such as firm size and ownership; innovation behavioral variables such as a strategy of openness to innovation, access to different information sources, and the use of public funds to innovate; and export experience and patent application. We also test the effect of several barriers to innovation, such as cost, market knowledge, and regulation.

The third hypothesis addressed in this study is that innovation intensity has a positive impact on innovation output and on firm productivity. Again, we benchmark services with manufacturing. We test this hypothesis using the CDM model. Equation 1.2 will indicate the impact of innovation intensity, ownership, export experience, and patent applications on innovation output. We expect to observe differences between the manufacturing and service sectors. Equation 1.3 and 1.3.1 will test the impact of innovation output and innovation investment on firms' productivity, respectively. We also identify the effects of patent applications and non-technology innovation.

The remaining parts of this study are organized as follows. Section 2 presents a brief overview of recent contributions to the literature on innovation in services. Section 3 introduces the main data sources used in this study, including the latest available *Encuesta sobre Innovación y Desarrollo Tecnológico* (ESIDET 2010), which includes an innovation survey with questions based on the Oslo Manual. This section also discusses the research strategy followed in this project. Section 4 is split into two parts. First, we describe the main aggregates that characterize the service sector in Mexico, including GDP and employment. Second, based on the information from ESIDET (2010), we present some descriptive statistics of service firms in Mexico. As benchmark, we incorporated information about the manufacturing sector in Mexico. Section 5 discusses some policy interventions intended to promote innovation and productivity among service firms in Mexico. Section 6 presents the results from our econometric analysis, based on a three-stage Crépon-Duguet-Mairesse (CDM) econometric model. Finally, Section 7 concludes.

2 Literature Review

2.1 *Three Theoretical Approaches to Understanding Innovation Processes*

In recent decades, the service sector has increased in importance, becoming the largest contributor to employment and gross domestic product (GDP) in both developed and developing countries (Evangelista, 2000; Hauknes, 1996; Miles et al., 1995). A recent study by the Inter-American Development Bank (IDB) asserts that improving productivity in services is the key to enhancing aggregate productivity in Latin American economies. This is because of the large presence of the service sector in the productive structure of the region (Crespi and Zuñiga, 2010). This notwithstanding, the study of innovation in services is relatively new, yet in full development (Drejer, 2004; Evangelista, 2000; Hauknes, 1996; Miles et al., 1995). Gallouj and Weinstein (1997) indicate that the analysis of innovation in services faces two main difficulties. First, theoretical developments have been based primarily on the study of technological innovation in manufacturing activities (Gallouj and Weinstein, 1997; Evangelista, 2000; Drejer, 2004). Second, there is a need to consider the specificities of service activities. In particular, the immaterial nature of services hinders the possibilities of measuring through traditional methods (research and development [R&D], productivity), while limiting the capacity to track improvements or changes in product-services (quality level) (Gallouj and Weinstein, 1997). Gallouj and Weinstein (1997) also assert that these difficulties are the starting point of two complementary approaches to studying innovation in services.

Hauknes (1996) calls the first approach the *technology-based approach*, also known as the *assimilation approach* (Drejer, 2004; Tether and Howells, 2007), which focuses on understanding the role of technology in services (introduction of equipment and systems). Consequently, the study of innovation in services builds on the same conceptual framework and definitions used to research the manufacturing sector (technological and product innovation). The approach likewise uses the same instruments for measuring innovation in manufacturing, which Djellal and Gallouj (2000) call *subordinated surveys*. Studies in this tradition have made important contributions to understanding the impact of technology adoption in the service sector, especially in information and communication technologies. Also important is the development of taxonomies of specific technological trajectories for the service sector (Soete and Miozzo, 1990, quoted in Gallouj and Weinstein, 1997).

Arguably, Barras is the first author to understand services innovation as an interactive process, complementary with other sectors of the economy, particularly the manufacturing sector. Based on the study of services including banking, insurance, and other financial services, Barras (1986, 1990) developed a theoretical model of innovation in services called *reverse product cycle*. The model contends that the life cycle of services runs opposite to the cycle of industrial products; the development of industrial products and their subsequent adoption by service firms contribute to innovation in services. Gallouj and Weinstein (1997) acknowledge the theoretical value of Barras' contribution; yet, they argue that, in addition to an integrated theory of innovation in services, Barras presents us with a theory of diffusion of technological innovations, from manufacturing to the service sector.

Djellal and Gallouj (2000) and Tether and Miles (2000) criticize the assimilation approach, arguing that it tends to ignore that innovation in services has specific characteristics. Moreover, they suggest that, in addition to technological innovations, the definition of innovation should encompass various forms of non-technological innovations, including organizational innovations. In their critique of the assimilation approach, Djellal and Gallouj (2000) likewise decry the limited usefulness of subordinated surveys—innovation surveys applied to the manufacturing sector, particularly the Community Innovation Survey (CIS). In their view, it is better to develop custom, autonomous surveys, more attuned to the specificities of innovation in services. Tether and Miles (2000) adopt a more radical view; they conclude that the approaches underpinning the CIS, and thus the Oslo Manual, exclude important elements of non-technological innovations; moreover, they are limited in their understanding of the real dynamics of innovation and its relationship to economic performance. And yet, empirical studies based on the assimilation approach, which use subordinated surveys, suggest that the differences between services and manufacturing are not significant. Based on panel data of firms, Mannheim, Germany, and Ebling (2000) found that the main determinants of exports by service firms in the region are variables associated with innovation activities, particularly technological innovations, as well as variables related to human capital. A comparative analysis of technological innovation in services and manufacturing by Sirilli and Evangelista (1998) used data from two surveys—

from 1993-95 for service firms, and 1990-92 for manufacturing firms. The authors found that innovations in the two sectors had more similarities than differences. Evangelista (2000) shares this conclusion; arguably the differences are more of degree than of kind of innovation. The similarities found in these studies, among others, are not a demonstration that the assimilation approach is the most appropriate to understand the dynamics of innovation in services, since these similarities may be the direct cause of the approach itself because it does not consider the potential differences resulting from other types of innovation (Drejer, 2004; Tether and Howells, 2007).

Against this background, a second approach, or *services-oriented* approach, emerges (Gallouj and Weinstein, 1997). Hauknes (1996) called this the *services-based approach* or *demarcation approach* (Drejer, 2004). This approach emphasizes the specificities of both innovation and production processes in services. It rejects the centrality of technological innovation; rather, it highlights the role of organizational innovation and knowledge-based service innovation, where R&D and *hard technologies* are of relatively lower importance compared to manufacturing sectors (Tether and Howells, 2007). This approach is linked to the use of *autonomous surveys* (Djellal and Gallouj, 2000); custom surveys seek to identify the dynamics and specificities of innovation in services. In that sense and by that definition, this approach does not compare the specificities of services innovation with those exhibited in the manufacturing sector. Consequently, a major shortcoming of this approach is the potential for errors in the inference of what is or what is not specific to the innovation processes in the service sector that it attempts to characterize (Drejer, 2004). Djellal and Gallouj’s (2001) is an example of this problem; the analysis confirms the importance of users in the development of innovations and the multiplicity of actors involved in the innovation process, and the interactive nature of innovation. Arguably, all these are common elements of innovation processes in manufacturing. Noteworthy in this debate is that the heterogeneous nature of services implies that even if innovation in certain service activities may show strong similarities with innovation in manufacturing, some others clearly show some specific characteristics (Hauknes, 1996). Hauknes (1996), Drejer (2004), and Gallouj and Weinstein (1997) provide some of the most important contributions to this approach.

Today, innovation scholars interested in service innovation recognize the importance of both technological and non-technological innovation. They stress the interactions and complementarities existing between these two types of innovations. This consensus is made explicit by a third approach to study innovation in services, which Hauknes (1996) called the *integrated approach*, or the *synthesis approach* (Tether and Howells, 2007; Drejer, 2004). This perspective highlights the growing complexity and multidimensional nature of innovation in both services and manufacturing. Attention is increasingly drawn to the complementarities and convergence between the production of goods and services. The synthesis approach argues that by understanding innovation in services, it is also possible to understand innovation processes in other sectors, including manufacturing. It recognizes the importance of both technological and non-technological innovation, especially organizational, and points to the interactions and complementarities between these two types of innovation (Tether and Howells, 2007). Hence, the focus of research has shifted from technology to knowledge, away from the study of individual firms, to understand value chains or networks, locating services and manufacturing as interconnected parts in a system. KIBS are an example, as they can be seen as either technological or knowledge intermediaries in the innovation system (Miles et al., 1995). The integrative perspective is relatively recent and has not been applied in many innovation surveys (Drejer, 2004). Some relevant contributions in this tradition include Gallouj and Weinstein (1997), Coombs and Miles (2000), Hollenstein (2003), Drejer (2004), Hipp and Grupp (2005), Tiri et al. (2006), Leiponen and Drejer (2007), Castellacci (2008), and Peneder (2010).

2.2 *Different Types of Patterns and Innovation in the Service Sector*

Table 1 summarizes some major attempts at developing a typology of innovation in services. The table provides key references for each major school of thought; it also highlights some defining features of the frameworks and taxonomies they have informed.

Soete and Miozzo (1989) propose a typology based on Pavitt (1984), which allowed the identification of different patterns of innovation in services. The typology was perhaps the first step in incorporating the study of innovation in the service sector. Since then, several studies have emerged, including Den Hertog and Bilderbeek (1999), Evangelista (2000), Tether and Hipp (2000), Sundbo and Gallouj (2000), Hollenstein (2003), Hipp and Grupp (2005), Hipp and Herstatt (2006), De Jong and Marsili (2006), Hortelano and González-Moreno (2007), and Miles (2008). Evangelista (2000) developed a similar typology based on an innovation survey of 19,000 service firms with 20 or more employees, collected for the period 1993–1995. Applying factor analysis to categorize service innovation, the author identified four patterns of innovation. By contrast, based on a cluster analysis of 2,731 service firms included in the 1999 Swiss Innovation Survey, Hollenstein (2003) identified five patterns of innovation in services. Both Soete and Miozzo (1989) and Hollenstein (2003) have been heavily criticized for their strong adherence to *assimilation-like/technology-based* approaches, and hence for failing to sufficiently capture non-technological innovations.

From an alternative perspective, Hipp and Grupp (2005) introduced the *network-based innovation* classification, which includes two kinds of activities: *scale-intensive and physical network-intensive sectors* (transport and wholesale trade), and *information-intensive networks sectors* (communication, finance, and insurance services). This classification consists of technical services, R&D, and software, which are identified with KIBS. The authors argue that, in general, existing typologies of innovation in services use traditional, narrow definitions of innovation. They stress the need for new concepts and indicators to help understand the dynamics of innovation in services. Hipp and Grupp (2005) suggest the need to study innovation processes in manufacturing and services based on a common analytical framework.

Table 1. Innovation-related Taxonomies of the Service Sector

Approach	Basis	Classification of services	Description	Authors
Assimilation	Soete and Miozzo(1989) based on Pavitt (1984)	Supplier dominated sectors	E.g., public or collective goods (education, health care, administration) and personal services (food and drink, repair businesses, hairdressers, etc).	Miozzo and Soete (2001)
		Production-intensive sectors	**Scale-intensive sectors**: services involving large-scale back-office administrative tasks that are well suited to the application of information technologies (IT) **Network sectors:** services dependent on physical networks (e.g. transport and travel services, and wholesale trades and distribution) or on elaborate information networks (e.g., banks, insurance, telecommunications, and broadcasting services). Public utilities may be included in this group, although they are often not considered services.	
		Specialized technology suppliers and science-based sectors	This group includes software and specialist business services, including consulting, technical and design services.	
Assimilation	Use data provided by the innovation survey carried out in Italy in 1997 by the National Statistical Office (ISTAT) and National Research Council. This survey collected information on innovation activities in the service sector on the basis of the guidelines indicated in the revised version of the OECD "Oslo Manual" (OECD-EUROSTAT, 1997)	Technology users	This group includes waste processing, land and sea transportation, security, cleaning, legal services, travel services and retail. They are the least innovative group and are similar to services known as *supplier dominated*. These firms rely on technologies brought in from external sources, usually the manufacturing and/or information technology (IT) sectors.	Evangelista (2000)
		Interactive services	This group includes advertising, banks, insurance, hotels and restaurants. Innovation is achieved through interaction with clients, rather than through internal R&D or technological acquisition. A heavy reliance is placed on developing and/or implementing software and/or acquiring know-how.	
		Science and technology-based services	This group includes R&D services, engineering, and computer and software services. They are major generators of new technological knowledge, which they then diffuse to manufacturers and other services providers. Their innovation activities are typically located 'upstream' at the 'front-end' of the innovation and knowledge generation chain, often involving close interactions with public and private research institutions. These are KIBS.	
		Technology consultancy services	These combine characteristics of science and technology-based services and interactive services. They carry out internal innovation activities but draw heavily on client's knowledge. While all services may be said to have some problem-solving activities of one sort or another, the technical consultants' main function is the provision of solutions to meet the specific needs of their clients.	

Synthesis	Use data provided by the innovation survey in the German service sector (2000). From the empirical results they derive a typology of services.	Knowledge intensity	This group includes technical services and R&D. Universities or other research institutes are important or very important sources of external knowledge. The companies having exhibited close customer relations and tight links with the scientific base. It takes into account KIBS as intermediaries between knowledge producers and knowledge users.	Hipp and Grupp (2005)
		Network based	This group includes banks, insurance companies, and telecommunications as network-intensive industries in the field of information networks. These are interactive network companies from an innovation perspective and their services products are substantially based on information and communication networks or they have to process large amounts of data.	
		Scale intensive	These companies are classified depending on their services output's degree of standardization.	
		Supplier dominated	They are characterized by their innovations being developed externally and, therefore, have been supplied from the outside.	
Synthesis	Typology of innovation for all manufacturing and service sectors, using data from 2,500 European firms included in the Innobarometer 2002.	Product-research (PR) mode	This group is composed mainly of medium-high-technology manufacturing and high-technology activities. It is characterized by the cooperation of firms with universities or R&D specialists	Tether and Tajar (2008)
		Process technologies (PT) mode	This group is dominated by low- and medium-low-tech manufacturing.	
		Organizational cooperation (OC) mode	This group is composed of services, especially distribution and trade activities. In this group it is likely to engage in cooperative practices with suppliers, customers and trade associations (supply-chain cooperation rather than research-based cooperative practices). The innovation activities carried out by these firms are basically oriented at organizational changes.	
Synthesis	Typology of innovation for all manufacturing and service sectors, using data from Fourth Community Innovation Survey (CIS4, 2002–2004) on the innovative activities in a sample of 24 European countries, and combines them with information on the economic	Advanced knowledge providers (AKP)	They are characterized by great technological capability and a significant ability to manage and create complex technological knowledge. This group is integrated by **Specialized suppliers of machinery, equipment and precision instruments** (within manufacturing)**,** and **Providers of specialized knowledge and technical solutions (**within services) like software, R&D, engineering and consultancy. These are KIBS.	Castellacci (2008)
		Sectors producing mass-production goods (MPGs).	They are a key component of manufacturing activities. They possess considerable capabilities to develop new products and processes internally. **Scale-intensive industries** (e.g. motor vehicles and other transport equipment). Firms frequently own and operate in-house R&D facilities and maintain close cooperation with specialized suppliers of precision instruments and machinery; and **Science-based sectors** (such as electronics). Firms have great ability to create new technologies internally, with an intensive reliance on interactions with universities and public research institutes.	
		Supporting infrastructural services (SIS).	They may be at an early stage of the vertical chain; they mostly produce intermediate products and services rather than items for personal consumption. The main difference from AKP is in terms of their more limited technological capability to develop new knowledge internally. Their innovative trajectory tends to be based	

	performance of these industrial sectors in the longer period 1970–2003 from the OECD-STAN database.		on the acquisition of machinery, equipment, and various types of advanced technological knowledge created elsewhere. This group functions as providers of supporting infrastructure for the business and innovative activities of firms in the whole economy. **Providers of distributive and physical infrastructure services (**e.g., transport and wholesale trade) and **Providers of network infrastructure services (**e.g., finance and telecommunications), often based on a heavy use of ICTs developed elsewhere.	
		Producers of personal goods and services (PGSs).	They are placed at the final stage of the vertical chain. Similar to Pavitt (1984) and Miozzo and Soete, (2001), Castellaci (2008) views these manufacturing and services industries mostly as recipients of advanced knowledge, with lower technological content and limited ability to develop new products and processes internally. Their dominant innovation strategy is the acquisition of machinery, equipment, and other types of external knowledge produced by their suppliers. PGSs include **Producers of personal goods** and **Providers of personal services.**	

Source: Authors' elaboration.

Consistent with a *synthesis approach*, Tether and Takhar (2008) developed a typology of innovation that involves both manufacturing and services. By looking at the firm's orientation towards innovation, the authors classify firms according to their innovative features, including their main source of access to technologies, and the firm's perception of its core innovation competencies. The authors conducted a quantitative analysis to identify three modes of innovation: (i) Product-Research (PR) mode, (ii) Process Technologies (PT) mode, and (iii) Organizational Cooperation (OC) mode.

Castellacci (2008) developed a typology that combines manufacturing and services within a common analytical framework. This typology builds on the Fourth Community Innovation Survey (CIS4, 2002–04), a sample of manufacturing and services in 24 European countries. These data are combined with information on the economic performance of these sectors from the OECD-STAN database for the period 1970–2003. Castellacci's taxonomy focuses on the role of each sector in the economic system, namely as providers and/or recipients of advanced products, services and knowledge; and on sectoral and technological trajectories. Hence, the author identifies four types of firms based on their specific features and stresses the importance of vertical ties for innovation (see Table 1).

These taxonomies make for interesting efforts to approach a complex and heterogeneous sector like the service sector. The availability of data largely follows a structure more appropriated to innovation in the manufacturing sector. In this sense, the approach followed in this document can be located somewhere in between the so-called assimilation approach and the synthesis approach described in Table 1. In addition to data restrictions, for comparability purposes, in this document we use a taxonomy of high-tech and low-low tech for the manufacturing sector and KIBs and traditional subsectors for the service sector. To the extent that data collection considers the specifics of the service sector, we will be able to make stronger international comparisons on innovation in the sector.

3 Data Sources

This study uses both primary and secondary data sources. The main source of primary data is Mexico's *Encuesta de Innovación y Desarrollo Tecnológico* (ESIDET), which includes an Innovation Survey with questions based on the Oslo Manual. We worked with preliminary data obtained in 2010, which collected information corresponding to the period 2008–2009. According to the ESIDET's methodology, the unit of analysis is the firm. ESIDET's geographical coverage is national, and sectoral coverage includes the productive sector, particularly the manufacturing and service sectors. For firms in the manufacturing and service sectors (excluding the maquila industry), ESIDET used a stratified random sample for each of the industries according to the OECD classification. The raw data consist of a representative sample of 4,156 firms, including manufacturing (2,455) and service (1,701) firms. There is a group of firms that is considered an unavoidable inclusion: those with 751 or more employees, and a set of 1,271 firms and institutions that conduct research and technological development and are included in the directories of CONACYT. The latter have been granted some public support to undertake R&D or other innovation-related activities.

The classifier used to identify the economic activity of firms in this study is the International Standard Industrial Classification (ISIC) Rev. 3.1. This was a challenge because ESIDET 2010 follows the North American Industry Classification System (NAICS) 2007, which is not fully compatible with standard industry classifications based on the technology intensity of firms. For the sake of internal analysis of the information, Mexico's National Institute for Statistics, Geography, and Informatics (INEGI) establishes equivalence between ISIC Rev. 3.1 and NAICS 2007. We classify firms into high-tech and low-tech manufacturing sectors, and KIBS and traditional service sectors. Based on a study entitled "The Use of Knowledge-Intensive Business Services in SME Manufacturing Firms in Quebec: Performance Diagnosis and Drivers of Innovation by Sector and Region," by Canada Economic Development for Quebec Regions, we identified the NAICS codes for the KIBS industries included in this study. Thus, based on the information available in ESIDET 2010, the classification of firms used in the empirical analysis is as follows: high-tech manufacturing (24, 29, 30, 31, 32, 33, 34 and 35, except 351), low-tech manufacturing (15, 16, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 351, 36, and 37), KIBS (72, 73 and 74, except 7492, 7493 and 7499) and traditional services (45, 50, 51, 52, 55, 60, 61, 62, 63, 64, 65, 66, 67, 70, 71 and 7492, 7493, and 7499).

The sample frame of ESIDET 2010 presents some limitations for the study of the innovation dynamics in the service sector. Only 32 percent of the firms sampled belong to the service sector, while, according to the 2009 Economic Census for Mexico, 60.4 percent of firms belong to this sector. Moreover, service firms, particularly in KIBS, tend to be micro or small;

firms with fewer than 50 employees produce over 51 percent of output in this subsector. Some of these limitations in the sampling of service firms result from the fact that ESIDET 2010 is biased towards large companies, as the sampling frame necessarily includes all companies that employ more than 751 people. In addition, the survey includes a sample of firms, some of which are micro and small firms, which have received support from CONACYT to conduct innovation activities.[3]

ESIDET 2010 contains specific modules that capture technology innovation in Mexico. The modules identify general firm characteristics, human resources, internal R&D, external R&D, expenditure in science and technology services, and technology transfer. The survey also contains information about awareness of and participation in government-led programs in support of R&D and innovation, international cooperation for R&D, technological innovation, firms' perception regarding factors that motivate innovation, and firms' assessment of the barriers they confront to innovate.

Secondary data sources informed the macro analysis of the service sector. Main sources included Mexico's National Accounts system, particularly the Goods and Services Accounts for the period 2007–2011. Figures on foreign direct investment (FDI) were obtained from the Ministry of Economy, General Directorate for Foreign Investment, and data on employment from the Employment and Occupation surveys.

In addition, this study is enriched by a set of face-to-face interviews with policy makers in charge of programs to fund innovation in the service sector. The results of these interviews inform Section 5 and shed light on the results obtained through the econometric models in Section 6.

[3] Notwithstanding its limitations, the sampling frame of ESIDET 2010 has improved compared to previous events; the target group has been expanded from including only firms with 50 or more employees to including firms with 20 or more employees.

4 The Service Sector in Mexico

4.1 *Macroeconomic Importance*

Recent figures on GDP, employment, and FDI by sector in Mexico reflect the overall importance of services for the economy. In 2011, the tertiary or service sector[4] contributed 61.3 percent to Mexico's GDP. By contrast, the secondary or manufacturing sector[5] represented 30 percent, and the primary (agriculture, forestry, fishing, and hunting) 3.5 percent (INEGI, 2011). With regard to FDI, services represented 42 percent of total inward investment in the country. Employment in services represented up to 62 percent of total employment in Mexico (Table 2, Figure 1, Figure 2, Figure 3).

Table 2. Importance of Services in Mexico, 2011

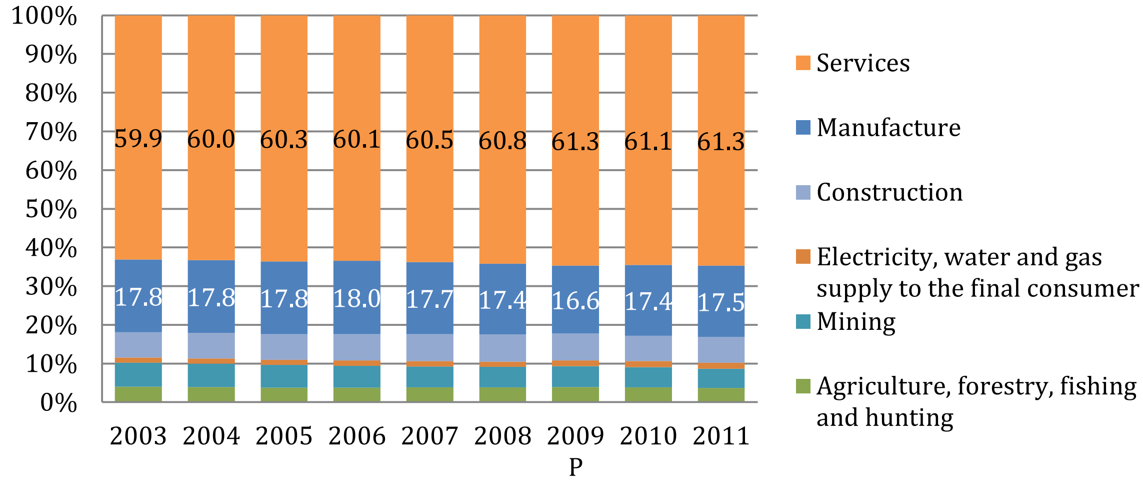
Sector[4]	GDP[1] Share	FDI[2] Share	Employment[3] Share
Services	61.3	42.2	62.0
Manufacturing	30.0	57.7	23.4
Agriculture, forestry fishing and hunting	3.5	0.1	13.9

Notes: 1/system of National Accounts, Goods and services account 2007-2011, first version. 2/INEGI with information from the Ministry of Economy, General Directorate of Foreign Investment. 3/National Survey of Occupation and Employment. Strategic Indicators. 4/The sectors correspond to the North American Industrial Classification System (NAICS). Data accessed October 2012.
Source: Authors based on information from INEGI.

The slight increase in the share of the service sector in GDP in the period 2003–2011 contrasts the sustained decrease in the share corresponding to the primary sector. The share of the manufacturing sector remains relatively constant over the period (Figure 1).

[4]According to the North American Industrial Classification System (NAICS), the tertiary sector consists of the following branches of productive activity: trade, transportation, posting and storage, mass media information, financial services and insurance, real estate and property and intangible goods rental, professional, scientific, and technical services, management of corporate and enterprises, support services for businesses, waste management and remediation services, educational services, health care and social assistance, recreational, cultural, and other recreational services, temporary accommodation and food and beverage preparation, other services except government activities, government activities and financial intermediation services.
[5] According to NAICS, the secondary sector consists of mining, electricity, water and gas supply to the final consumer, construction, and manufacturing.

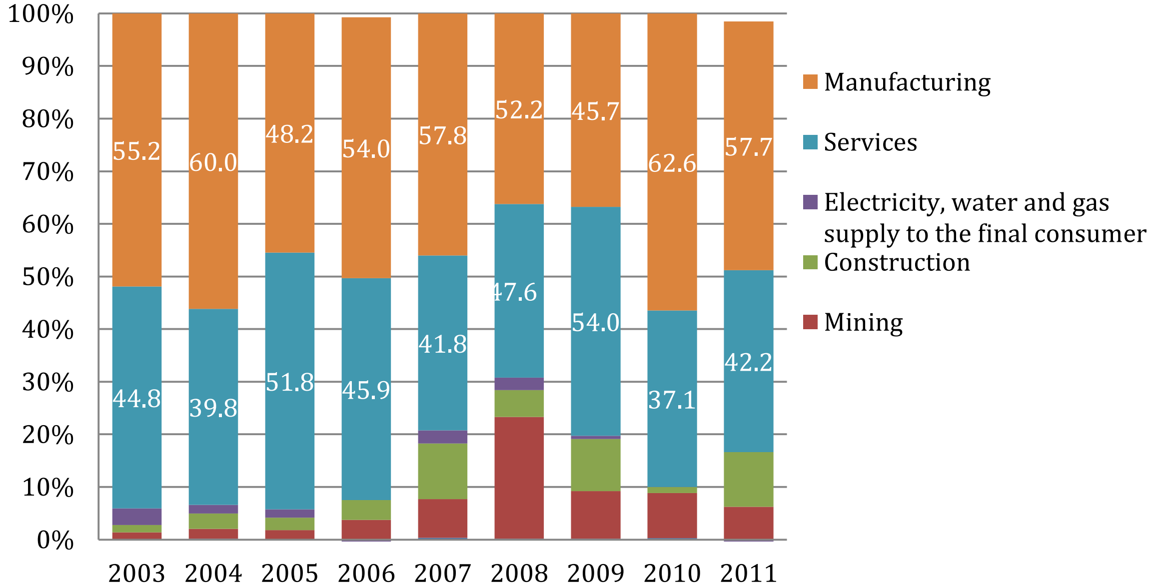
Figure 1. Mexico, Composition of GDP by Sector, 2003-2011



Source: Based on data from INEGI. P: Preliminary data from 2009.

In the period 2003–2011, the concentration of FDI in services and manufacturing activities is remarkable. Figure 2 shows that, notwithstanding fluctuations in FDI flows, the share of services averaged about 45 percent of the total. Traditional services concentrated a substantial part of FDI, particularly insurance and financial services, followed by tradable services. The averages for the whole period were 16.3 percent and 8.2 percent, respectively. Noteworthy is the dynamics of manufacturing activities, which received, on average, 54.8 percent of inward FDI investment flows.

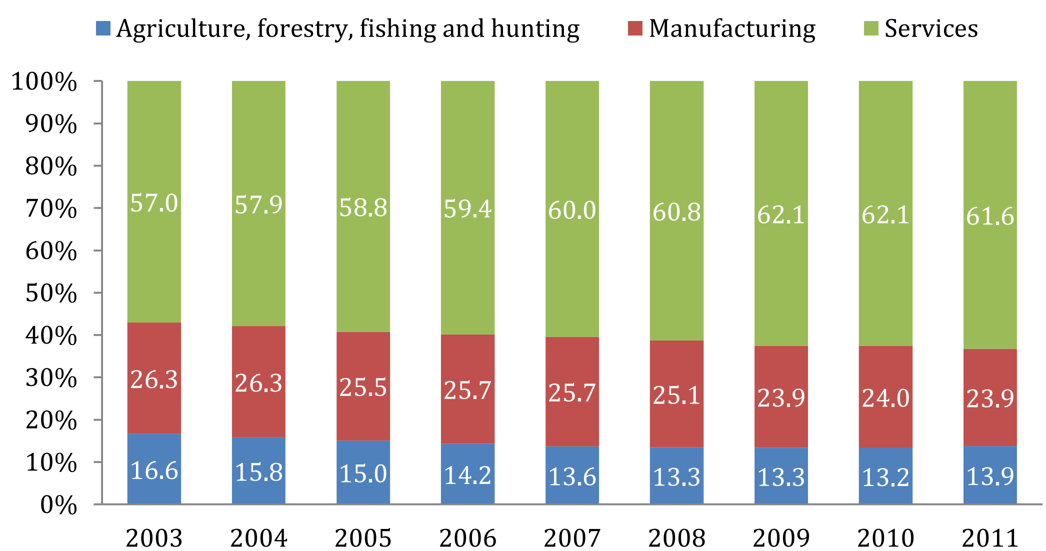
Figure 2. Mexico, FDI by Sector of Destination, 2003–2011



Source: Based on data from INEGI. P: Preliminary data from 2009.

Finally, in the period 2003–2011, the sectoral composition of employment in Mexico shows a sustained increase in the share of services in total employment (Figure 3). By contrast, the shares of employment in both the manufacturing and the primary sectors have been steadily declining.

Figure 3. Evolution of the Composition of Employment by Sector 2003–2011



Source: Based on data from INEGI.

Within the service sector, the subsectors that contributed the most to employment in the period 2003–2011 are commerce (19.7 percent), diverse services[6] (10.3 percent), social services[7] (8.3 percent), temporary accommodations and the preparation of food and beverages (6.2 percent), and professional, financial, and corporate services (5.6 percent).

Figure 4. Evolution of the GDP Service Sector by Type of Service 2003-2011

Source: Based on data from INEGI. P: Preliminary data from 2009.

In 2011, the GDP composition of the service sector shows that 72 percent corresponds to traditional services,[8] 10 percent to KIBS,[9] and the remaining 18 percent to other services[10] (Figure 4). This structure has remained relatively constant since 2003, except for a slight increase in the share of traditional services in total GDP for the service sector.

[6] The information provided by INEGI adds in the category of *diverse services* the following subsectors: real estate services and rental of property and intangible goods; recreational, cultural, other recreational services; and other services except government activities.
[7] The information provided by INEGI adds the following subsectors to the category of *social services*: educational services and health care and social assistance.
[8] Traditional services include: trade, transportation, posting and storage, mass media information, financial services and insurance, real estate services and rental of property and intangible goods, recreational, cultural, and other recreational services, temporary accommodation and food and beverage preparation and financial intermediation services.
[9] The KIBS (*knowledge-intensive business services)* include: scientific and technical services, management of corporate enterprises and support services for businesses, waste management and remedial services.
[10] *Other services* include: educational services, health care and social assistance, and government activities.

The composition of employment in the industrial sector in the period 2003–2011 was: 64.7 percent in manufacturing, 32 percent in construction, and 3.3 percent in mining, electricity, water, and gas. Since 2003, the rate of growth of the service sector has outpaced that of the overall Mexican economy. Between 2003 and 2011, total GDP grew at an annual rate of 2.33 percent, while GDP in services expanded at an average rate of 2.83 percent. A similar pattern can be seen in the dynamics of job creation. While total employment in the Mexican economy grew at an average annual rate of 1.93 percent, employment in the service sector grew at an average rate of 2.92 percent.[11] In summary, the service sector is currently the most dynamic sector of the Mexican economy. Both GDP and employment in the sector have outperformed the growth rates for the economy as a whole.

4.2 *Microeconomic Dynamics*

4.2.1 Firm Characteristics

Building on data from ESIDET 2010, this section presents descriptive statistics on both services and manufacturing firms in Mexico. Table 3 reports that approximately two-thirds of the firms in the sample perform manufacturing activities, the remaining being service firms. Firms in low-tech manufacturing and in traditional services account for the majority of firms in the manufacturing sector and in services, respectively. Some 44.3 percent of firms included in the survey are part of a larger group, with manufacturing firms more frequently grouped together in an industrial conglomerate. Only one-third of firms in the sample reported participation of foreign capital as part of the total social capital of the firm. However, manufacturing firms are nearly three times more likely to receive foreign investment than service firms. By far, the largest share of foreign capital goes to manufacturing firms in high-technology activities; the lowest share targets firms in KIBS.

[11] Accessible data does not allow differentiating employment between KIBS and traditional services.

Table 3. Characteristics of Manufacturing and Service Firms in Mexico, by Technological Intensity, 2010

			Percent						
	Total firms	**Total**	**Group**		**FDI**		**Sales1/**	**Employment/3**	**Sales per worker/2**
Manufacturing	2,128	66.7	49.0	73.8	38.1	85.3	410,280	911.1	451.7
High-tech	829	26.0	66.0	38.7	60.9	53.1	418,123	763.8	567.2
Low-tech	1,299	40.7	38.2	35.1	23.6	32.2	409,111	1,000.0	404.4
Services	1,061	33.3	34.9	26.2	13.2	14.7	287,987	1,291.2	228.4
KIBS	179	5.6	22.3	2.8	12.8	2.4	153,378	552.1	315.6
Traditional	882	27.7	37.4	23.4	13.3	12.3	317,072	1,435.1	212.8
Total	3,189	100.0	44.3	100.0	29.8	100.0	414,303	845.4	358.8

Notes: For the columns with the percentage of firms in a group and those reporting FDI, the first column refers to the share relative to total firms in the sample; the second column reports the share relative to total firms reporting membership to a group or some foreign capital ownership, respectively. 1/ Median in thousands of Mexican Pesos; 2/ Median in thousands of Mexican Pesos per worker; 3/Median of employment
Source: Authors based on information contained in ESIDET 2010.

With regard to sales, the median for the total sample is slightly more than 414 million Mexican pesos. The median sales for manufacturing firms consistently rank close to the median for all firms in the sample. By contrast, service firms reported median sales below the median total. The opposite occurs if one considers employment. Service firms provide more employment than manufacturing firms, particularly in traditional sectors. These two contrasting situations confirm the customary conclusion that manufacturing firms tend to be more productive than service firms. Measured in terms of median sales per employee, manufacturing firms report twice as much relative to service firms. The traditional service sector is the less dynamic if one considers this indicator.

4.2.2 Innovation

Table 4 reveals that about one-fifth of manufacturing and service firms in Mexico have formally constituted a specialized unit which documents the productive processes carried out by the firm. Such a unit is more frequently found among manufacturing firms. Interestingly, KIBS firms tend to report having such a specialized unit more frequently than firms in traditional services.

With regard to innovation, overall, only 13.7 percent of firms in the sample reported having innovated in 2008-09. Manufacturing firms, particularly in high-technology sectors, are more prone to perform some kind of innovation project; the least dynamic in this area were firms in traditional service activities. As can be expected, manufacturing firms were overwhelmingly more productive at innovation (Table 6 and Table 7). Table 4 reports that about 16.1 percent of manufacturing firms reported innovation in the form of products or services, and 9.5 percent some kind of process innovation. Although KIBS firms tend to report lower sales and sales per worker, they are more active at innovation compared to firms in traditional service activities.

Table 4. Innovation Performance of Manufacturing and Service Firms in Mexico, by Technological Intensity, 2010. Percentage Distribution

	Technical Unit		Innovation project		Product/service		Process	
	Percent of firms reporting	Percent of total firms	Percent of firms reporting	Percent of total firms	Percent of firms reporting	Percent of total firms	Percent of firms reporting	Percent of total firms
Manufacturing	24.2	81.6	17.3	84.0	16.1	83.4	9.5	81.5
High Tech	29.2	38.3	23.2	43.8	21.8	44.1	11.5	38.2
Low Tech	22.0	37.3	14.2	34.7	12.7	33.2	8.6	36.9
services	10.9	18.4	6.6	16.0	6.4	16.6	4.3	18.5
KIBS	15.6	10.3	10.5	10.0	9.6	9.8	6.7	11.2
Traditional	7.7	7.8	3.9	5.7	4.1	6.3	2.7	6.8
Total	19.8	100.0	13.7	100.0	12.9	100.0	7.8	100.0

Notes: This table presents two distinct ways to look at differences in the innovation behavior of manufacturing and service firms in Mexico. For each concept in the table, the split of the information in two columns is as follows: the first column indicates the total number of firms in the usable sample from ESIDET 2010, either in manufacturing or in services, that reported data for each item. For instance, 24.2 percent of manufacturing firms reported the existence of a technical unit in house; by contrast, only 10.9 percent of service firms indicated the presence of such a unit. The second column indicates the relative distribution of manufacturing and service firms for each indicator. For example, of the total number of firms that reported having carried out some kind of innovation project, 84 percent were manufacturing firms, and 16 percent were service firms.
Source: ESIDET 2010.

Table 5 describes the performance of service and manufacturing firms in Mexico with regard to more detailed definitions of innovation activities. Based on ESIDET (2010), firms in Mexico feature eight possible innovation and technological learning activities, namely, the purchase of machinery and equipment linked to innovation, acquisition of other external technologies linked to innovation activities, the provision of training linked to innovation activities, preparatory processes leading to the launch of innovations into the market, R&D, industrial design or prototyping of new or improved processes or products, purchase of software, and the logistics underpinning the introduction of a new service or new or improved delivery systems to the market (Appendix A2).

Tables 5 and 7 document that the acquisition of machinery and equipment is the most common activity carried out by firms in the service sector in Mexico. However, as reported in Table 5, R&D comes in a close second, with some 6.6 percent of firms in the sample. The purchase of specialized software ranks third but somewhat far from the preceding two items.

The behavior across groups of industries, classified according to technological intensity, is rather heterogeneous. Manufacturing firms tend to dominate in activities such as the purchase of machinery and equipment, R&D, industrial design or prototyping, and the purchase of software. By contrast, service firms tend to be more active in the provision of training linked to innovation activities. Table 5 confirms the relatively lower importance of R&D in capturing innovation performance of service firms; however, the share of KIBS firms (4.1 percent) reporting R&D is quite close to those in low-tech manufacturing activities (6.6 percent). One can see strong similarities between high-tech firms and KIBS firms; about a quarter of firms in either sector indicated that acquisition of other external technologies was an important innovation activity.

Tables 6 and Table 7 confirm these results regarding the performance of technological and non-technological innovation, and inputs and outputs of innovation. These tables report the results for an expanded dataset of ESIDET. In addition, Appendix A5 includes a broader group of variables for the descriptive statistics on policy-relevant characteristics for services and manufacturing, as well as data by subsectors.

Table 5. Innovation Activities Performed by Manufacturing and Service Firms in Mexico, by Technological Intensity and Type of Activity, 2010

	Machinery and equipment	Other external technology	Training	R&D	Logistics innovation launch	Design	Software purchase	Delivery systems
Manufacturing	8.4	1.8	5.9	8.6	2.5	3.8	3.2	1.8
High-Tech	9.4	1.8	15.2	12.7	2.4	4.5	4.2	1.3
Low-Tech	8.3	2.1	11.7	6.6	2.7	3.3	2.5	2.3
Services	4.6	1.9	11.9	2.7	1.5	0.8	2.7	1.2
KIBS	6.7	3.3	15.1	4.1	2.2	1.4	4.1	1.2
Traditional	3.1	0.9	9.9	1.7	0.9	0.2	1.6	1.1
Total/1	7.1	1.9	2.0	6.6	2.2	2.8	3.1	1.6
Manufacturing	78.5	66.1	77.8	86.3	76.8	91.0	70.4	74.5
High-Tech	34.2	25.4	38.9	49.5	29.0	41.6	35.7	21.6
Low-Tech	39.0	39.0	34.0	33.5	42.0	39.3	27.6	49.0
Services	21.5	33.9	22.2	13.7	23.2	9.0	29.6	25.5
KIBS	12.3	23.7	14.2	8.0	13.0	6.7	17.3	9.8
Traditional	8.8	10.2	7.4	5.2	8.7	1.1	10.2	13.7
Total/2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Notes: 1/ Relative to total firms in the sample; 2/ Relative to total firms reporting performance of a particular innovation activity.
Source: Authors' elaboration based on information contained in ESIDET (2010).

Table 6. Innovation Behavior

		Technological Innovation					Non-Technological Innovation				
	N	Product	Process	Innovative firms (1)	In-house tech-Innov	New to Market (2)	Organization	Marketing	Non-tech innovation (3)	Any innovation (4)	Tech and non-tech Innovation (5)
All service Industry	**16936**	**797**	**469**	**828**	**617**	**415**	**7551**	**3651**	**8190**	**8201**	**818**
KIBS	3038	446	217	464	381	190	1753	627	1844	1852	455
Traditional	13797	326	227	340	153	201	5714	3024	6263	6265	338
National	16222	676	350	706	561	370	7105	3497	7717	7727	696
Foreign	714	122	119	123	56	45	445	154	473	474	122
All manuf. industry	**14491**	**1669**	**1048**	**1885**	**1290**	**942**	**6024**	**3655**	**6671**	**7100**	**1456**
Low-tech	11992	1136	762	1316	732	727	4719	2825	5237	5580	973
High-Ttech	2499	533	286	569	558	214	1305	830	1434	1520	483
National	12459	1400	895	1596	1043	807	5231	3285	5813	6185	1224
Foreign	2032	269	153	290	247	135	793	370	858	915	233

(1) Product or process innovation
(2) New to Market product innovation
(3) Organization or marketing innovation
(4) Technological or non-technological innovation
(5) Technological and non-technological innovation
Source: Authors' elaboration based on information contained in ESIDET (2010).

Table 7. Inputs and Outputs of Innovation, Service Sector

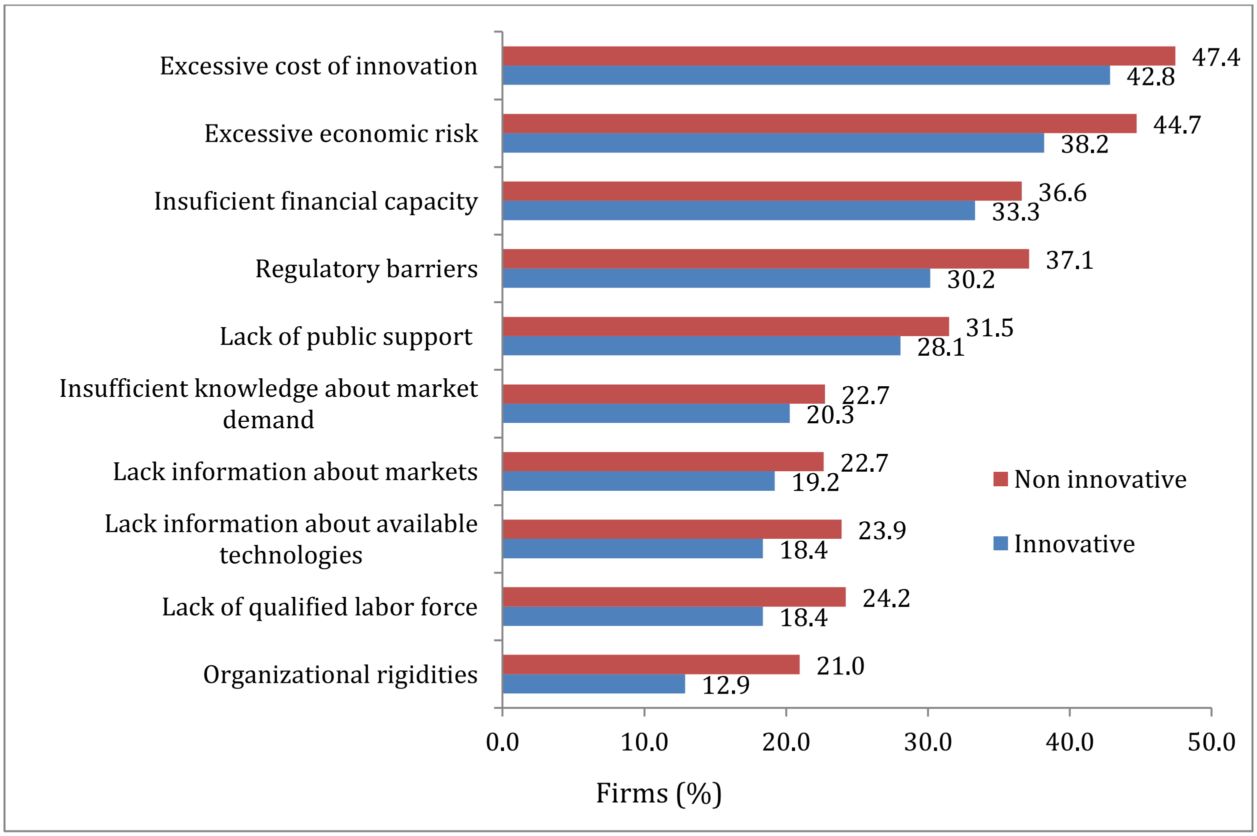
		Inputs					Outputs	
	N	Expenditure on innovation (6)	R&D (7)	Machinery acquisition (8)	Other innovation activities (9)	Firms that performed R&D on a continuous basis*	Turnover from product innovations	Turnover from new to market product innovations
All service	**16936**	**0.30**	**40.95**	**45.04**	**14.01**	**257**	**7800**	**3242**
KIBS	3038	0.23	16.10	55.92	27.98	34	3100	1170
Traditional	13797	0.16	30.71	40.60	28.69	199	4500	1968
National	16222	0.15	22.74	55.15	22.11	152	6500	2840
Foreign	714	0.29	46.14	18.85	35.01	104	1300	402
All manuf.	**14491**	**0.48**	**53.99**	**31.37**	**14.64**	**767**	**39700**	**11382**
Low-tech. manuf.	11998	0.27	27.29	53.53	19.18	467	19700	5422
High-tech manuf.	2499	0.72	65.72	21.63	12.64	300	20000	5960
National	12459	0.59	62.97	24.75	12.28	633	25500	7216
Foreign	2032	0.35	37.00	43.90	19.10	134	14200	4166

(6) Total expenditures on innovation (as a percent of total turnover)
(7) Expenditure on R&D as a percent of total expenditure on innovation
(8) Expenditure on machinery acquisition as a percent of total expenditure on innovation
(9) Expenditure on the rest of innovation activities as a percent of total expenditure on innovation
*Data about firms that performed R&D both on continuous and discontinuous bases is not available.
Source: Authors' elaboration based on information contained in ESIDET (2010).

4.2.3 Barriers to Innovation

Based on the information obtained from ESIDET 2010, Figure 5 documents the most significant obstacles to innovation, as perceived by the firm. Clearly, the cost of innovation and excessive economic risks tend to explain the poor innovation performance of firms in Mexico. Insufficient financial capacity and regulatory barriers follow very closely. Barriers related to insufficient manpower and organizational rigidities were ranked very low. Appendix 1A further elaborates the analysis of the factors that hinder the innovation activities of firms in Mexico.

Figure 5. Main Obstacles to Innovation in Mexico *(as perceived by the firm)*



Notes: Barriers perceived as being the most important from the perspective of the firm.
Source: ESIDET (2010).

5 Public Support to Innovation and Productivity of Service Firms in Mexico

Traditionally, science, technology, and innovation (STI) policies in Mexico have tended to support scientific and technological activities to the detriment of innovation. Only in the last decade have Mexican authorities promoted policies that sought to trigger innovation, particularly in manufacturing firms.

Three main public support programs target the service sector:

1) Innovation Stimulus Program (ISP)
2) Innovation Fund (FINNOVA by its Spanish acronym)
3) Information Technology Services Development Program (PROSOFT 2.0)

Among these three programs, PROSOFT is the only one that was specifically designed to support the service sector. Although ISP and FINNOVA support the development of services in Mexico, they were designed to be crosscutting programs without a sector-specific focus. This section describes the objectives of these programs, some changes in them, and some of their outputs, based on document information and interviews with policymakers.

5.1 *Innovation Stimulus Program (ISP)*

The objectives of the ISP are to establish public policies that allow for the promotion of innovation in the productive and service processes, and to increase productivity and competitiveness. CONACYT allocates economic resources to foster investment in innovation within firms that will translate into business opportunities. The economic stimulus provided is complementary for firms carrying out research and technological development activities (RTD) and other innovation activities.

The ISP began operating in 2009, and its predecessor is the fiscal stimulus program for R&D.[12] The ISP was established under three modalities:

- INNOVAPyME: focused on small and medium enterprises (SMEs) with high value added. It fosters linkages between SMEs and higher education institutions and public research centers and firms.

[12] This program of indirect support allowed firms to discount up to 30 percent of their tax payments associated with their expenses on R&D.

- INNOVATEC: directed toward large firms. It seeks to promote projects that make investments on R&D infrastructure, and high-value job creation.
- PROINNOVA: directed toward any kind of firm. Projects must develop linkages with higher education institutions and public research centers.

Governance and program orientation. In contrast to the fiscal stimulus program, an indirect support whose governance was composed by the Ministries of Finance, Public Education and CONACYT, the governance of the ISP is carried out only by CONACYT. Governance is shared with state subcommittees; hence, there was an explicit institutional decision to share the governance and operation of the program with federal entities. This is considered one of the factors that explain the success of the program. ISP is a demand-driven program, that is, it responds to innovation opportunities identified by firms.

Program outputs. It is not easy to evaluate the extent to which specific results in the service sector are attributable to this program, both because of its cross-cutting nature and because of the lack of homogenous statistical classifications. CONACYT uses two classification systems: the North American Industry Classification System (NAICS) and the National Registry of Scientific and Technological Institutions and Firms (RENIECYT). Based on the first classification, 2 percent of the 2000 projects founded between 2009 and 2011 are service-related (classified as professional, scientific and technical services.[13] Using the RENIECYT classification, the participation of services would be much larger, with information technologies comprising the largest share.

During its first three years of operation, the ISP has benefited 1,763 projects, with funds amounting to nearly six billion Mexican pesos. Cumulative figures show that PROINNOVA has the largest share of the total funds (about two-fifths), covering a little more than one quarter of the projects. Small and medium-sized firms grouped under INNOVAPyME have the lowest share of the total funds (Table 8).

[13] Interview with M. Chavez Lomeli, Director of Innovation, CONACYT.

Table 8. ISP: Number of Projects and Funds Accumulated by Modality (2009–2011)

Modalities	Modalities projects		Total funds	
	N	Percent	$ (millions of pesos)	Percent
INNOVATEC	648	36.8	2084.3	34.8
PROINNOVA	471	26.7	2339.9	39.1
INNOVAPyME	644	36.5	1557.5	26.0
TOTAL	1763	100.0	5981.7	100.0

Source: CONACyT, Reports of activities and self-evaluation reports, 2009–2011.

The following are some of the program's results:

- On average, for every peso coming from public resources, 1.4 pesos were invested by the private sector in the last four years.[14] This relationship was 1-2.1 and 1-1.7 in 2009 and 2010, respectively.
- Limits were established to prevent the concentration of support on a few large firms (the maximum ceiling of support is 50 million pesos per firm per year). No firm has received more that 1.7 percent of the total accumulated support in the three years that the program has been in operation.
- More support is given to SMEs, which have invested more than in the past.
- While SMEs can receive 65 percent of project funds through PROINOVA, large firms can receive 40 percent.
- The participation of all states has helped ensure a broader geographical representation of projects and funds. However, there is no clear criterion for allocating resources.

Table 9 emphasizes the importance of the ISP for the service sector. Based on the RENIECYT classification, in 2012, information technology was the most significant sector in terms of the number of projects supported by the ISP, and the third most important according to its share of total funds provided that year. The automotive sector received the most support.

[14] Interview with M.Chavez Lomeli, Director of Innovation, CONACYT; and Farias, A. "El Impulso a la Innovación desde el CONACYT", <http://www.cepal.org/ddpe/agenda/5/43985/Alejandro_Farias_CONACYT.pdf>.

Table 9. ISP: Supported Projects and Funds by Sector, 2012

Sectors	Projects		Funds (millions of pesos			Share of the total funds (percent)
	N	Percent	Provided by firms	Provided by CONACyT	TOTAL	
Information technologies	74	14.1	144.5	231.4	376.0	9.2
Food	47	9.0	191.5	198.5	390.0	9.5
Automotive	41	7.8	385.9	187.6	573.5	14.0
Biotechnology	33	6.3	118.9	128.4	247.4	6.1
Agro-industrial	30	5.7	109.6	138.7	248.3	6.1
Other sectors*	299	57.1	1177.8	1071.0	2248.8	55.1
Total	524	100.0	2128.2	1955.7	4083.9	100.0

Source: FCCyT, ISP Beneficiaries, 2012.
Note: Other sectors * includes all sectors sharing less than 5 percent of total projects.

5.2 *Innovation Sectoral Fund (FINNOVA)*

FINNOVA is a fund recently created by the Ministry of Economy and CONACyT. It is one of the set of sectoral funds created by CONACyT with partners. Its objectives are to increase the base of innovative firms and multiply the development of public goods or projects with high positive externalities. FINNOVA originated with the modifications to the Science and Technology Law of 2009. It was created in 2009, approved in 2010, and began operating in August 2011. It is the only innovation sectoral fund that has been formally created in Mexico. FINNOVA established four support modalities:

- Creation and strengthening of technology or knowledge transfer offices
- Development of public goods with high positive externalities and pillars of innovation
- Establishment of a productive biotechnology program
- Strengthening of seed capital and angel capital markets[15]

FINNOVA's aim is to strengthen the ecosystem of innovation, which is divided into six pillars, set forth in the National Innovation Program. The objectives and main actors are listed below:

[15] According to interviews conducted in CONACYT, this modality was not put into practice within the program in order to avoid duplication, since the Ministry of Economy had established a seed capital fund with NAFIN.

- National and international market: the objective is to strengthen domestic and external demand for innovative products, services, models, and businesses created in Mexico. (Actors: consumers, firms and government).
- Strategic knowledge generation: the objective is to increase opportunities for applying knowledge to innovation (Actors: higher education institutions, public research centers and firms).
- Strengthening entrepreneurial innovation: reinforcing the base of firms and public entities that demand the generation of innovative ideas and solutions in order to take them to the market (Actors: firms and public entities).
- Funding innovation: promote the concurrence of public and private resources to increase funding for entrepreneurship and innovation. (Actors: government, private investors, and financial markets).
- Human resources: improve and increase productive, creative, and innovative contributions of people (Actors: workers, students, entrepreneurs, and higher education institutions).
- Regulatory and institutional framework: setting the foundations of a normative and institutional framework that favors innovation. (Actors: public, private, and academic sectors).

The calls for agreements may be oriented toward demand, supply, the regulatory framework, or intermediary institutions. Examples of this are the calls for production technology and environmental measures that seek to reduce greenhouse gases or produce NAMAS (National Appropriate Mitigation Actions). These two callings are both crosscutting and sectoral, because mitigation measures encompass improvement of the regulatory environment, reforestation, transportation, biotechnology, food, and others. They are calls that seek to advance the national interest in a certain direction. However, it would be difficult to say whether their main driver is supply or demand, or whether they are promoting a productive or service sector in particular. FINNOVA also seeks to promote the development of biotechnology in Mexico by financing biotechnology application projects to meet specific production needs.

FINNOVA identifies a set of priorities and translates them into modalities, which are approved by the trust fund's technical committee. The specific calls are formulated for those modalities. The calls are made as often as needed, for as long as there is demand, for as long as the technical committee deems them pertinent, or for as long as there are funds available. For example, in the case of the transfer offices there have been two calls for processes of pre-certification, but it is no longer considered necessary to issue another call. Once the certification is concluded, there will be an evaluation to assess whether another call is warranted.

FINNOVA's aim is to create value through innovation. For example, although NAMAS was conceived to generate ideas for the mitigation of greenhouse gases, the design of the measure and its implementation may generate new business or investment opportunities.

There were six calls in 2011, resulting in 202 projects for a total of 250.3 million Mexican pesos (Table 10). Calls for proposals were done twice for NAMAS and technology transfer offices (TTO) during that year. Almost three-fifths of the funds approved were allocated to biotech projects aimed at developing new productive businesses. One-fifth of the approved funds were allocated to projects to promote technology transfer offices.

Table 10. Number of Projects and Funds Approved (2011)

	Projects		**Funds**	
Calls for proposals	**N**	**percent**	**Millions of Mexican pesos**	**percent**
2011-01,05 NAMAS	27	13.4	15.0	6.0
2011-02,06 TTO**	66	32.7	50.3	20.1
2011-03 Biotechnology	61	30.2	145.0	57.9
2011-04 Ecosystems of Innovation	48	23.8	40.0	16.0
Total	202	100.0	250.3	100.0

Note: * National Appropriate Mitigation Actions, two callings
** Technology Transfer Offices, two callings
Source: CONACyT, Report of Activities, Jan - March 2012, and Self-evaluation Report, 2012

5.3 *The Sector Development Program of Information Technology Services (PROSOFT 2.0)*

PROSOFT supports the promotion of economic development by granting temporary subsidies for projects that foster the creation, development, consolidation, viability, productivity, competitiveness, and sustainability of firms in the information technology and related service sectors. The specific objectives are:

- Contribute to the preservation and generation of formal jobs in the software and IT sector

- Promote regional economic development
- Foster the creation of firms dedicated to the development of software and related services, and stimulate the strengthening of existing firms
- Promote opportunities for productive development in the IT sector
- Foster technological innovation, development, and modernization of the IT sector
- Contribute to the improvement of productive processes in firms in the IT sector
- Boost human resource training in the software industry
- Foster integration and strengthening of productive chains in the IT sector
- Contribute to the development of physical infrastructure and high-technology parks in order to favor the integration of technical, operational and commercial capabilities of the firms in the IT sector.

The design of PROSOFT began in 2001, and the seven initial strategies were defined by regional and federal public and private actors. In 2003, PROSOFT 1.0 was published, with a 10-year vision (2003-2013) and three main goals:

- Position Mexico to become a leader in Latin America
- Having a turnover of US$5 billion
- Achieve an increase in IT/GDP

In its first phase, PROSOFT focused only on software. In 2007, with more clarity from the IT sector, it undertook a review, resulting in PROSOFT 2.0 in 2008. The changes resulting from that review are summarized in Table 11.

Table 11. Comparison between PROSOFT Versions 1.0 and 2.0

PROSOFT 1.0 strategies (2002)	PROSOFT 2.0 strategies (2008)
1. Increase exports in order to attract investment	1. Increase exports in order to attract investment (similar) • Diversify the firms that export
2. Human capital (quantity and quality)	2. Human capital • The activities to carry out this strategy are changed; activities managed here are "retrain existing human capital" • "Mexico First," a program of human resource certification, a strategy focused on both technical competencies and businesses, was added.
3. Legal framework • Focused on the user and supply. Closing the cycle of electronic commerce.	More devoted to personal protection (cyber-security)
4. Domestic market (opening) • What was learned in PROSOFT 1.0 is that even though policies support both supply and demand, PROSOFT did not have an impact on demand. It needed to foster the use of ICTs	4. Focus: ▪ E- government
5. Local industry	5. Competitiveness, innovation, and productivity • Focused on clusters, associations, and parks
6. Quality Focus: organizational certifications	6. Quality • Focus: teams, people, firms, organizations
7. Infrastructure. Broadband	7. Infrastructure • Broadband comes from PROSOFT • Strategy is converted to formation of clusters and groups • Funding (not subsidy) to increase: credit, seed capital, venture capital • Employment incorporated into the objectives (619,000 jobs in the sector, including the whole branch)

Source: PROSOFT reports and interviews.

One difference between PROSOFT 1.0 and 2.0 is that the goals tripled in magnitude in some cases.

- The positioning goal is aimed at making Mexico the third exporting country in the world (after India and the Philippines)
- The IT/GDP goal is to reach 3.3 percent
- The production goal tripled from 5 to 15 million

In 2012, a review with international experts was convened to prepare a plan for 2013–2022. Now, PROSOFT is focusing on globalization (it is no longer focusing on exports); however, human capital, the legal framework, and the domestic market remain relevant. The generation of ecosystems—the local means required to grow—is on the horizon, more than clusters. However, it is not yet clear whether this program will be in the policy mix of the new Administration that took office in December 2012.

Governance and program orientation. The formal governing body is the board of PROSOFT (presided over by the Ministry of Economy). The public policy review, carried out by working groups, is inclusive. The public is invited to participate, as long as they have some expertise and participate actively. Every year, challenges are issued, in some cases based on the proposals that arrive, and the initiatives are updated. PROSOFT includes a range of actors that facilitate its initiatives. PROSOFT supports academic projects as long as they are linked to the productive sector. IT members, as well as local government, academia, and IT users participate in this process.

According to those interviewed, the driver of the program cannot be identified on either the supply or the demand side. PROSOFT promotes clusters and forms networks that link supply and demand.

Some important outputs of the program are the following:

- Mexico has acquired an important position in the export market, becoming the third major exporter internationally.
- The domestic impact is reflected in employment and mean salary, which is higher than in other sectors.
- Firms with high value added have been created.
- It has one of the most impressive bases of certified human resources, which generates specialization and allows for the acquisition of contracts.

Table 12 shows that the PROSOFT's executed budget has increased in the last four years. It grew 41.6 percent between 2009 and 2012. Altogether, the cumulated budged for that period amounts to 2.605 billion pesos.

Table 12. PROSOFT's Executed Budget

	N	Millions of pesos
2009	869	536.5
2010	1094	625.7
2011	960	682.0
2012	ND	760.9

Source: CONEVAL, Evaluation of consistency and results 2011-2012 and PROSOFT's beneficiaries register.

6 Empirical Analysis: Determinants of Innovation and Productivity in Service firms: A CDM Econometric Model

The core econometric analysis in this study consists of an application of a three-stage Crépon-Duguet-Mairesse (CDM) econometric model to study the main determinants of technological innovation, and the impacts of innovation on productivity of service firms. For comprehensiveness of the analysis, we benchmarked the results of service firms with those of manufacturing firms.

This part of the study endorses Tacsir, Guaipatin et al. (2011), who stress that models based on the methodology proposed by Crépon, Duguet, and Mairesse (1998) are useful in identifying and testing the determinants of innovation and, by extension, the effects of innovation outputs on productivity in the manufacturing sector. The model summarizes the process that goes from a firm's decision to engage in R&D to the use of innovation in production activities, and its impact on productivity. The question is how applicable the methodology is to the study of the determinants of innovation and the impacts of innovation on productivity in service firms. A challenge of using the CDM model in the case of service firms is that the model tends to rely on R&D expenditures as a proxy to identify innovative firms. The literature indicates, however, that for service firms, R&D may not be the preferred learning mechanism underpinning innovations (OECD, 2009). Service firms may find it difficult to track and record R&D expenditures, or even consider the funds used for innovation in the same way, as it is understood in the manufacturing context. To overcome this challenge, and based on the information contained in ESIDET, our empirical analysis will incorporate, in addition to R&D, data about the broader technological behavior or learning strategies of firms, including investment in machinery and equipment, acquisition of technologies, training linked to innovation activities, acquisition of software, investment in industrial design and prototyping, and investment for services innovation.

6.1 *The Model*

Based on Crépon, Duguet, and Mairesse (1998), we will analyze the main determinants of the learning strategies and innovation of service firms and their subsequent impacts on innovation output and productivity performance. We perform a three-stage Heckman (1978) model, where the first stage focuses on the main factors underpinning the likelihood that a firm will invest in learning activities, and the decision to invest in learning or innovation activities. This first stage should correct for selection bias, as not all firms in the service sector engage in learning and innovation activities. The second stage will focus on the innovation output, measured as product or process innovation captured in the form of a dummy variable. The third stage will study the effects of innovation on productivity in the service sector. It is important to note that the focus of this analysis is the service sector; however, we also perform the analysis on manufacturing firms as a benchmark for our discussion. Based on Hipp and Grupp (2005), Tether and Takhar (2008), and Castellacci (2008), who emphasize the heterogeneity of service activities, we classified the firms in the ESIDET 2010 database according to their technological intensity, either in high-tech or low-tech manufacturing, or KIBS or traditional services.

The Heckman model for the first stage of the analysis includes two equations. The first equation indicates the main determinants for learning strategies and innovation in the service sector. The second equation indicates the intensity of those learning and innovation activities. The dependent variable for equation 1 (dummyEXCAP_i) is a dummy variable that equals 1 if the firm performs any type of learning or innovation activity. Specifically, we do not rely only on the performance of R&D activities; we also include other learning activities. We include those same eight activities presented in Table 5 and Appendix A2.

The independent variables for equation 1 are the set of explanatory variables that might influence the likelihood that a firm engages in any of those learning and innovation activities. The explanatory variables (x_i) account for exports, ownership, size, patents, and the use of public funds for innovation, for instance:

$$(1) \qquad dummyEXCAP_i = x_i b, j_{i1}, ...j_{in} + e_i$$

The dependent variable for the second equation of stage 1 (1.1) (*logEXCAP*$_i$) is the learning and innovation effort per employee expressed in logarithms. We build this proxy variable by calculating the expenditures on learning and innovation activities per worker in case the firm reports such expenditures. Specifically, we use those innovation activities that imply financial investments by the firm, namely the development of own technology, the acquisition of machinery and equipment linked to innovation, the purchase of other external technologies linked to innovation, payment for training linked to innovation, conducting R&D, or the purchase of software. The vector of explanatory variables (x_{ii}) will account for exports, ownership, patents, the use of public funds to innovate, openness strategy, sources of information and barriers to innovation, for instance:

$$(1.1)\ logEXCAP_i = x_{ii}b, j_{i1}, ...j_{in} + e_i$$

The innovation production function indicates the innovation output of firms. Innovation output is measured by a dummy variable that indicates either product innovations or process innovations (*innov_dummy*). The independent variables are the predictor from equation 1 (*EXCAP_eq11*), firm size, exports, and ownership.

$$(1.2)\ innov\_dummy_i = EXCAP\_eq11_i + x_i b, j_{i1}, ...j_{in} + e_i$$

The last equation indicates the impact of innovation on firm performance, measured as productivity per employee. Productivity measured in terms of sales per employee and expressed in logarithms is the dependent variable. The independent variables are the predictors from equation 1.2, firm size, and non-technological innovation.

$$(1.3)\quad logproductivity09_i = innov\_eq12_i + a_i c_i, j_{i1}, ...j_{in} + e_i$$

We also performed a robustness analysis by performing the same analysis using the predictors from equation 1.1 as expressed below.

$$(1.3.1)\ logproductivity09_i = EXCAP\_eq11_i + a_i c_i, j_{i1}, ...j_{in} + e_i$$

We calculated this three-stage model on different samples of the ESIDET 2010 database to better capture the behavior of firms in the service sector. In total, we calculated the model across seven different subsamples, the first model cuts across the complete database where we had 2,297 censored observation and 892 uncensored observations. The second model captures the behavior of all firms in the manufacturing sector. The third model analyzes high-tech manufacturing in particular. The fourth model focuses on low-tech manufacturing. These three models had 1,445 censored observations and 683 uncensored observations. The fifth model captures the behavior of all firms in the service sector. The sixth model focuses on KIBS and the last model focuses on traditional services. These last three models had 852 censored observations and 209 uncensored observations.

6.2 *Variables: Determinants of Learning and Innovation Activities and Innovation Intensity*

Learning and experimentation activities: This project looks beyond R&D to characterize the innovative behavior of service firms in Mexico. The goal is to reflect the fact that learning and experimentation activities adopted by firms in the service sector are more diverse, often difficult to capture by usual measurements of R&D. The construction of the learning and innovation variables (*dummyEXCAP* and *logEXCAP*) reflects the information available in ESIDET 2010, as documented in Table 5 and Appendix A2. On the one hand, *dummyEXCAP* is a dummy variable that takes the value of one if the firm performs any of the learning and innovation activities. On the other hand, *logEXCAP* captures the innovation intensity effort by measuring the investment in learning and innovation activities per employee in its logarithm form.

The independent variables identified as determinants for learning and innovation performance and intensity are related to structural factors, performance factors, and behavioral factors (De Fuentes and Dutrénit, 2012). Structural factors account for size and ownership. Several scholars have claimed the importance of firm size for innovation activities (Cohen and Levinthal, 1989; Benavente, 2006; Crespi and Peirano, 2007). Larger firms are more prone to benefit from economies of scale related to production and R&D; they also benefit from a larger pool of human resources. We include size as a continuous variable that indicates the number of employees in logarithm form (*log_firm_labor08*). Regarding ownership, Blomström and Kokko (2003) and Girma and Gorg (2007), who focus on the analysis of knowledge spillovers from multinational companies, claim that foreign direct investment brings positive benefits associated with higher knowledge. Accordingly, we expect that foreign ownership has a positive effect on the innovation decisions and innovation intensity of firms in Mexico. We include ownership as a dummy variable (*ownership*) that takes the value of one if the share of FDI in the firm's social capital is 20 percent or more.

Performance factors account for patents and exports. Patents can be associated with innovation efforts regarding the capacity to manage intellectual property (Crespi and Zúñiga, 2010). We measured the effect of patents on the equations on innovation decisions and innovation intensity. We included patents as a dummy variable that indicates if the firm filed for patents during 2008 (*patent_sol08_dummy*). Regarding exports, one can expect that firms with export activities compete in a more dynamic environment and have to meet more stringent standards resulting in learning and the need to keep innovating. Zúñiga et al. (2007) and Santiago and Alcorta (2012) found that export behavior conditions the technological performance of firms in Mexico. We included exports in the equations that measure both innovation decision and intensity; we use the value of exports for 2008 in logarithmic form (*log_export08*).

Behavioral factors account for the use of public funds for innovation, strategy of openness to innovation, sources of information, and barriers to innovation. Several authors stress the importance of public funds to foster firms' investment in R&D. In particular, Hall and Maffioli (2008), Mairesse and Mohnen (2010) and De Fuentes and Dutrénit (2012) find that firms in different contexts increase their innovation behavior and in some cases these public funds even foster collaboration with universities (Dutrénit, De Fuentes, and Torres, 2010; De Fuentes and Dutrénit, 2012). We included the use of public funds for innovation in both the innovation decision and innovation intensity equations. To capture the use of public funds for innovation we built a dummy variable that takes the value of one if the firm used any form of public funds from a list of funds that support innovation (*u_innov_fund_dummy*). Regarding active collaboration for innovation, we base the construction of this variable on a previous study by Laursen and Salter (2004), where they recognized that firms with a strategy of openness to innovation tend to engage more in R&D activities and thus demonstrate a higher innovative behavior. Firms with a strategy of openness to innovation tend to use resources to innovate more effectively and identify external knowledge that can benefit their innovative strategy. We included a variable that indicates openness strategy only in the innovation intensity equation. The openness strategy variable (*open_strategy*) is a dummy variable that equals one if the firm experienced any of these three forms of collaboration: contract technology development (*contract_productive_open*), acquisition of external technology (*buy_tech09_open*) and collaboration for innovation (*main_innovator_open*).

Based on Crespi and Zúñiga (2010), we included in the innovation intensity equation variables related to sources of information. In particular, we built three dummy variables that take the value of one if the firm uses these particular sources of information. Market sources of information (*INFOMarket*) include information from clients, competitors, suppliers, consulting firms, and experts. Scientific sources (*INFOScience*) include information from universities and public research organizations. Public sources of information (*INFOPublic*) include information from the Internet, journals, patents, publications, fairs, and meetings. To build this variable we rely on a question that asked firms to rank the importance of the different sources of information for innovation from a list of sources of information. We only considered those firms that identify specific sources as the "most important" sources of information. Barriers to innovation are an important element to analyze innovation intensity of firms. D'Este et al. (2012) concludes that firms that report no innovation activities are more likely to assess barriers to innovation as more important than do firms with low levels of engagement. Based on the results from the accompanying study presented in Apendix A1, we included four dummy variables that account for cost barriers (*cost_factor*), knowledge barriers (*knowledge_factor*), market barriers (*market_factor*) and regulatory barriers (*regulation_factor*).

6.3 Determinants of Innovation Output

The dependent variable for innovation output is a dummy variable that equals one if the firm has performed either product or process innovations (*innov_dummy*) as captured by the survey. The independent variables identified as determinants of innovation output are associated with structural factors. These are firm size (*log_firm_labor09*) and ownership (*firm_fdi_20*), measured as expressed above; however, in this case we evaluated firm size as the number of employees in 2009 in its logarithmic form. We included the predicted value from innovation intensity (*EXCAP_eq11*).

6.4 Determinants of Productivity Output

The dependent variable for productivity output is measured in terms of sales per employee and expressed in logarithms. The independent variables are related to structural factors, such as firm size (*log_firm_labor09*), and behavioral factors, for example performing non-technological innovation—organizational innovation and marketing innovation. We included the predicted values from innovation output (*innov_eq12*). Control variables are indicated by firm sector and subsector. This study seeks to identify innovation in services, but also compare it to innovation in the manufacturing sector. Table 13 indicates the descriptive statistics for the variables used in the three-stage model.

Table 13. Descriptive Statistics for the Three-Stage Model

Variables	Description	Mean	St. Dev	Min	Max
Dependent Variables					
Learning and innovation activities (dummyEXCAP)	1 if the firm reports any type of learning and innovation activities; 0 otherwise	0.280	0.449	0	1
Learning and innovation intensity (logEXCAP_employeess)	Natural logarithm of the firm's total investment on learning and innovation activities per employee	0.354	1.707	-7.455	10.774
Technological innovation output (innov_dummy)	1 if the firm reports product or process innovation; 0 otherwise	0.149	0.356	0	1
Firms' productivity (logproductivity_09)	Natural logarithm of the firm's productivity measured as sales per employee in 2009	6.010	1.497	0	18.105
Independent Variables					
Firm size 08 (log_firm_labor08)	Natural logarithm of the firm's total labor force in 2008	5.894	2.595	0	11.887
Firm size 09 (log_firm_labor09)	Natural logarithm of the firm's total labor force in 2009	5.860	2.578	0	11.808
Ownership (firm_fdi_20)	1 if the firm reports more than 20 percent foreign capital in the firm's total capital; 0 otherwise	0.283	0.451	0	1
Exports (log_export08)	Natural logarithm of the firm's total exports in 2008	5.149	6.108	0	18.322
7 Patent applications (patent_sol08_dummy)	1 if the firm reports any patent application in 2008; 0 otherwise	0.018	0.134	0	1
Public funds for innovation (u_innov_fund_dummy)	1 if the firm access any type of public fund for innovation; 0 otherwise	0.158	0.365	0	1
Openness strategy (open_strategy)	1 if the firm reports any type of collaboration for innovation; 0 otherwise	0.088	0.284	0	1
Market sources of information (INFOMarket)	1 if the firm considers market sources of information highly important (suppliers, clients, competitors, consulting firms and experts); 0 otherwise	0.655	0.476	0	1
Scientific sources of information (INFOScience)	1 if the firm considers scientific sources of information highly important (universities and public research centers); 0 otherwise	0.214	0.410	0	1
Public sources of information (INFOPublic)	1 if the firm considers market sources of information highly important (suppliers, clients, competitors, consulting firms and experts); 0 otherwise	0.407	0.491	0	1
Organizational innovation (innov_organization)	1 if the firm performed organizational innovation; 0 otherwise	0.479	0.500	0	1
Marketing innovation (innov_market)	1 if the firm performed marketing innovation; 0 otherwise	0.279	0.448	0	1

Variables	Description	Mean	St. Dev	Min	Max
Cost barriers (cost_factor2)	1 if the firm experienced cost barriers to innovation and reported it as highly important; 0 otherwise	0.655	0.476	0	1
Knowledge barriers (knowledge_factor2)	1 if the firm experienced knowledge barriers to innovation and reported it as highly important; 0 otherwise	0.341	0.474	0	1
Market barriers (market_factor2)	1 if the firm experienced market barriers to innovation and reported it as highly important; 0 otherwise	0.396	0.489	0	1
Regulatory barriers (Regulation_factor2)	1 if the firm experienced regulatory barriers to innovation and reported it as highly important; 0 otherwise	0.359	0.480	0	1
Predictor for innovation intensity (EXCAP_eq11)	Predicted value from equation 1.1	1.053	0.770	-0.323	4.713
Predictor for innovation output (innov_eq12)	Predicted value from equation 1.2	0.149	0.205	0.005	0.991
High-tech manufacturing (htmanuf)	1 if the firm operates in a high-technology manufacturing industry; 0 otherwise	0.265	0.441	0	1
Low-tech manufacturing (ltmanuf)	1 if the firm operates in a low-technology manufacturing industry; 0 otherwise	0.407	0.491	0	1
services (services)	1 if the firm is classified as part of the service sector; 0 otherwise	0.328	0.470	0	1
KIBS (Kibs)	1 if the firm is in a knowledge intensive business services activity; 0 otherwise	0.063	0.243	0	1
Traditional services (Tradserv)	1 if the firm operates in a traditional services activity; 0 otherwise	0.261	0.439	0	1

The results from the models are reported in Table 14, Table 15, and Table 16. A detailed discussion of the results is provided in the following subsections.

6.5 The Decision to Invest in Innovation and the Intensity of Innovation Expenditure

Results from equations (1) and (1.1) indicate the determinants of likelihood to engage in innovation activities, and the innovation intensity expressed as the log of innovation and learning activities per worker. Our results across the different models (complete dataset, manufacture, high-tech manufacture, low-tech manufacture, services, KIBS and traditional services) show interesting patterns regarding the motivation of firms to innovate and the determinants that influence their innovation intensity. It is important to note that regarding manufacturing, our results find certain similarities with results from previous studies that identify the determinants of innovation activity in some Latin American countries (Crespi and Zuñiga, 2010).

We found that the most important determinants of likelihood to engage in innovation decisions are related to firm’s ownership, previous experience regarding exports, and the use of public funds to innovate. In the Mexican case, our results suggest that firms in the manufacturing sector, in particular high-tech manufacturing with foreign ownership (higher than 20 percent of capital) show a lower propensity to innovate, and there is no distinct impact on innovation intensity. This result contradicts previous discussions (Crespi and Zuñiga, 2010; Girma and Görg, 2005). Crespi and Zúñiga (2010), in particular, found for other Latin American countries that those firms with more than 10 percent of foreign ownership are more prone to innovate and also have a higher rate of innovation intensity. Our finding can be explained by the fact that multinational companies seldom invest in R&D in developing countries, in this case, Latin America (Chaminade and Vang, 2008; Crespi and Zuñiga, 2010; Pietrobelli and Rabellotti, 2009) or, if they do invest in R&D, this is usually geared to adapt existing products to the local market (Lasserre, 2011). Our results also point out that foreign ownership has no distinctive effect on the propensity to innovate by service firms. This result needs to recognize the differences between firms in KIBS and in the traditional service sector. KIBS tend to be highly innovative and dynamic independently of their ownership. In this case, our results suggest that there is no difference in the determinants to innovate between Mexican-owned firms and foreign-owned firms. Concerning the traditional service sector, foreign ownership in these firms might not play an important role in the decision to innovate, as they might not follow an active R&D strategy.

Export experience plays an important role in whether firms engage in innovation activities across all the models. These results confirm those by Ebling (2000), Zúñiga et al. (2007), Santiago and Alcorta (2012), and Chaminade and De Fuentes (2012), who found that an active export behavior has positive effects on firms' innovation performance. The marginal effect is about 0.04 for the entire sample—manufacturing, high-tech and low-tech—and 0.03 for services, KIBS, and traditional services. On the other hand, export experience has a marginal effect for innovation intensity, but only for the whole sample model and the services model.

Our results suggest that behavioral factors, such as accessing publicly funded programs in support of innovation, openness strategy, and access to different sources of information useful for innovation, seem to play an important role in both the decision to innovate and the innovation intensity. The use of public funds to innovate is an important determinant for innovation activities across the different models analyzed. However, only firms from manufacturing, high-tech and low-tech, which receive public funds to innovate invest significantly more than firms that do not receive these funds. Crespi and Zúñiga (2010) and Dutrénit, De Fuentes, and Torres

(2010) obtained similar results. Our results show that firms in manufacturing that received public funds invest 110 percent more on innovation and learning activities than firms that did not receive such benefits. High-tech and low-tech firms that receive public funds for innovation invest about 95 percent more than those firms that do not receive public funding to innovate. In contrast, the use of public funds to innovate did not show a significant impact on the innovation intensity for firms in the service sector.

Crespi and Zúñiga (2010) found that manufacturing firms that have patents have a higher propensity to invest in innovation activities in different Latin American countries. Our results partially confirm those findings, as low-tech manufacturing firms that have filed for patents have a higher propensity to invest more in innovation and learning activities.

An openness strategy to innovate plays an important role for innovation investment across all models. This result is in line with those by Veugelers and Cassiman (1999), Laursen and Salter (2004), and results reported by OECD economies (OECD 2009), where firms that have openness strategies for R&D activities usually have higher innovative performance. Crespi and Zúñiga (2010) found that only a few Latin American countries reported that a strategy of openness to collaborate impacts their investment on innovation activities.

Results regarding the sources of information proved to be significant only for firms in the service sector. Market sources of information (competitors, customers, consultants, and suppliers) are significant determinants of innovation and learning intensity for KIBS and traditional service firms. KIBS that access market sources of information invest about 94 percent more in learning and innovation activities than those firms that do not benefit from this source of information. Traditional service firms that access market sources of information invest about 90 percent more than those firms that do not benefit from these sources. On the other hand, public sources of information, which include patents, conferences, Internet, and fairs, seem to have a negative effect on the innovation and learning intensity of firms in the service sector, for both KIBS and traditional services. This result suggests that our model is capturing the effects of spillovers from public sources of information. In the extent that firms access free public information, they tend to decrease or might not be interested in carrying out innovative efforts by themselves. This result is interesting because it is very strong in services, where the intangible nature of innovative investments might be more intensely affected by these types of spillovers.

Thus, we can argue that firms in the service sector "trade" innovation intensity for information that can be publicly obtained. This negative result and the lack of significance from different sources of information on the innovation intensity across the different models point out an important element identified also by Crespi and Zúñiga (2010), related to the limited knowledge exchange among actors, and might express the limited capacity of firms to take advantage of the knowledge available to compete based on their innovation intensity.

6.6 The Impact of Innovation Investment on the Probability of Technological Innovation

We also estimated a knowledge production function (eq. 1.2). Our results show that the effects for learning and innovation intensity are statistically significant across all seven of our models. Learning and innovation intensity has an impact of about 0.9 for the complete sample and manufacturing, and it reported an impact of about 0.5 for service firms. This result confirms those by Crespi and Zúñiga (2010), Griffith et al. (2006), and Raffo, Lhuillery and Miotti (2008) and indicates that firms with higher innovation intensity per employee show a higher probability of introducing at least one product or process innovation. Foreign ownership represents an important determinant for the probability of producing technological innovation, but only for low-tech manufacturing firms. Our results show that previous export experience is an important determinant for technological innovation, but only for high-tech manufacturing firms. The firms with this characteristic have about a 2 percent higher propensity to produce product or process innovations than firms with no export experience. However, export experience had no effect on the innovation output of firms in the service sector.

6.7 Determinants of Productivity

Finally, we estimated the determinants of productivity in equation 1.3, measured in term of sales per employee. Our results show a highly significant and positive impact of innovation performance on firm productivity across the seven models. Our results indicate an impact of 1.92 for all firms in the sample, 1.92 for all manufacturing firms, 1.95 for high-tech and low-tech manufacturing, 1.06 for all service firms, and about 1.3 for KIBS and for traditional service firms.

In this case, structural factors such as firm size are important determinants of firm productivity. Our result suggests that smaller firms have higher productivity measured in terms of sales per employee. This result contributes to those by Crespi and Zúñiga (2010), as they did not identify the impact of firm size on productivity. This result suggests that smaller firms might have more flexibility to introduce changes that are needed in a changing environment, thus having a positive effect on its productivity. Non-technological innovation is also an important determinant of productivity. In this regard, Tether and Howells (2007) recognize the importance of both technological and non-technological innovation, especially organizational innovation, pointing to the existence of complementarities between these two types of innovation. In particular, organizational innovation is significant for all the models. The elasticity reported by KIBS and traditional services is 0.19, and the elasticity reported by manufacturing firms varies from 0.11 to 0.19. On the other hand, market innovation is only significant for manufacturing, in particular high-tech, but has no effect on the services models. This result confirms those of Crespi and Zúñiga (2010).

Table 14. Results for Determinants of Innovation and Productivity for the Complete Sample

VARIABLES	1	1.1	1.2	1.3	1.3.1
firm_fdi_20	-0.139**	-0.251	0.0877		
	(0.0657)	(0.237)	(0.0821)		
log_export08	0.0399***	0.0407*	-0.00224		
	(0.00491)	(0.0218)	(0.00642)		
log_firm_labor08	-0.0133				
	(0.00972)				
log_firm_labor09			-0.0120	-0.402***	-0.408***
			(0.0119)	(0.0203)	(0.0201)
patent_sol08_dummy	8.210	0.690			
	(102,627)	(0.581)			
u_innov_fund_dummy	1.103***	0.975**			
	(0.0666)	(0.422)			
innov_organization				0.102*	0.0863
				(0.0575)	(0.0570)
innov_market				0.185***	0.173***
				(0.0642)	(0.0636)
open_strategy		1.361***			
		(0.231)			
INFOMarket		0.247			
		(0.235)			
INFOScience		-0.113			
		(0.241)			
INFOPublic		-0.0650			
		(0.215)			
cost_factor2		0.478			
		(0.360)			
knowledge_factor2		-0.205			
		(0.214)			
market_factor2		-0.221			
		(0.236)			
regulation_factor2		-0.0718			
		(0.219)			
EXCAP_eq11			0.990***		0.563***
			(0.0422)		(0.0348)
innov_eq12				1.928***	

VARIABLES	1	1.1	1.2	1.3	1.3.1
				(0.133)	
Athrho		-0.145			
		(0.186)			
Lnsigma		1.035***			
		(0.0293)			
Sigma				1.345***	1.334***
				(0.0181)	(0.0179)
Constant	-0.923***	0.426	-2.253***	8.357***	8.104***
	(0.0677)	(0.839)	(0.0958)	(0.142)	(0.143)
Observations	2,765	2,765	2,765	2,765	2,765

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors based on preliminary information contained in ESIDET 2010.

Table 15. Results for Determinants of Innovation and Productivity for Manufacturing *(high-tech and low-tech)*

	Manufacturing					High-tech					Low-tech				
VARIABLES	1	1.1	1.2	1.3	1.3.1	1	1.1	1.2	1.3	1.3.1	1	1.1	1.2	1.3	1.3.1
firm_fdi_20	-0.171**	-0.261	0.0716			-0.261***	-0.406	0.148			-0.143	-0.498	0.304**		
	(0.0734)	(0.258)	(0.0889)			(0.0764)	(0.272)	(0.0938)			(0.105)	(0.370)	(0.134)		
log_export08	0.0373***	0.0136	0.0140**			0.0341***	0.000439	0.0246***			0.0364***	0.0117	0.0128		
	(0.00584)	(0.0241)	(0.00698)			(0.00591)	(0.0236)	(0.00691)			(0.00747)	(0.0310)	(0.00899)		
log_firm_labor08	-0.0160					-0.0135					0.00165				
	(0.0126)					(0.0127)					(0.0161)				
log_firm_labor09			-0.0144	-0.339***	-0.339***			-0.0136	-0.329***	-0.314***			0.00174	-0.367***	-0.357***
			(0.0140)	(0.0266)	(0.0266)			(0.0140)	(0.0267)	(0.0269)			(0.0186)	(0.0359)	(0.0361)
patent_sol08_dummy	7.992	0.730				8.332	0.560				8.055	1.530*			
	(70,063)	(0.615)				(171,822)	(0.617)				(70,345)	(0.897)			
u_innov_fund_dummy	1.008***	1.133***				0.981***	0.948**				1.011***	1.153**			
	(0.0772)	(0.433)				(0.0776)	(0.428)				(0.106)	(0.579)			
innov_organization				0.105	0.111*				0.112*	0.135**				0.194**	0.222***
				(0.0653)	(0.0655)				(0.0651)	(0.0656)				(0.0847)	(0.0851)
innov_market				0.148**	0.134*				0.153**	0.142*				0.0245	0.0230
				(0.0715)	(0.0719)				(0.0714)	(0.0725)				(0.0927)	(0.0936)
open_strategy		1.122***					1.057***					0.859**			
		(0.265)					(0.264)					(0.373)			
INFOMarket		0.125					0.0710					0.174			
		(0.268)					(0.266)					(0.338)			
INFOScience		-0.258					-0.284					-0.257			
		(0.279)					(0.277)					(0.386)			
INFOPublic		0.195					0.146					-0.0808			
		(0.247)					(0.246)					(0.327)			
cost_factor2		0.557					0.610					0.173			
		(0.396)					(0.393)					(0.505)			

	Manufacturing					High-tech					Low-tech				
VARIABLES	1	1.1	1.2	1.3	1.3.1	1	1.1	1.2	1.3	1.3.1	1	1.1	1.2	1.3	1.3.1
knowledge_factor2		-0.307					-0.362					-0.312			
		(0.244)					(0.242)					(0.315)			
market_factor2		-0.0945					-0.0972					0.119			
		(0.269)					(0.267)					(0.353)			
regulation_factor2		-0.282					-0.304					-0.525			
		(0.250)					(0.248)					(0.333)			
EXCAP_manuf_eq11			0.903***		0.495***			0.966***		0.463***			0.913***		0.383***
			(0.0465)		(0.0395)			(0.0513)		(0.0429)			(0.0666)		(0.0531)
innov_eq12				1.929***					1.915***					1.824***	
				(0.148)					(0.154)					(0.217)	
htmanuf						0.296***	0.699***	-0.467***	0.101	-0.0524					
						(0.0665)	(0.248)	(0.0879)	(0.0612)	(0.0671)					
ltmanuf											-0.296***	-0.699***	0.467***	-0.101	0.0524
											(0.0665)	(0.248)	(0.0879)	(0.0612)	(0.0671)
athrho		-0.106					-0.193					-0.0951			
		(0.202)					(0.208)					(0.275)			
lnsigma		1.030***					1.029***					0.957***			
		(0.0303)					(0.0367)					(0.0418)			
sigma				1.257***	1.260***				1.255***	1.267***				1.267***	1.277***
				(0.0206)	(0.0206)				(0.0205)	(0.0207)				(0.0266)	(0.0268)
Constant	-0.816***	0.751	-2.244***	8.051***	7.773***	-0.891***	0.963	-2.475***	7.941***	7.542***	-1.026***	0.889	-2.150***	8.206***	8.066***
	(0.0884)	(0.878)	(0.119)	(0.182)	(0.185)	(0.0908)	(0.906)	(0.127)	(0.186)	(0.192)	(0.114)	(1.172)	(0.151)	(0.248)	(0.251)
Observations	1,866	1,866	1,866	1,866	1,866	1,866	1,866	1,866	1,866	1,866	1,866	1,866	1,866	1,866	1,866

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Authors based on preliminary information contained in ESIDET 2010.

Table 16. Results for Determinants of Innovation and Productivity for Service Sector *(KIBS and traditional services)*

	Services					KIBS					Traditional				
VARIABLES	1	1.1	1.2	1.3	1.3.1	1	1.1	1.2	1.3	1.3.1	1	1.1	1.2	1.3	1.3.1
firm_fdi_20	-0.108	-0.634	0.243			-0.0900	-0.431	0.164			-0.0864	-0.489	0.206		
	(0.154)	(0.623)	(0.221)			(0.157)	(0.594)	(0.220)			(0.157)	(0.597)	(0.221)		
log_export08	0.0297**	0.0885*	-0.0119			0.0257**	0.0547	0.00238			0.0249**	0.0601	-0.00172		
	(0.0117)	(0.0533)	(0.0163)			(0.0120)	(0.0467)	(0.0161)			(0.0120)	(0.0475)	(0.0161)		
log_firm_labor08	-0.00208					-0.000399					-0.000397				
	(0.0205)					(0.0184)					(0.0189)				
log_firm_labor09			-0.00300	-0.447***	-0.446***			-0.00461	-0.470***	-0.469***			-0.00538	-0.465***	-0.464***
			(0.0240)	(0.0323)	(0.0323)			(0.0241)	(0.0334)	(0.0334)			(0.0241)	(0.0333)	(0.0333)
patent_sol08_dummy	7.487	2.178				7.947	1.842				7.886	1.941			
	(41,913)	(1.880)				(50,280)	(1.512)				(43,109)	(1.596)			
u_innov_fund_dummy	1.366***	2.175				1.256***	1.406				1.246***	1.437			
	(0.133)	(1.413)				(0.136)	(0.998)				(0.136)	(1.057)			
innov_organization				0.208*	0.190*				0.216*	0.190*				0.215*	0.190*
				(0.112)	(0.113)				(0.112)	(0.114)				(0.112)	(0.113)
innov_market				0.205	0.214				0.197	0.207				0.194	0.205
				(0.130)	(0.130)				(0.130)	(0.130)				(0.130)	(0.130)
open_strategy		2.130***					2.008***					1.993***			
		(0.462)					(0.447)					(0.451)			
INFOMarket		0.763					0.940**					0.895*			
		(0.468)					(0.455)					(0.457)			
INFOScience		0.334					0.0441					0.0479			
		(0.462)					(0.454)					(0.458)			
INFOPublic		-0.915**					-0.879**					-0.897**			
		(0.413)					(0.399)					(0.401)			
cost_factor2		0.130					0.242					0.225			
		(0.812)					(0.788)					(0.792)			

	Services					KIBS					Traditional				
VARIABLES	1	1.1	1.2	1.3	1.3.1	1	1.1	1.2	1.3	1.3.1	1	1.1	1.2	1.3	1.3.1
knowledge_factor2		0.468					0.397					0.402			
		(0.447)					(0.427)					(0.430)			
market_factor2		-0.377					-0.656					-0.611			
		(0.479)					(0.469)					(0.471)			
regulation_factor2		0.393					0.582					0.551			
		(0.444)					(0.432)					(0.434)			
EXCAP_serv_eq11			0.563***		0.125***			0.662***		0.179***			0.660***		0.179***
			(0.0480)		(0.0422)			(0.0603)		(0.0511)			(0.0605)		(0.0513)
innovserv_eq12				1.066***					1.336***					1.329***	
				(0.363)					(0.381)					(0.382)	
Kibs						0.642***	1.616***	-0.619***	-0.413***	-0.612***					
						(0.116)	(0.601)	(0.194)	(0.141)	(0.168)					
Tradserv											-0.649***	-1.519**	0.566***	0.347**	0.536***
											(0.114)	(0.638)	(0.190)	(0.139)	(0.165)
athrho		0.379					0.149					0.178			
		(0.570)					(0.449)					(0.482)			
lnsigma		1.016***					0.944***					0.952***			
		(0.145)					(0.0662)					(0.0749)			
sigma				1.475***	1.475***				1.469***	1.469***				1.471***	1.471***
				(0.0348)	(0.0348)				(0.0347)	(0.0347)				(0.0347)	(0.0347)
Constant	-1.105***	-2.907	-0.726***	8.444***	8.767***	-1.228***	-2.404	-0.936***	8.659***	9.011***	-0.585***	-0.942	-1.441***	8.273***	8.452***
	(0.136)	(2.570)	(0.165)	(0.235)	(0.244)	(0.127)	(2.082)	(0.174)	(0.247)	(0.261)	(0.152)	(1.786)	(0.198)	(0.244)	(0.237)
Observations	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors based on preliminary information contained in ESIDET 2010.

6.8 Summary of the Analysis

This section summarizes the main results of the analysis regarding the determinants of innovation (decision and intensity) and their impacts on innovation output and productivity (see Table 17). According to the variables in our analysis, we have distinguished between the impact of trade integration (exports), fixed cost FDI (ownership), fixed cost (size), patent protection, public funds for innovation, formal linkages for innovation, market sources of information, public sources of information, effects of innovation investments on innovation output and on productivity, effect of innovation output on productivity, and the transmission mechanism regarding technological and non-technological innovation.

Table 17. Summary of Results for Determinants of Innovation and Productivity

	All	Manufacturing	High-tech	Low-tech	Services	Kibs	Trad
Determinants of innovation (Eq1)							
Trade integration (exports)	(***)	(***)	(***)	(***)	(**)	(**)	(**)
Fixed costs FDI (FDI ownership higher than 20 percent)	(-**)	(-**)	(-***)				
Public funds for innovation	(***)	(***)	(***)	(***)	(***)	(***)	(***)
Innovation intensity (Eq 1.1)							
Trade integration (Exports)	(*)				(*)		
Public funds for innovation	(**)	(***)	(**)	(**)			
Intellectual Property				(*)			
Formal linkages for innovation (Openness strategy)	(***)	(***)	(***)	(**)	(***)	(***)	(***)
Public sources of information (INFOPublic)					(-**)	(-**)	(-**)
Market sources of information (INFOMarket)						(**)	(*)
Innovation output (Eq. 1.2)							
Effect of innovation investment on innovation output (EXCAP)	(***)	(***)	(***)	(***)	(***)	(***)	(***)
Fixed costs FDI (FDI ownership higher than 20 percent)				(**)			
Trade integration (Export experience)		(**)	(***)				
Productivity (Eq. 1.3)							
Effect of innovation investment on productivity (EXCAP)	(***)	(***)	(***)	(***)	(***)	(***)	(***)
Effect of innovation output on productivity (innov)	(***)	(***)	(***)	(***)	(***)	(***)	(***)
Fixed costs (Firm size 09)	(-***)	(-***)	(-***)	(-***)	(-***)	(-***)	(-***)
Organization innovation	(*)	(*)	(**)	(**)	(*)	(*)	(*)
Market innovation	(***)	(**)	(**)				

*** p<0.01, ** p<0.05, * p<0.1

Source: Summary of results from Table 15 and Table 16. Authors based on preliminary information contained in ESIDET 2010.

i) Trade integration (Exports). The importance of export experience on firms' innovative behavior and performance has been highlighted previously. Our results confirm that export experience is an important determinant of the decision to innovate; firms with export experience in the service sector also have a higher innovation intensity measured by expenditures. Our results also show that high-tech manufacturing firms with export experience have in general higher innovation output. Firms in low-tech manufacturing and in the service sector did not confirm this result.

ii) Fixed-cost FDI (ownership). Firm ownership has also been analyzed in terms of its effects on the decision to innovate. In general, previous studies have dual findings. Some authors agree that firms with foreign ownership tend to perform more innovation activities, while some other studies have shown that firms with a certain degree of foreign ownership do not perform innovation activities. This second finding is more linked to our results for the case of high-tech manufacturing, as we found that 20 percent or more of foreign ownership has a negative effect on the decision to innovate in high-tech manufacturing firms. This result may be specific to subsidiaries located in developing countries, where subsidiaries do not perform much R&D, or when they do, it is mainly to adapt processes and products to the local context or target market. Interestingly, our results point out that foreign ownership does not have a distinctive effect on the decision to innovate for firms in low-tech manufacturing and firms the service sector, including KIBS and traditional services. On the other hand, foreign ownership plays an important role in the innovation output equation in low-tech manufacturing firms, which might indicate that once low-tech manufacturing firms decide to perform R&D and learning activities, foreign ownership plays an important role in the development of innovations.

iii) Fixed cost (size). Contrary to previous studies that highlight the importance of firm size for the decision to innovate, we did not find any effect of firm size on the determinants of innovation. However, we did find that firm size has an important effect on firm productivity. Our result suggests that smaller firms have higher productivity measured in terms of sales per employee; as such, smaller firms might be more flexible, which may have a positive effect on their productivity.

iv) Patent protection. In general, patent protection does not affect the decision to engage in innovation and learning activities across all manufacturing and services models. However, it can play an important role in the innovation intensity decision for low-tech manufacturing firms.

v) Public funds for innovation. Several authors have agreed on the importance of public funding for innovation to foster the innovation decision and innovation intensity. Our results show that the use of public funds for innovation is an important determinant for innovation activities across manufacturing and services. However, only firms from manufacturing, high-tech and low-tech that receive public funds to innovate invest significantly more in innovation than firms that do not receive these funds. In contrast, the use of public funds to innovate did not have a significant impact on the innovation intensity of firms in the service sector.

vi) Formal linkages for innovation. We also acknowledged the importance of firms having an openness strategy to collaborate with different agents for innovation. We analyzed the effect of an openness strategy for innovation on the innovation intensity equation (Eq. 1.1). Our results show that an openness strategy to innovate plays an important role in innovation investment across all models in the services and manufacturing sectors.

vii) Market and public sources of information. Access to different sources of information has also been discussed as an important factor in the decision to innovate or in innovation intensity. In our model, we included the analysis of three different sources of information in the investment decision to innovate, market, public, and science. Only market (competitors, customers, consultants, and suppliers) and public (patents, conferences, Internet, and fairs) sources of information are significant determinants of innovation and learning intensity for KIBS and traditional service firms. KIBS and traditional service firms that access market sources of information invest more in learning and innovation activities than firms that do not benefit from this particular source of information. We observed a negative impact of public sources of information on the innovation and learning intensity of firms in the service sector, both for KIBS and traditional services. This result suggests that spillovers from public sources of information have a higher impact on service firms. Thus, to the extent that service firms can get access to free public information, they will decrease their investment in innovation. We can thus can argue that firms in the service sector trade innovation intensity for information that can be publicly obtained.

viii) Effects of innovation investments on innovation output and productivity. Our results show that the effects of learning and innovation intensity on innovation output (Eq. 1.2) and on productivity (Eq. 1.3) are statistically significant for services and manufacturing. The results did not show a difference in terms of significance between high-tech or low-tech manufacturing, and KIBS and traditional services. However, learning and innovation intensity has a higher impact for the complete sample of manufacturing than for service firms. These results indicate that manufacturing firms are able to obtain more benefit from their investment in learning and innovation activities when it comes to innovation output and productivity.

ix) Effect of innovation output on productivity. Our results show that innovation output has a significant and positive impact on firm's productivity for both, services and manufacturing firms. However, differences arrive in terms of the impact. As suggested above, manufacturing firms seem to grasp more benefits from innovation output to increase their productivity. For service firms, the impact is lower, suggesting that technological innovation has a more powerful effect on fostering productivity in manufacturing firms.

x) Transmission mechanism regarding technological and non-technological innovation. Regarding the impact of non-technological innovation on firm productivity, we observe the following results. On the one hand, organizational innovation is significant for services and manufacturing firms, but there is a greater impact for services than for manufacturing firms. The highest elasticity is reported by KIBS and traditional services (0.19), and the lowest elasticity is reported by high-tech manufacturing firms (0.11). On the other hand, market innovation is only significant for high-tech manufacturing, but has no effect on low-tech manufacturing, KIBS, and traditional services. These results point to the existence of complementarities between technological and non-technological innovation that foster firm productivity.

7 Conclusions

This paper contributes to the analysis of the drivers of innovation and innovation intensity and their effect on technological innovation output and firm productivity. We focus our analysis on firms in the service sector; however, we also analyze manufacturing firms as a benchmark for the results in service firms. We acknowledge the heterogeneity across the different subsectors in services and manufacturing; hence, we differentiate between high-tech and low-tech manufacturing, and KIBS and traditional services.

The manufacturing and service sectors in Mexico differ in terms of their characteristics, markets, networks, and performance. This study has documented the limited innovation and learning behavior of both manufacturing and service firms in Mexico. The bulk of firms in our sample tended not to actively engage in innovation and, whenever they did so, it was only on a very limited scale. This situation tends to reaffirm the view that a large number of firms in Mexico prefer imported technologies to the development of internal technological capabilities (Dutrénit et al. 2010; OECD, 2012). From a capacity-building perspective, the missed learning opportunities for firms in Mexico would conform to what D'Este et al. (2012) characterize as a situation of "withdrawal" and "failure without learning" (p.487).[16] The innovation management literature documents that innovation projects need not succeed in order to provide useful lessons for the firm. This also suggests that opportunities for policy learning are reduced because the activity being targeted by public intervention is so severely restrained by the agents. In the end, they are the ultimate intended beneficiaries of the intervention.

The need to enhance the intensity and productivity of innovation activities carried out by firms in Mexico is persistent. At the same time, science, technology and innovation authorities must strive to enlarge the base of firms that are active innovators as part of a long-term, sustained business strategy. Notwithstanding the recent improvements recorded at the level of micro interventions via specific instruments to promote innovation (FCCyT, 2006; OECD, 2012), some of which are described in Section 5, the governance of Mexico's national system of innovation requires significant improvement in order to attract private investment in innovation.

With regard to actual innovation behaviors, and based on the descriptive statistics presented in Section 6, this document argues that manufacturing firms have more mature

[16] Emphasis made by the authors in the original.

innovation processes than service firms. For example, a higher percentage of manufacturing firms have specialized units that document the productive processes that the firm carries out. Looking closer at the different types of manufacturing and service firms, high-tech manufacturing and KIBS are more active innovators than low-tech manufacturing and traditional industries, respectively.

Our results also show differences in terms of the types of innovation activities performed by the different types of firms. For example, manufacturing firms tend to dominate in activities such as the purchase of machinery and equipment, R&D, industrial design or prototyping, and the purchase of software. By contrast, service firms tend to be more active in the provision of training linked to innovation activities. An important component is related to the decision to engage in innovation activities according to the ownership structure. Foreign ownership affects negatively the decision to innovate in high-tech manufacturing firms, but it does not demonstrate an important effect for low-tech manufacturing and service firms. Regarding collaboration with other agents, the results reported in this study indicate that manufacturing firms establish more collaboration activities with different agents and access more public funds for innovation than service firms.

7.1 Determinants of innovation and Impact of Innovation on Productivity

The results from the model on innovation determinants and impact of innovation on productivity show that innovation intensity has a strong impact on the innovation output, and innovation output also demonstrates a high impact on firm's productivity. These results are consistent with those by Crépon, Duguet, and Mairesse (1998) and Crespi and Zúñiga (2010), as firms that invest more on learning and innovation per employee have a higher propensity to produce innovations, and those firms also show a higher productivity performance.

Important determinants for the decision to innovate and innovation intensity are related to structural, behavioral, and performance factors. However, our results show some contradictory findings in comparison to other studies, which suggests that we must analyze the results with care. For example, firm size has been associated with higher R&D investment (Benavente, 2006; Crespi and Peirano, 2007) due to large economies of scale in innovation; however, our results suggest that firm size is not an important determinant in the decision to innovate or of innovation intensity.

We also find that innovation barriers have no effect on innovation intensity. D'Este et al. (2012) conclude that firms that report no innovation activity are more likely to assess barriers to innovation as more important than do firms with low levels of engagement. As we mentioned in Section 6.1, according to our results, innovation barriers show that firms that engage in three or four innovation activities are more likely to report market barriers to innovation as significant, suggesting that firms need to engage in more innovation activities before they rank several barriers of innovation as highly important. This might explain the non-significant result of innovation barriers on innovation intensity. As suggested by the results in our study of innovation barriers, we argue that the lack of statistical significance may be a consequence of the poor innovation behavior and the missed learning opportunities for firms in Mexico.

Emphasizing the differences between manufacturing and service firms in Mexico, our results demonstrate that these two sectors have different patterns with respect to the determinants of innovation, innovation output, and the effect of innovation on firm productivity. Even though a slightly higher number of foreign-owned manufacturing firms perform innovation activities than service firms, foreign ownership has a negative effect on the determinants of innovation for high-tech manufacturing firms, but it seems not to play a significant role for low-tech manufacturing and service firms (KIBS and traditional services).

Regarding the determinants of innovation intensity, we found that even though firms in the service sector are less engaged in international markets compared to manufacturing firms, as shown in Table A5.1 and Table A5.2 of the Appendix, previous export experience seems to play a more beneficial role for firms in the service sector. However, previous export experience comes into play as a determinant of innovation output in manufacturing firms.

Regarding the effect of innovation intensity, the use of public funds for innovation seems to play an important role for manufacturing firms but not for services, neither KIBS nor traditional, and a higher percentage of firms in manufacturing use public funds for innovation than service firms. Sources of information also show a different pattern between manufacturing and service firms. For example, service firms that access market sources of information seem to have higher innovation intensity levels, while for manufacturing firms access to different sources of information do not have an effect on innovation intensity.

Finally, with respect to the effect of innovation on productivity, our results show that non-technological innovation, such as organizational innovation, is an important determinant of productivity in manufacturing and service firms, but market innovation only has a significant effect on productivity for manufacturing firms.

The results from the econometric model suggest that manufacturing firms in Mexico present more mature schemes for innovation than firms in the service sector, as they benefit from export experience and non-technological innovation. Based on the results from the model, we can say little about the differences between KIBS and traditional services in Mexico.

7.2 Policy Implications and Further Research

These results stress the importance for policymaking of understanding the determinants of innovation and innovation intensity, and the need to address barriers to innovation.

One important variable that impacts the decision to innovate has to do with public funds for innovation. This result highlights the fact that firms that access public funds to innovate have an active innovation strategy and show higher innovation intensity. Another variable is having strategy of openness to innovation, which suggests that firms with higher absorptive capacities are able to identify and benefit from external knowledge, and are also those firms that invest more in innovation and learning activities. The challenge here for policy action is related to the need to address internal failures in firms that prevent them from developing an active innovation strategy, including establishing networks with other agents to benefit from knowledge outside the firm.

This study also suggests some recommendations for advancing the sample design for future surveys of ESIDET in Mexico. ESIDET 2010 represented a significant advance in coverage, including firms with 20 employees or more, unlike previous versions that only included firms with 50 employees or more. However, a detailed analysis of the biases of ESIDET 2010 compared to the census data from 2009 would suggest including more firms with fewer than 250 employees in the sample design in order to have a greater coverage of KIBS, and of fewer than 100 employees for traditional services (see Appendix A4).

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Appendix

Appendix A1. Learning, Innovation and Barriers to Innovation in Services and Manufacturing Firms in Mexico: A Complementary Study

Studies on the barriers to innovation faced by firms in developing countries such as Mexico are scant; moreover, they tend to neglect sectoral specificities, particularly in the case of the service sector. This complementary study contributes to addressing this gap. Specifically, the objectives of this study are twofold: first, and based on the discussion in Section 4.2.2 and the data presented in Section 4.2.3, to uncover the reasons why firms in a developing country such as Mexico show such a limited inclination to invest in technological learning and innovation. The second objective is to inform the specification of the CDM econometric analysis presented in Section 6 in the main body of this study.

1. Barriers to Innovation in Mexico

The literature documents a number of barriers to innovation, which help explain the poor innovation performance of firms observed in Mexico. The factors that hinder incentives and actual investment in innovation are related to market structures, regulatory regimes, knowledge gaps, and the actual cost of innovation (Solleiro and Castañón, 2005; Dutrénit et al., 2010; CII 2011). Based on the literature, market-related barriers to investment and innovation performance derive from the general macroeconomic environment, including heavily concentrated markets which generally favor large firms, asymmetric access to both local and export markets, inadequate funding mechanisms, and a perceived limited demand for locally generated technologies. Small and medium-size enterprises tend to suffer the most from these barriers. Dutrénit et al. (2010) further document rent-seeking behaviors of firms in Mexico, as they tend to follow short-term strategies that privilege economies of scale and the import of foreign technologies.

FCCyT (2006) and Dutrénit et al. (2010) highlight some regulatory barriers to innovation in Mexico, including persistent gaps in areas such as competition policy, financial regulation, and governance of key sectors such as telecommunications. Regulatory barriers are also perceptible at more disaggregated levels. For instance, in a study of pharmaceutical firms, Santiago and

Dutrénit (2012) suggest that principles and practices governing public procurement, the governance and ethics of research, and provisions regarding intellectual property rights can significantly impact motivation and opportunities to innovate.

Recent institutional and regulatory reforms related to science, technology, and innovation (STI) have been implemented very slowly (Dutrénit et al., 2010; OECD, 2012). These reforms have seldom translated into tangible commitments to grant increased funding and political empowerment of the organization responsible for STI policy making and implementation, namely the National Council for Science and Technology (CONACYT). Persistent bureaucratization and erratic funding structures result in mixed stimuli for the agents in the system, mainly those in the public education and research system, to move in different, often contradictory directions (CII 2011). Some instruments motivate researchers to carry out innovation and R&D designed to address national problems, while financial incentives and recognition tend to privilege curiosity-driven scientific research. Few economic incentives promote stronger linkages and interaction within the system.

All of these barriers add, at least to some extent, to the costs incurred by firms in order to innovate. Whereas public funds seem to be insufficient to offset risks and persuade firms to carry out innovation in Mexico, private funding, in the form of venture capital and other mechanisms, remains scant (Dutrénit et al., 2010; CII, 2011). At the same time, the complexity and bureaucracy surrounding publicly funded mechanisms and the excessive cost of private funds increase the cost and enhance the perceived risks of innovating.

Among knowledge-related barriers to innovation, one that is frequently cited is the limited labor force qualified to perform R&D. Dutrénit et al. (2010) stress the limitations imposed by the absence of human resources on technological learning and innovation by firms. Solleiro and Castañón (2005) decry the insufficient development and presence of entrepreneurial skills and risk taking in Mexico; they likewise underscore the limitations of the country's education and training systems and the regional concentration of educational opportunities. The dearth of interaction and cooperation between public and private organizations with respect to the professionalization of the labor force (CII 2011) is compounded by the limited mobility of highly qualified human resources and the weakness of education and research networks (Dutrénit et al., 2010). The lack of efficient information systems and scientific and technological infrastructure also contribute to the knowledge-related barriers to innovation in Mexico (Solleiro and Castañón, 2005; Dutrénit et al., 2010; CII, 2011). Barriers to innovation in Mexico, as perceived by firm, are explored in the following sections.

2. The Variables

Table A1.1 and Appendix A2 list the variables used in this complementary study, together with some descriptive statistics. Appendix A3 presents the pairwise correlation analysis of the variables used here. A broader discussion of the data follows.

2.1. Barriers to Innovation

ESIDET asks firms to report whether they have experienced barriers to innovation, and if so, to assess their importance. Ten items capture factors that hamper innovation efforts or that influence a firm's innovation decision, namely: excessive economic risk, excessive cost of the innovation process, inadequate funding sources, organizational rigidities, insufficient qualifications of the labor force, lack of information about the technology, insufficient market information, obstacles related to current legal frameworks (norms, standards, taxes or regulations), insufficient demand for new products or services, and lack of public support for innovation activities. Based on D'Este et al. (2012), we grouped these obstacles to innovation into four constructs denoting: cost factors, knowledge factors, market factors, and regulatory factors; then, four dependent variables, one for each set of barriers, are constructed as dichotomous variables (Table A1.1 and Appendix A2).

2.2. Engagement in Innovation

Section 4.2.2 of this study described some of the innovation-related activities performed by firms in Mexico. Based on this information, and for the purpose of this complementary study on barriers to innovation, we identified whether or not firms innovated; the firm may have engaged in one or several, up to eight, innovation activities. Based on Savignac (2008) and D'Este et al. (2012) we singled out potential innovator firms from those that did not engage at all in innovation during 2008-2009. Hence, excluded from the analysis are firms that reported to be both non-innovation-active and not experiencing any of the eight barriers to innovation presented in

Appendix A2. Based on Savignac, (2008) and D'Este et al. (2008 and 2012) we expect that the exclusion of these 266 non-innovation-oriented firms can minimize potential problems of selection bias. After cleaning for missing values, the remaining 2,772 firms included in the analysis are considered potential innovators in the sense that they engaged in at least one kind of innovation activity in the period 2008–2009. Alternatively, firms may have failed to engage in innovation because of the barriers they encountered. Similar to D'Este et al. (2012), the analysis of the firm's degree of engagement in innovation is captured by a set of three dummy variables that take the value of one if the firm engaged in one or two (1–2), three or four (3–4), or five or more (5–8) innovation activities; the reference category is firms that engaged in zero innovation activities.

Table A1.1. Variables Used to Study Barriers to Innovation in Mexico: Descriptive Statistics

Variables	Description	Mean	St. Dev	Min	Max
Dependent variables					
Cost barriers	1 if the firm experienced cost barriers to innovation and reported it as highly important; 0 otherwise	0.655	0.476	0	1
Knowledge barriers	1 if the firm experienced knowledge barriers to innovation and reported it as highly important; 0 otherwise	0.341	0.474	0	1
Market barriers	1 if the firm experienced market barriers to innovation and reported it as highly important; 0 otherwise	0.396	0.489	0	1
Regulatory barriers	1 if the firm experienced regulatory barriers to innovation and reported it as highly important; 0 otherwise	0.359	0.480	0	1
Independent variables					
Zero	1 if the firm reports zero innovation activity; 0 otherwise	0.868	0.338	0	1
1-2	1 if the firm performs one or at the most two innovation activities; 0 otherwise	0.088	0.283	0	1
3-4	1 if the firm performs three or at the most four innovation activities; 0 otherwise	0.029	0.168	0	1
5-8	1 if the firm performs five or more innovation activities; 0 otherwise	0.015	0.121	0	1
log_labor	Natural logarithm of the firm's total labor force in 2009	6.784	1.186	0.647	11.808
Ownership	1 if the firm reports foreign capital in the firm's total capital; 0 otherwise	0.289	0.453	0	1
Standalone	1 if the firm is not part of a group or conglomerate; 0 otherwise	0.587	0.492	0	1
Export	1 if the firm reports sales in foreign markets; 0	0.416	0.493	0	1

Variables	Description	Mean	St. Dev	Min	Max
	otherwise				
subsidiary	1 if the firm is a subsidiary of a larger firm; 0 otherwise	0.358	0.480	0	1
manufacturing	1 if the firm is classified as part of the manufacturing sector; 0 otherwise	0.672	0.470	0	1
services	1 if the firm is classified as part of the service sector; 0 otherwise	0.328	0.470	0	1
htmanuf	1 if the firm operates in a high-technology manufacturing industry; 0 otherwise	0.265	0.441	0	1
ltmanuf	1 if the firm operates in a low-technology manufacturing industry; 0 otherwise	0.407	0.491	0	1
Kibs	1 if the firm is in a knowledge-intensive business service activity; 0 otherwise	0.063	0.243	0	1
Tradserv	1 if the firm operates in a traditional service activity; 0 otherwise	0.261	0.439	0	1

Notes: Observations: 2772.
Source: Authors based on information contained in ESIDET 2010.

We controlled for firm characteristics, including firm size, measured by the logarithm of the number of employees in 2009 (log_labor), and whether the firm is a single entity or part of an enterprise group (standalone). Based on evidence from pharmaceutical firms in Mexico, Zúñiga et al. (2007) and Santiago and Alcorta (2012) found that capital origin and export behavior strongly condition the technological performance of firms in Mexico. In order to capture the degree of market internationalization, we included a dummy variable denoting the firm’s participation in export markets,[17] and one on capital ownership (ownership).[18] We had no information to compute the age of the firm. Four dummy variables captured the technological intensity and market characteristics associated with the industry affiliation of the firm, namely: low- or high-tech manufacturing, and in the case of services, traditional services and KIBS.

[17] D’Este et al. (2012) measured the variable on internationalization via the relative distance of the markets served by the firm, whether local, national (UK), European or a non-European country. We lack more complete information on the specific export markets of firms in our sample.
[18] We also explored the effects of a dummy, which indicates that the firm is a subsidiary. The results, available to the authors upon request, provided little additional information compared to what is reported here.

3. Methodology

The four dependent variables used in the empirical analysis are dichotomous constructs, each of which captures the perception of obstacles to innovation as being highly important for the firm. In order to account and control for the expected correlation in the barriers to innovation, and based on Cappellari and Jenkins (2003) and D'Este et al. (2012), we used the multivariate probit model (MPM) technique to analyze the relationship between the four categories of barriers and the innovation activities of the firm. We followed a two-pronged approach to the empirical analysis. First, working with the full sample of manufacturing and service firms, we identified a basic model featuring dummies for the different levels of innovation activity and variables on firm characteristics. Then we included dummies to identify firms according to sectoral affiliation—whether the firm is in services—and their characteristic technological intensity—whether the firm is in a high- or low-tech industry, or in KIBS or traditional services. Second, we replicated the previous analysis, this time using the subsample of service firms only.

We ran several checks for the robustness of results, including models with an alternative definition of the constructs for the obstacles to innovation, as rated by the firm. Specifically, we used a less restrictive construct to indicate if the firm had experienced at least one barrier to innovation and had ranked such barrier as either moderately or highly important. For instance, the alternative construct of cost factors indicates whether economic risks where moderate or highly important, and so on. We also ran models where we consolidated some of the variables on innovation activity, specifically, a dummy, which captures firms that performed three or more innovation activities. The results from those alternative models are consistent with those reported here. However, for the sake of comprehensiveness of the analysis, we omit them from presentation. Footnotes in subsequent sections provide additional details on the robustness checks performed.

4. Empirical Analysis

Table A1.2 presents the distribution of firms in our sample by level of engagement in innovation. The table reveals that firms in Mexico display quite modest learning behavior, with the largest share of them, 86.8 percent, claiming not to have performed any innovation activity at all. Among those firms that actively innovate, the majority carried out only one or two activities, 8.8 percent, and the proportion decreases significantly as the number of innovation activities carried out increases to three or more activities. The table also distinguishes the sectoral affiliation of firms in our sample between manufacturing and services, as well as the technological intensity characteristic of their activities. In general, manufacturing firms tend to be more active than service firms, but their behavior tends to cluster around one or two innovation activities. Differences in the innovation behavior of manufacturing and services are evident, services being by far the less active. Arguably, firms in Mexico have experienced limited learning effects, and have a low capacity to identify and rank the obstacles encountered once they engage in innovation.

Table A1.2. Mexico: Innovation Behavior and Proportion of Firms Reporting Barriers to Innovation as Important, by Degree of Engagement in Innovation Activities

	Zero	1-2	3-4	5-8	□^{2}
1. Innovation activities	86.8	8.8	2.9	1.5	9700*
2. Manufacturing	56.3	7.5	2.3	1.1	4600*
a. High-tech	21.0	3.9	1.2	0.4	6100*
b. Low-tech	35.3	3.6	1.1	0.7	3100*
3. Services	30.6	1.2	0.6	0.4	3000*
a. KIBS	5.3	0.6	0.2	0.2	432.8*
b. Traditional	24.9	0.5	0.4	0.2	2600*
4. Cost factors	56.5	6.2	1.9	0.9	4900*
5. Knowledge factors	29.7	3.0	0.9	0.5	2600*
6. Market factors	34.3	3.4	1.4	0.6	3000*
7. Regulation factors	31.6	2.9	0.8	0.6	2800*

Notes: Observations, 2,772; *significant at the 1 percent confidence level.
Source: Authors based on data from ESIDET 2010.

D'Este et al. (2012) found that regardless of the type of barrier to innovation, the assessment of barriers as important to firms in the UK increased between low (1-2 activities) and high (5 or more activities) levels of involvement in innovation. Hence, the authors corroborated that assessment of barriers to innovation is not independent from the extent of firm engagement in such activity; the more firms engage in innovation, the more likely they are to identify and rate the obstacles they face. The observed limited innovation behavior of firms in our sample makes it difficult to assess this argument in the case of Mexico. However we can support D'Este et al.'s (2012) conclusion that firms that report no innovation activities are more likely to assess barriers to innovation as more important than do firms with low levels of engagement. In the case of Mexico, firms that reported no innovation activities assessed the barriers to innovation, particularly cost factors, as more important than did firms that perform one or two innovation activities. The perception of barriers to innovation related to knowledge, market and regulatory environment are evenly distributed; market factors are slightly more frequently reported.

4.1. Comparing Manufacturing and Service Firms

Table A1.3 reports results from the MPM models. Model (1) is our basic model. D'Este et al. (2012) found evidence of a non-linear, in fact a curvilinear, relationship between engagement in innovation and the capacity to perceive and qualify barriers to innovation, specifically cost and market barriers. UK firms that engaged heavily in innovation activities, as well as those that did not engage in innovation at all, were more likely to assess barriers as important. The results of this study tend to partially support this argument. In Mexico, firms that engage in three or four innovation activities are more likely to report market barriers to innovation as significant; by contrast, although the coefficients associated with the performance of five or more innovation activities are positive, they are not statistically significant. Somewhat surprisingly, we found no statistical significance in cost-related factors, the ones that the firms in our sample more frequently reported as a hindrance to innovation (Table A1.2). Our results tend to confirm D'Este et al.'s view that it may be that firms need to progress beyond a certain threshold of engagement in innovation activity before a positive relationship emerges. Below this threshold, the relationship is negative or, as in our case, difficult to perceive. We can also confirm the weakness of revealed learning effects, as no significant relationship appeared between engagement in a larger number of innovation activities and the perception of barriers to innovation.

With respect to variables on firm characteristics, stand-alone firms are more likely to report challenges resulting from their involvement in innovation. Constraints related to the cost of innovation, market conditions, and regulatory frameworks are the most important. Foreign-owned firms are less likely to report barriers associated with knowledge or, to a lesser extent, market factors. This is clearly a sign of the technological advantages enjoyed by foreign affiliates as compared to local firms. The lack of statistical significance of coefficients related to the variable on firm size may be explained by ESIDET biases in data collection, with only a sample of small firms being included in the survey. A finer gradation of the sampling procedure, which would have allowed more small firms to be included, may further explain this finding. Exposure to competition through exports failed to provide statistically significant information.

Model 2 in Table A1.3 now includes a dummy for service firms. No major changes are evident relative to our preceding discussion of estimates from Model 1. The individual coefficients for the services dummy indicate that service firms are less likely to report cost and market-related barriers to innovation. Next, we included sector dummies to identify firms in low- or high-tech manufacturing industries and in KIBS or traditional services. We did this in two ways: first, all four industry dummies were introduced at once; second, pairs of variables, each of which identifies firms which are either in manufacturing or in services, were introduced This split helped to contrast the different views that manufacturing and service firms may have with respect to the obstacles associated with their involvement in innovation. The results are consistent with those discussed for Models 1 and 2. Model 3 reports results for the four industry dummies. Firms that perform three to four innovation activities identified market-related barriers as important. As for the perception of barriers across industries, manufacturing firms failed to report statistically significant information. By contrast, service firms reported negative effects for regulatory and cost-related barriers.

Table A1.3. Multivariate Probit Results. Dependent Variables: Whether the Firm Assesses at Least One Barrier-Item as Highly Important, by Type of Barrier and Technological Intensity of the Industry where the Firm Belongs.

	Model 1				Model 2				Model 3			
Variables	Cost	Knowledge	Market	Regulation	Cost	Knowledge	Market	Regulation	Cost	Knowledge	Market	Regulation
1-2	0.13	0.013	0.010	-0.065	0.11	0.005	-0.002	-0.075	0.089	-0.0009	-0.023	-0.076
	(0.087)	(0.085)	(0.084)	(0.085)	(0.087)	(0.086)	(0.085)	(0.085)	(0.087)	(0.086)	(0.085)	(0.086)
3-4	0.064	-0.077	0.31**	-0.22	0.051	-0.081	0.30**	-0.23	0.037	-0.095	0.28*	-0.23
	(0.15)	(0.15)	(0.14)	(0.15)	(0.15)	(0.15)	(0.14)	(0.15)	(0.15)	(0.15)	(0.14)	(0.15)
5-8	-0.16	-0.035	0.042	0.11	-0.16	-0.036	0.043	0.11	-0.18	-0.011	0.053	0.12
	(0.19)	(0.20)	(0.19)	(0.20)	(0.19)	(0.20)	(0.19)	(0.20)	(0.19)	(0.20)	(0.19)	(0.19)
log_labor	-0.020	-0.023	-0.013	-0.026	-0.011	-0.020	-0.009	-0.022	0.001	-0.022	0.0003	-0.025
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.022)	(0.022)	(0.022)	(0.022)
ownership	0.0047	-0.17**	-0.071	-0.013	-0.010	-0.18**	-0.079	-0.020	-0.033	-0.22***	-0.12*	-0.054
	(0.070)	(0.071)	(0.070)	(0.071)	(0.070)	(0.071)	(0.070)	(0.071)	(0.072)	(0.073)	(0.072)	(0.073)
standalone	0.19***	0.065	0.24***	0.15**	0.19***	0.063	0.24***	0.14**	0.19***	0.081	0.25***	0.16***
	(0.059)	(0.060)	(0.059)	(0.059)	(0.059)	(0.060)	(0.059)	(0.059)	(0.059)	(0.060)	(0.059)	(0.060)
export	0.026	0.022	-0.024	-0.028	-0.059	-0.0073	-0.066	-0.062	-0.082	-0.015	-0.079	-0.074
	(0.059)	(0.059)	(0.059)	(0.060)	(0.064)	(0.063)	(0.062)	(0.064)	(0.065)	(0.064)	(0.063)	(0.064)
services					-0.22***	-0.076	-0.11*	-0.092				
					(0.059)	(0.059)	(0.058)	(0.059)				
htmanuf									-0.42	0.15	0.48	-0.41
									(0.41)	(0.37)	(0.41)	(0.35)
Ltmanuf									-0.53	-0.008	0.32	-0.56
									(0.41)	(0.37)	(0.41)	(0.34)
Kibs									-0.59	-0.22	0.28	-0.81**
									(0.42)	(0.38)	(0.41)	(0.36)
Tradserv									-0.77*	0.0036	0.24	-0.57*
									(0.41)	(0.37)	(0.41)	(0.34)
Constant	0.40**	-0.25	-0.30*	-0.25	0.46***	-0.23	-0.27*	-0.23	0.88**	-0.27	-0.69	0.30
	(0.16)	(0.16)	(0.16)	(0.16)	(0.16)	(0.16)	(0.16)	(0.16)	(0.44)	(0.40)	(0.43)	(0.38)
atrho21	0.69***	(0.038)			0.68***	(0.038)			0.69***	(0.038)		
atrho31	0.89***	(0.040)			0.88***	(0.040)			0.89***	(0.040)		
atrho41	0.76***	(0.038)			0.76***	(0.038)			0.76***	(0.039)		
atrho32	0.75***	(0.036)			0.75***	(0.036)			0.75***	(0.036)		
atrho42	0.74***	(0.035)			0.74***	(0.035)			0.74***	(0.035)		
atrho43	0.91***	(0.038)			0.91***	(0.038)			0.92***	(0.038)		
Log Likelihood	-6076				-6069				-6051			
DF	28				32				44			
Chi^2	68.1				83.1				114			
Prob>F	3.4e-05				2.0e-06				3.6e-08			

Notes: No innovation activity is the reference category; Observations: 2,772; Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Source: Authors based on preliminary information contained in ESIDET 2010.

Table A1.4. Multivariate Probit Results. Dependent Variables: Whether the Firm Assesses at Least One Barrier-Item as Highly Important, by Type of Barrier and Technological Intensity of the Industry where the Firm Belongs.

	Model 4				Model 5			
	Cost	Knowledge	Market	Regulation	Cost	Knowledge	Market	Regulation
1-2	0.097	-0.013	-0.019	-0.091	0.10	0.017	-0.003	-0.063
	(0.087)	(0.086)	(0.085)	(0.085)	(0.087)	(0.086)	(0.085)	(0.086)
3-4	0.041	-0.10	0.29**	-0.24	0.045	-0.074	0.30**	-0.22
	(0.15)	(0.15)	(0.15)	(0.16)	(0.15)	(0.15)	(0.14)	(0.15)
5-8	-0.16	-0.030	0.048	0.11	-0.18	-0.017	0.038	0.13
	(0.19)	(0.20)	(0.19)	(0.20)	(0.19)	(0.20)	(0.19)	(0.20)
log_labor	-0.0071	-0.013	-0.0016	-0.015	-0.0043	-0.029	-0.0076	-0.031
	(0.022)	(0.021)	(0.021)	(0.022)	(0.022)	(0.021)	(0.021)	(0.022)
ownership	-0.037	-0.22***	-0.12*	-0.059	-0.0091	-0.18**	-0.078	-0.021
	(0.072)	(0.073)	(0.072)	(0.073)	(0.070)	(0.071)	(0.070)	(0.071)
standalone	0.19***	0.076	0.25***	0.16***	0.18***	0.069	0.24***	0.15**
	(0.059)	(0.060)	(0.059)	(0.060)	(0.059)	(0.060)	(0.059)	(0.060)
export	-0.069	-0.023	-0.082	-0.077	-0.072	0.00074	-0.064	-0.059
	(0.064)	(0.064)	(0.063)	(0.064)	(0.064)	(0.064)	(0.063)	(0.064)
htmanuf	0.29***	0.20***	0.23***	0.21***				
	(0.078)	(0.077)	(0.076)	(0.077)				
ltmanuf	0.19***	0.033	0.070	0.052				
	(0.061)	(0.061)	(0.060)	(0.061)				
kibs					-0.095	-0.26**	-0.079	-0.31***
					(0.11)	(0.11)	(0.10)	(0.11)
tradserv					-0.27***	-0.027	-0.11*	-0.054
					(0.064)	(0.065)	(0.063)	(0.064)
Constant	0.21	-0.36**	-0.43***	-0.37**	0.42**	-0.18	-0.28*	-0.17
	(0.17)	(0.17)	(0.17)	(0.17)	(0.16)	(0.16)	(0.16)	(0.16)
atrho21	0.68***	(0.038)			0.69***	(0.038)		
atrho31	0.88***	(0.040)			0.89***	(0.040)		
atrho41	0.75***	(0.039)			0.76***	(0.039)		
atrho32	0.75***	(0.036)			0.75***	(0.036)		
atrho42	0.74***	(0.035)			0.74***	(0.035)		
atrho43	0.91***	(0.038)			0.91***	(0.038)		
Log Likelihood	-6064				-6060			
DF	36				36			
Chi2	92.4				101			
Prob>F	7.6e-07				4.6e-08			

Notes: No innovation activity is the reference category; Observations: 2,772; Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Source: Authors based on preliminary information contained in ESIDET 2010.

Table A1.4 presents the results for models where we introduced, first, manufacturing firms in low- or high-tech activities (Model 4);[19] then, firms in traditional services or in KIBS sectors (Model 5). The results document that overall, the individual coefficients for the variables on firm characteristics behave exactly as discussed thus far. It is striking to see the difference that more active innovation behavior of manufacturing firms makes relative to service firms. In particular, manufacturing firms in high-tech industries reported positive learning in all four categories of barriers included in this study, with the coefficient for cost-related factors slightly larger than those for knowledge, market, and regulatory factors. Firms in low-tech manufacturing activities reported cost of innovation as the main obstacle to innovation. By contrast, service firms continued to report negative effects in terms of both revealed and perceived barriers to innovation. Whereas KIBS firms reported knowledge and regulatory factors, firms in traditional services indicated cost and market barriers.

4.2. The Case of Service Firms

The next step was to narrow the inquiry to the innovation behavior of the subsample of 909 service firms in Mexico and the importance that such firms ascribe to the obstacles they face in order to innovate. The estimates presented in Table A1.5 document that as we move from services in general to more disaggregate definitions of firms in the sector, the learning effects are more noticeable in the case of cost, market, and regulatory barriers to innovation. Lack of statistical significance in the case of knowledge-related barriers might be a consequence of the extremely poor innovation behavior and the missed learning opportunities for service firms in Mexico.

When we entered industry dummies in an alternate way, in Models 8 and 9, we found evidence to support D'Este et al.'s (2012) view that below a certain threshold of involvement in innovation, the relationship with innovation barriers is negative or at least difficult to perceive. Revealed or learning effects from engagement in innovation increased compared to previous models. In the case of cost, market, and regulatory barriers, the threshold of positive learning begins to emerge as firms move from performing one or two innovation activities to performing

[19] We also ran models where in addition to dummies for both low- and high-technology manufacturing firms, we introduced a dummy for service firms. This specification generated multi-collinearity problems leading to the variable for high-technology manufacturing firms to drop out of the model. Because our intention is to use manufacturing firms as a benchmark for service firms we preferred the model construction presented here.

three to four. Cost and to a lesser extent regulatory barriers gained importance as firms carried out five or more innovation activities. KIBS firms are more likely to identify barriers, particularly cost-related, as effective obstacles to innovation. By contrast, KIBS firms are less likely to report revealed or learning effects associated with regulatory barriers. As expected, and similar to D'Este et al. (2012), size, as measured by the log of total employment, significantly affects perceptions of the obstacles to innovation. That is, larger firms are less likely to perceive them as relevant as compared to smaller firms.

5. Conclusions

The findings in this complementary study indicate that obstacles to innovation in Mexico tend to conform to a pattern characterized by deterring barriers (markets, cost-related and, to a much lesser extent, regulatory barriers). With respect to revealed barriers, the most visible effects were related to cost and regulation in the case of service firms. Overall, we found weak evidence to assess the conclusion of D'Este et al. (2012) on the curvilinear relationship between engagement in innovation and the importance of the obstacles to innovation, as experienced by the firm.

These results suggest that although considerable attention is usually drawn to insufficient public funding available for innovation in Mexico, increasing subsidies may not suffice to improve the country's innovation performance. The constructs used in this paper indicate the complexity and the multiplicity of factors that determine firms' perceptions of the barriers to innovation. The actual cost of innovation includes financial, organizational, and risks factors, each of which requires distinct remedial strategies. Moreover, factors that shape market and regulatory barriers are also heterogeneous. Because the responsibility and capacity to tackle many of these factors is beyond the purview of STI authorities, increased coordination is needed with other agencies of the Mexican government responsible for competition policy, government procurement, and so on. Firms that engage poorly in innovation are unlikely to identify, learn from, and categorize knowledge-related barriers to innovation.

The literature stresses the lack of interactivity within national innovation systems as a root cause of poor innovation performance in developing countries. This study provided some indirect evidence to support this argument. Firms that engage in innovation individually were more likely to rate barriers to innovation as high. Instruments intended to promote enhanced collaboration, not only among firms, but also between firms and other agents in Mexico's national system of innovation seem most pertinent.

Our study confirmed that innovation in Mexico occurs mostly among manufacturing firms, yet service firms do innovate. Unfortunately, innovation in services is still so low that manufacturing firms, particularly in high-tech industries, tend to accrue most learning or revealed effects associated with barriers to innovation.

Table A1.5. Multivariate Probit Results. Dependent Variables: Whether the Service firm Assesses at Least One Barrier Item as Highly Important, by Type of Barrier and Technological Intensity of the Industry where the Firm Belongs

	Model 6				Model 7				Model 8				Model 9			
	Cost	Knowledge	Market	Regulation	Cost	Knowledge	Market	Regulation	Cost	Knowledge	Market	Regulation	Cost	Knowledge	Market	Regulation
1-2	0.32	-0.21	0.10	-0.073	0.28	-0.13	0.095	0.050	0.16	-0.11	0.16	0.012	0.15	-0.12	0.15	-0.009
	(0.23)	(0.22)	(0.21)	(0.22)	(0.24)	(0.23)	(0.22)	(0.23)	(0.21)	(0.19)	(0.20)	(0.19)	(0.21)	(0.19)	(0.20)	(0.19)
3-4	0.98**	0.25	0.82***	0.074	0.96**	0.28	0.81***	0.12	0.97**	0.37	0.81***	0.46*	0.96**	0.37	0.81***	0.45*
	(0.39)	(0.32)	(0.31)	(0.33)	(0.39)	(0.31)	(0.31)	(0.32)	(0.39)	(0.26)	(0.29)	(0.26)	(0.39)	(0.27)	(0.29)	(0.26)
5-8	0.57	0.26	0.25	0.55	0.52	0.35	0.27	0.61*	0.81**	0.032	-0.15	0.40	0.80*	0.020	-0.17	0.39
	(0.35)	(0.35)	(0.32)	(0.36)	(0.36)	(0.36)	(0.33)	(0.34)	(0.41)	(0.34)	(0.35)	(0.33)	(0.42)	(0.34)	(0.35)	(0.34)
log_labor	-0.0039	-0.018	-0.027	-0.046	0.0078	-0.038	-0.027	-0.072**	-0.043	-0.0052	-0.052	-0.089***	-0.040	-0.0024	-0.048	-0.083**
	(0.031)	(0.031)	(0.031)	(0.032)	(0.033)	(0.033)	(0.033)	(0.034)	(0.033)	(0.032)	(0.032)	(0.033)	(0.033)	(0.032)	(0.032)	(0.033)
ownership	-0.028	-0.22	-0.076	0.047	-0.013	-0.23	-0.081	0.058	-0.035	-0.18	0.099	0.090	-0.032	-0.18	0.10	0.089
	(0.14)	(0.15)	(0.15)	(0.14)	(0.14)	(0.15)	(0.15)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
standalone	0.17*	0.096	0.27***	0.11	0.16*	0.12	0.28***	0.14	0.068	0.043	0.21**	0.030	0.066	0.041	0.21**	0.025
	(0.097)	(0.10)	(0.099)	(0.10)	(0.097)	(0.10)	(0.100)	(0.10)	(0.098)	(0.096)	(0.097)	(0.097)	(0.098)	(0.096)	(0.097)	(0.097)
export	0.064	0.22	-0.081	0.073	0.019	0.26*	-0.056	0.083	0.061	0.20	-0.058	0.055	0.050	0.20	-0.070	0.053
	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
kibs					-0.55	-0.16	0.21	-0.78**	0.049	0.011	0.068	-0.22*				
					(0.43)	(0.36)	(0.39)	(0.36)	(0.12)	(0.12)	(0.12)	(0.12)				
tradserv					-0.68	0.10	0.22	-0.45					-0.095	-0.045	-0.11	0.15
					(0.42)	(0.35)	(0.38)	(0.35)					(0.12)	(0.11)	(0.11)	(0.12)
Constant	0.14	-0.37	-0.30	-0.16	0.72	-0.30	-0.51	0.50	0.55**	-0.051	0.15	0.76***	0.62**	-0.031	0.23	0.56**
	(0.24)	(0.24)	(0.25)	(0.25)	(0.48)	(0.43)	(0.44)	(0.43)	(0.26)	(0.26)	(0.25)	(0.26)	(0.25)	(0.24)	(0.24)	(0.24)
atrho21	0.82***	(0.069)			0.83***	(0.070)			0.92***	(0.067)			0.92***	(0.067)		
atrho31	1.03***	(0.076)			1.04***	(0.076)			0.81***	(0.064)			0.81***	(0.064)		
atrho41	0.85***	(0.069)			0.86***	(0.070)			0.94***	(0.067)			0.94***	(0.067)		
atrho32	0.80***	(0.063)			0.80***	(0.064)			0.88***	(0.064)			0.88***	(0.064)		
atrho42	0.88***	(0.064)			0.87***	(0.065)			0.91***	(0.064)			0.91***	(0.064)		
atrho43	0.97***	(0.069)			0.99***	(0.069)			1.02***	(0.067)			1.02***	(0.068)		
Log Likelihood	-1930				-1917				-1967				-1968			
DF	28				36				32				32			
Chi2	38.8				61.8				58.4				57.1			
Prob>F	0.084				0.0047				0.0030				0.0041			

Notes: No innovation activity is the reference category; Observations: 909; Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Source: Authors based on preliminary information contained in ESIDET 2010.

Appendix A2 Variables in ESIDET 2010 Used for the Empirical Analysis in this Study

Table A2

Variable	Description	Mean	St. Dev	Min	Max
	Barriers to innovation				
Cost-related					
obst_eco_risk	The firm reports excessive economic risks as barrier to innovation according to its importance: 1 none, 2 not important, 3 moderate, 4 high	3.023	1.070	1	4
obst_innov_cost	The firm reports the cost of the innovation process as barrier to innovation according to its importance: 1 none, 2 not important, 3 moderate, 4 high	3.086	1.057	1	4
obst_innov_finance	The firm reports inadequate funding as barrier to innovation according to its importance: 1 none, 2 not important, 3 moderate, 4 high	2.814	1.124	1	4
obst_innov_organiz	The firm reports organizational rigidities as barrier to innovation according to its importance: 1 none, 2 not important, 3 moderate, 4 high	2.403	1.081	1	4
Knowledge related					
obst_innov_labqualif	The firm reports insufficient qualification of the labor force as barrier to innovation and its importance: 1 none, 2 not important, 3 moderate, 4 high	2.490	1.107	1	4
obst_innov_infotech	The firm reports insufficient information about technology as barrier to innovation and its importance: 1 none, 2 not important, 3 moderate, 4 high	2.452	1.122	1	4
obst_innov_infomakt	The firm reports insufficient information about the market as barrier to innovation and its importance: 1 none, 2 not important, 3 moderate, 4 high	2.401	1.121	1	4
Market related					
obst_innov_demand	The firm reports insufficient knowledge about the market demand as barrier to innovation and its importance: 1 none, 2 not important, 3 moderate, 4 high	2.460	1.106	1	4
obst_innov_pubsupp	The firm reports the lack of public support as barrier to innovation according to its importance: 1 none, 2 not important, 3 moderate, 4	2.584	1.184	1	4

	high				
Regulation related					
obst_innov_regul	The firm reports insufficient demand for new products or services as barrier to innovation and its importance: 1 none, 2 not important, 3 moderate, 4 high	2.720	1.173	1	4
	Innovation activities				
machinery_learn	1 if the firm reported acquisition of other external technologies linked to innovation activities; 0 otherwise	0.070	0.255	1	0
external_mach_learn	1 if the firm reported as learning strategy the acquisition of machinery and equipment from external sources.; 0 otherwise	0.018	0.133	1	0
training_learn	1 if the firm the provision of training linked to innovation activities; 0 otherwise	0.051	0.219	0	1
launchmkt_innov09	1 if the firm preparatory processes leading to the launching of innovations into the market; 0 otherwise	0.063	0.244	0	1
rd_innov09	1 if the firm performed research and development; 0 otherwise	0.022	0.146	0	1
design_learn	1 if the firm reported industrial design or prototyping of new or improved processes or products; 0 otherwise	0.030	0.171	0	1
software_learn	1 if the firm reported purchase of software; 0 otherwise	0.031	0.172	0	1
delivery_learn	1 if the firm reported logistics underpinning the introduction of a new services or new or improved delivery systems; 0 otherwise	0.017	0.128	0	1

Source: Authors based on preliminary information contained in ESIDET 2010.

Appendix A3. Correlation Analysis of the Variables Included in this Paper

Table A3

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1)	Cost factor	1																
(2)	Knowledge factor	**0.35**	1															
(3)	Market factor	**0.45**	**0.43**	1														
(4)	Regulation factor	**0.39**	**0.42**	**0.50**	1													
(5)	zero	-0.02	0.01	-0.01	0.03	1												
(6)	1-2	**0.03**	0.00	-0.01	-0.02	**-0.80**	1											
(7)	3-4	-0.00	-0.01	0.03	**-0.03**	**-0.45**	**-0.05**	1										
(8)	5-8	-0.02	-0.01	-0.00	0.01	**-0.32**	**-0.04**	-0.02	1									
(9)	log_labor	**-0.031**	-0.03	-0.03	**-0.03**	**0.04**	**-0.05**	0.02	-0.00	1								
(10)	ownership	**-0.031**	**-0.07**	**-0.08**	**-0.04**	-0.02	0.02	-0.01	0.01	**0.05**	1							
(11)	standalone	**0.07**	**0.06**	**0.11**	**0.07**	**0.09**	**-0.05**	**-0.07**	**-0.04**	**-0.14**	**-0.51**	1						
(12)	export	-0.01	**-0.04**	**-0.06**	**-0.04**	**-0.17**	**0.14**	**0.08**	**0.04**	**0.04**	**0.53**	**-0.37**	1					
(13)	services	**-0.07**	-0.00	-0.01	-0.01	**0.13**	**-0.12**	**-0.04**	-0.02	**0.10**	**-0.27**	**0.15**	**-0.44**	1				
(14)	htmanuf	**0.03**	0.02	0.01	0.02	**-0.13**	**0.13**	**0.06**	0.00	**-0.11**	**0.43**	**-0.28**	**0.41**	**-0.42**	1			
(15)	ltmanuf	0.04	-0.01	-0.00	-0.01	-0.01	0.01	-0.01	0.01	0.01	**-0.12**	**0.11**	**0.05**	**-0.58**	**-0.51**	1		
(16)	kibs	0.01	**-0.03**	0.01	**-0.04**	-0.02	0.01	-0.00	0.03	**-0.16**	**-0.11**	**0.10**	**-0.12**	**0.37**	**-0.16**	**-0.22**	1	
(17)	tradserv	**-0.08**	0.02	-0.01	0.01	**0.15**	**-0.14**	**-0.05**	**-0.04**	**0.20**	**-0.23**	**0.10**	**-0.40**	**0.85**	**-0.36**	**-0.49**	**-0.15**	1

Notes: Figures in bold are significant at the 10 percent or lower.
Source: Authors with preliminary information from ESIDET 2010.

Appendix A4. Bias Analysis

Table A4

	Percent of firms by subsector type and size CENSO 2009	Percent of firms by subsector type and size ESIDET 2010	Recommendation
services	**60.4 percent**	**32.0 percent**	
KIBS	**16.8 percent**	**14.4 percent**	
From 21 to 30 employees	27.4 percent	2.5 percent	Include more firms of less than 250 employees in the sample design for KIBS
From 31 to 50 employees	23.6 percent	2.5 percent	
From 51 to 100 employees	19.7 percent	2.5 percent	
From 101 to 250 employees	16.9 percent	6.1 percent	
From 251 to 500 employees	6.5 percent	6.9 percent	
From 501 to 1000 employees	3.4 percent	20.4 percent	
1001 or more employees	2.6 percent	59.0 percent	
Traditional services	**43.6 percent**	**17.6 percent**	
From 21 to 30 employees	36.4 percent	0.6 percent	Include more firms of less than 100 employees in the sample design for traditional services
From 31 to 50 employees	28.9 percent	0.0 percent	
From 51 to 100 employees	20.8 percent	2.3 percent	
From 101 to 250 employees	9.3 percent	4.4 percent	
From 251 to 500 employees	2.8 percent	9.6 percent	
From 501 to 1000 employees	1.0 percent	20.9 percent	
1001 or more employees	0.8 percent	62.2 percent	
Manufacturing	**39.6 percent**	**68.0 percent**	
Manufacturing high-tech	**9.8 percent**	**18.2 percent**	Include more firms of less than 250 employees in the sample design for manufacturing high tech, at the expense of large firms
From 21 to 30 employees	19.6 percent	0.4 percent	
From 31 to 50 employees	19.2 percent	0.6 percent	
From 51 to 100 employees	21.4 percent	2.6 percent	
From 101 to 250 employees	19.2 percent	7.3 percent	

From 251 to 500 employees	10.0 percent	11.9 percent	
From 501 to 1000 employees	6.5 percent	26.8 percent	
1001 or more employees	4.1 percent	50.4 percent	
Manufacturing low-tech	**29.8 percent**	**49.8 percent**	
From 21 to 30 employees	25.9 percent	0.7 percent	Include more firms of less than 250 employees in the sample design for manufacturing high tech, at the expense of large firms
From 31 to 50 employees	22.2 percent	0.5 percent	
From 51 to 100 employees	20.7 percent	1.3 percent	
From 101 to 250 employees	16.6 percent	5.1 percent	
From 251 to 500 employees	8.2 percent	12.5 percent	
From 501 to 1000 employees	4.2 percent	31.1 percent	
1001 or more employees	2.2 percent	48.9 percent	
Total	**100.0 percent**	**100.0 percent**	

Source: Own elaboration based on CENSO (2009) and ESIDET 2010.

Appendix A5. Descriptive Statistics

Table A5.1 Policy-Relevant Characteristics, Service Sector

	N	International markets (10)	Co-operated with foreign partners (11)	Co-operated (12)	Co-operated with Universities or Gov. (13)	Public Support (14)	Applied for patents (15)
All service Industry	16936	0.09	0.00	0.01	0.01	0.10	0.00
KIBS	3038	0.37	0.13	0.26	0.17	0.50	0.17
Traditional	13797	1.57	0.00	0.10	0.10	1.34	0.00
National	16222	0.08	0.00	0.01	0.01	0.09	0.00
Foreign	714	0.48	0.04	0.14	0.11	0.29	0.00
All Manuf. Industry	14491	0.28	0.01	0.02	0.02	0.12	0.01
Low Tech. Manuf.	11992	0.22	0.01	0.02	0.01	0.10	0.01
High Tech Manuf.	2499	0.55	0.01	0.05	0.03	0.22	0.02
National	12459	0.19	0.01	0.02	0.01	0.12	0.02
Foreign	2032	0.82	0.02	0.05	0.03	0.13	0.01

(10) Share of firms that were active on international markets
(11) Share of firms that cooperated with foreign partners on innovation
(12) Share of firms that cooperated on innovation activities
(13) Share of firms that cooperated with universities/higher education or government research institutes
(14) Share of firms that received public financial support for innovation
(15) Share of firms that applied for one or more patents
Source: Authors based on information contained in ESIDET 2010.

Table A5.2 Policy-Relevant Characteristics, Service Sector by Subsectors

	N	ISIC	International markets (10)	Co-operated with foreign partners (11)	Co-operated (12)	Co-operated with Universities or Gov. (13)	Public Support (14)	Applied for patents (15)
All service Industry	16936		9.27 percent	0.17 percent	1.18 percent	1.02 percent	10.03 percent	0.03 percent
KIBS								
Licensing	1	53	0.00 percent	0.00 percent	0.00 percent	0.00 percent	0.00 percent	0.00 percent
Professional services	2933	54	16.52 percent	0.00 percent	3.05 percent	3.05 percent	30.82 percent	0.00 percent
R&D-related services	25	54	18.14 percent	13.09 percent	21.53 percent	12.38 percent	16.60 percent	17.31 percent
Corporate services	79	55	2.53 percent	0.00 percent	1.27 percent	1.27 percent	2.53 percent	0.00 percent
Subtotal	3038		16.16 percent	0.11 percent	3.15 percent	3.08 percent	29.96 percent	0.14 percent
Traditional services								
Wholesale trade	116	43	64.42 percent	0.00 percent	0.00 percent	0.00 percent	35.58 percent	0.00 percent
Transport, port and warehouse	3671	48-49	3.04 percent	0.00 percent	0.03 percent	0.03 percent	2.44 percent	0.00 percent
Information services	106	51	4.26 percent	0.00 percent	0.00 percent	0.00 percent	1.42 percent	0.00 percent
Financial services	923	52	0.95 percent	0.00 percent	0.00 percent	0.00 percent	5.40 percent	0.11 percent
Real estate	497	53	17.72 percent	0.00 percent	0.00 percent	0.00 percent	19.87 percent	0.00 percent
Business support	2238	56	7.17 percent	0.04 percent	3.44 percent	3.44 percent	9.72 percent	0.00 percent
Leisure services	16	71	0.00 percent	0.00 percent	6.13 percent	6.13 percent	6.13 percent	0.00 percent
Hotels and restaurants	6228	72	9.86 percent	0.00 percent	0.00 percent	0.00 percent	3.30 percent	0.00 percent
Other	2	81	50.00 percent	0.00 percent	0.00 percent	0.00 percent	50.00 percent	0.00 percent
Subtotal	13797		7.71 percent	0.01 percent	0.57 percent	0.57 percent	5.11 percent	0.01 percent
National and Foreign Capital								
National	16222		7.59 percent	0.02 percent	0.60 percent	0.59 percent	9.19 percent	0.03 percent
Foreign	714		47.65 percent	3.57 percent	14.35 percent	10.78 percent	29.26 percent	0.00 percent

(10) Share of firms that were active on international markets
(11) Share of firms that cooperated with foreign partners on innovation
(12) Share of firms that cooperated on innovation activities
(13) Share of firms that cooperated with universities/higher education or government research institutes
(14) Share of firms that received public financial support for innovation
(15) Share of firms that applied for one or more patents
Source: Authors based on information contained in ESIDET 2010.

Table A5.3 Policy-Relevant Characteristics, Manufacturing Sector

	N	ISIC	International markets (10)	Cooperated with foreign partners (11)	Cooperated (12)	Cooperated with Universities or Gov. (13)	Public Support (14)	Applied for patents (15)
All Manuf. Industry	14491		27.99 percent	0.77 percent	2.38 percent	1.65 percent	11.96 percent	1.43 percent
Low Tech. Manuf.	11992	15, 16, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 351, 36 y 37.	22.37 percent	0.64 percent	1.81 percent	1.36 percent	9.83 percent	1.37 percent
High Tech Manuf.	2499	24, 29, 30, 31, 32, 33, 34 y 35 (except 351)	54.95 percent	1.36 percent	5.07 percent	3.02 percent	22.20 percent	1.70 percent
National and Foreign Capital								
National	12459		19.20 percent	0.64 percent	1.93 percent	1.42 percent	11.80 percent	1.55 percent
Foreign	2032		81.84 percent	1.56 percent	5.09 percent	3.05 percent	12.94 percent	0.65 percent

(10) Share of firms that were active on international markets
(11) Share of firms that cooperated with foreign partners on innovation
(12) Share of firms that cooperated on innovation activities
(13) Share of firms that cooperated with universities/higher education or government research institutes
(14) Share of firms that received public financial support for innovation
(15) Share of firms that applied for one or more patents
Source: Authors based on information contained in ESIDET 2010.

Table A5.4 Innovation Behavior, Service Sector by Subsectors

			Technological Innovation					Non-Technological Innovation				
	N	ISIC	Product	Process	Innovative firms (1)	In-house tech-innov	New to market (2)	Organization	Marketing	Non-Tech innovation (3)	Any innovation (4)	Tech and non-tech innovation (5)
All service Industry	16936		797.39	468.62	828.44	616.69	414.88	7550.69	3650.69	8190.23	8200.74	817.93
KIBS												
Licensing	1	53	0	0	0	0	0	0	0	0	0	0
Professional services	2933	54	438.31	210.56	454.79	375.66	185.53	1738.87	620.75	1829.83	1836.27	448.35
R&D-related services	25	54	6.71	5.46	7.78	4.39	4.21	11.06	4.39	11.06	13.13	5.71
Corporate services	79	55	1	1	1	1	0	3	2	3	3	1
Subtotal	3038		446.02	217.02	463.57	381.05	189.74	1752.93	627.14	1843.89	1852.4	455.06
Traditional services												
Wholesale trade	116	43	74.94	74.94	74.94	41.39	0	116.33	0	116.33	116.33	74.94
Transport, port and warehouse	3671	48-49	63.84	27.26	66.84	2	65.84	1202.6	686.89	1408.24	1408.24	66.84
Information services	106	51	0	10.5	10.5	11.5	0	76.36	44.75	86.86	86.86	10.5
Financial services	923	52	32.13	4	32.13	1	23.4	479.88	140.3	480.88	481.88	31.13
Real estate	497	53	0	0	0	0	0	199.54	39.1	199.54	199.54	0
Business support	2238	56	121.6	94.34	121.6	94.34	94.34	1060.24	506.79	1078.64	1078.64	121.6
Leisure services	16	71	0	0	0	1	0	16.3	15.3	16.3	16.3	0
Hotels and restaurants	6228	72	32.6	16.3	32.6	1	17.3	2561.1	1589.42	2874.14	2875.14	31.6
Other	2	81	1	0	1	1	0	2	1	2	2	1
Subtotal	13797		326.11	227.34	339.61	153.23	200.88	5714.35	3023.55	6262.93	6264.93	337.61
National and Foreign Capital												
National	16222		676	350	706	561	370	7105	3497	7717	7727	696
Foreign	714		122	119	123	56	45	445	154	473	474	122

(1) Product or process innovation
(2) New to Market product innovation
(3) Organization or marketing innovation
(4) Technological or non-technological innovation
(5) Technological and non-technological innovation
Source: Authors based on information contained in ESIDET (2010).

Table A5.5 Innovation Behavior, Manufacturing Sector

	N	ISIC	Technological Innovation: Product	Process	Innovative firms (1)	In-house tech-innov	New to market (2)	Non-Technological Innovation: Organization	Marketing	Non-tech innovation (3)	Any innovation (4)	Tech and non-tech innovation (5)
All Manuf. Industry	14491		1669	1048	1885	1290	942	6024	3655	6671	7100	1456
Low Tech. Manuf.	11992	15, 16, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 351, 36 y 37.	1136	762	1316	732	727	4719	2825	5237	5580	973
High Tech Manuf.	2499	24, 29, 30, 31, 32, 33, 34 y 35 (except 351)	5323	286	569	558	214	1305	830	1434	1520	483
National and Foreign Capital												
National	12459		1400	895	1596	1043	807	5231	3285	5813	6185	1224
Foreign	2032		269	153	290	247	135	793	370	858	915	233

(1) Product or process innovation
(2) New to Market product innovation
(3) Organization or marketing innovation
(4) Technological or non-technological innovation
(5) Technological and non-technological innovation
Source: Authors based on information contained in ESIDET 2010.

Table A5.6 Inputs and Outputs of Innovation, Service Sector by Subsectors

	N	ISIC	Inputs: Expenditure on innovation (6)	Inputs: R&D (7)	Inputs: Machinery Acquisition (8)	Inputs: Other Innovation activities (9)	Inputs: Firms that performed R&D	Inputs: Firms that performed R&D on a continuous basis	Outputs: Turnover from product innovations	Outputs: Turnover from new to market product innovations
All service Industry	16936		0.30 percent	40.95 percent	45.04 percent	14.01 percent	256.67		7800	3242
KIBS										
Licensing	1	53	0.00 percent	0.00 percent	0.00 percent	0.00 percent	0		0	0
Professional services	2933	54	0.16 percent	18.05 percent	48.38 percent	33.56 percent	27.23		2400	875
R&D-related services	25	54	6.86 percent	12.03 percent	71.61 percent	16.36 percent	5.64		700	295
Corporate services	79	55	0.00 percent	60.34 percent	0.00 percent	39.66 percent	1		0	0
Subtotal	3038		0.23 percent	16.10 percent	55.92 percent	27.98 percent	33.87		3100	1170
Traditional services										
Wholesale trade	116	43	1.50 percent	40.69 percent	18.62 percent	40.69 percent	74.94		100	0
Transport, port and warehouse	3671	48-49	0.01 percent	25.65 percent	46.31 percent	28.03 percent	26.26		900	630
Information services	106	51	0.07 percent	0.00 percent	22.24 percent	77.76 percent	0		300	108
Financial services	923	52	0.13 percent	22.32 percent	20.83 percent	56.84 percent	2		900	319
Real estate	497	53	0.00 percent	0.00 percent	100.00 percent	0.00 percent	0		100	100
Business support	2238	56	0.45 percent	29.83 percent	60.60 percent	9.58 percent	93.34		1300	570
Leisure services	16	71	0.24 percent	100.00 percent	0.00 percent	0.00 percent	0		100	50
Hotels and restaurants	6228	72	0.02 percent	14.25 percent	38.64 percent	47.10 percent	1		600	171
Other	2	81	11.39 percent	70.87 percent	12.62 percent	16.50 percent	1		100	10

	N	ISIC	Inputs						Outputs	
			Expenditure on innovation (6)	**R&D (7)**	**Machinery Acquisition (8)**	**Other Innovation activities (9)**	**Firms that performed R&D**	**Firms that performed R&D on a continuous basis**	**Turnover from product innovations**	**Turnover from new to market product innovations**
Subtotal	13797		0.16 percent	30.71 percent	40.60 percent	28.69 percent	198.54		4500	1968
					National and Foreign Capital					
National	16222		0.15 percent	22.74 percent	55.15 percent	22.11 percent	152.22		6500	2840
Foreign	714		0.29 percent	46.14 percent	18.85 percent	35.01 percent	104.45		1300	402

(6) Total expenditures on innovation (as a percent of total turnover)
(7) Expenditure on R&D as a percent of total expenditure on innovation
(8) Expenditure on machinery acquisition as a percent of total expenditure on innovation
(9) Expenditure on the rest of innovation activities as a percent of total expenditure on innovation
Source: Authors based on information contained in ESIDET 2010.

Table A5.7 Inputs and Outputs of Innovation, Manufacturing Sector

	N	ISIC	Inputs						Outputs	
			Expenditure on innovation (6)	R&D (7)	Machinery acquisition (8)	Other innovation activities (9)	Firms that performed R&D	Firms that performed R&D on a continuous basis	Turnover from product innovations	Turnover from new to market product innovations
All Manuf. Industry	14491		0.48%	53.99%	31.37%	14.64%	767.13		39700	11382
Low Tech. Manuf.	11992	15, 16, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 351, 36 y 37.	0.27%	27.29%	53.53%	19.18%	466.78		19700	5422
High Tech Manuf.	2499	24, 29, 30, 31, 32, 33, 34 y 35 (except 351)	0.72%	65.72 %	21.63%	12.64%	300.35		20000	5960
National and Foreign Capital										
National	12459		0.59%	62.97%	24.75%	12.28%	633.32		25500	7216
Foreign	2032		0.35%	37.00%	43.90%	19.10%	133.81		14200	4166

(6) Total expenditures on innovation (as a percent of total turnover)
(7) Expenditure on R&D as a percent of total expenditure on innovation
(8) Expenditure on machinery acquisition as a percent of total expenditure on innovation
(9) Expenditure on the rest of innovation activities as a percent of total expenditure on innovation
Source: Authors based on information contained in ESIDET 2010.