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# Firm Size, Knowledge Intensity and Employment Generation

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**Innovation, Firm Size, Knowledge Intensity, and Employment Generation**

**The Microeconometric Evidence for the Service Sector in Uruguay**[1]

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## Abstract

The employment impact of innovation in the heterogeneous universe of services was studied using data from the 2004–09 Uruguayan service innovation surveys. The empirical evidence shows that the impact of product innovation on employment is positive, while process innovation appears to have no effect. The effect varies according to the skill level of the labor force, across sectors, and the type of innovation strategy pursued by firms. Process innovation activities tend to substitute low-skilled jobs with higher-skilled jobs, while product innovation allows for more gains in efficiency in the production of new products with unskilled labor and no gains with the skilled labor force. Producing technology in-house has in most cases no impact on employment, while the combined strategy of acquiring technology outside the firm and producing it in-house has strong positive effects. The results found for knowledge-intensive business services and small firms, with some exceptions, are similar to the ones found for whole sample.

**Keywords:** service sector, innovation, innovation strategies, firm size, knowledge intensity, employment quantity and quality, innovation surveys, Uruguay.
**JEL codes:** D2, J23, L8, O31, O33.

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## 1. Introduction

The service sector is one of the sectors that contributes the most to production and employment in Uruguay, as it is in more developed economies. Today, the service sector is a major component of advanced economies, accounting for between 50 and 75 percent of jobs and value-added in most OECD countries (OECD, 2000a). Innovation in the service sector, like in the manufacturing sector, is considered a key driver of sustained economic growth.

Despite the increasing role of the service sector in these economies, it has been traditionally considered a lagging sector in terms of capacity for innovation. Policy instruments and innovation strategies have been concentrated in the manufacturing sector, relegating the service sector to a second or third order of importance with respect to innovation policy in the global economy. However, recent studies on developed countries confirm that services are more innovative than previously thought (Evangelista and Savona, 2003; Harrison et al., 2008), and that some service subsectors are even more innovative than the manufacturing sector (Bogliacino, Lucchese, and Pianta, 2007). Therefore, there is a growing interest in the study of innovation in the service sector, particularly its importance as an engine of economic growth.

Technology and innovation are increasingly recognized as major forces behind the growth of services. Information and communication technologies (ICTs) are playing a pivotal role in revolutionizing the ways in which most "traditional" services are produced, traded, and delivered.

Some common features distinguish the service sector from others: low levels of capital equipment; discontinuous production processes; a limited role for economies of scale; the immaterial and information-intensive nature of the product, which makes storage and transportation difficult; high participation of small and medium-size firms (SMEs); the fundamental role of service delivery; and the close interaction between production and consumption over time and space. Additionally, the sector is characterized by diversity in its composition, both in relation to the size and type of activities and their dynamics. Because of these features, the overall impact of technological change on employment in services is very difficult to assess empirically. This may partially explain the limited number of empirical studies (relative to studies on manufacturing) that have been conducted.

Empirical papers for OECD countries show that product innovation is generally associated with employment growth in the service sector, while process innovation tends to have negative or no effect (Dachs and Peters, 2011; Evangelista and Vezzani, 2010; Harrison et al., 2008; Peters, 2004; Evangelista and Savona, 2003). There is some evidence that foreign-owned firms suffer higher employment losses than domestically owned ones as a consequence of innovation activities (Dachs and Peters, 2011). The introduction of new technologies tends to privilege the use of skilled workers and to make previous professions and skills obsolete. In this sense, innovation seems to be skill biased (Evangelista and Savona, 2003; OECD, 1996).

This paper analyzes the impact of innovation on employment in the service sector in Uruguay. Using empirical evidence, it examines the nature of innovation activities in the service sector and their impact on employment. The empirical evidence is based on data from innovation surveys carried out in Uruguay by the National Statistics Bureau (INE) in collaboration with the National Agency for Research and Innovation (ANII). The paper reviews two waves of service innovation surveys: 2004–06 and 2007–09.

The results of the analysis indicate that product innovations are an important source of firm-level employment growth. Process innovations, which are likely to be associated with price reductions, tend to have negative or no effects on employment depending on the composition of the labor force. Process innovation tends to have displacement effects on unskilled labor but no impact on the skilled labor force. In the case of small firms, process innovation tends to have a weak positive effect on employment (at 10 percent confidence level and in 2 out of 3 regressions). Product innovation is more complementary to skilled than to unskilled labor. Different innovation strategies have different impacts on employment and employment composition. The in-house production of technology strategy has no effect on employment, while acquiring technology externally tends to have the biggest effect. Results are in general similar for small firms and knowledge-intensive business services (KIBS).

This paper is structured as follows: the next section provides an overview of the service sector in Uruguay, while Section 3 presents the conceptual framework and the main results. In subsection 3.1 we discuss the heterogeneous and sector-specific nature of innovation within services. Subsections 3.2 to 3.4 contain an empirical assessment of the employment impact of innovation, exploring the quantity and quality aspects of employment and the impact of innovation associated with different types of firm strategies. In every section we explore the differential impact of innovation on employment of KIBS and small firms. The final section summarizes the main results presented in the paper.

## 2. The Service Sector in Uruguay

The service sector is one of the major contributors to output and employment in Uruguay. In the last five years, it has represented approximately 60 percent of GDP and employs more than 70 percent of the total workforce. During this period of intense dynamism of the economy (which has grown at an annual rate of 6.2 percent), the rate of growth of the sector has been even higher (average annual growth rate of 7 percent).

Both, the employment and the output of the service sector are relatively concentrated. Half the GDP of the sector is composed of three subsectors: retail, communications, and real estate rental and business. The same applies to employment: two sectors—retail and professional services and domestic household services—account for 50 percent of total employment in services.

Because innovation surveys in Uruguay do not cover the universe of the service sector, the analysis and results found in this paper cannot be considered representative of the entire sector. However, the weight of the subsectors considered here is significant in terms of output and employment, representing more than 50 percent of GDP and 33 percent of employment of the sector (see Table 1).

The subsectors covered by the innovation surveys (ISIC Rev. 3) are electricity, gas, steam and hot water; water collection, purification, and distribution; hotels and restaurants; land transport; water transport; air transport; auxiliary transport activities; post and telecommunications; machinery and equipment rentals; informatics and related activities; research and development; business services; and activities related to human health.

**Table 1. Contribution of the Service Sector to GDP and Employment in Uruguay (average years 2005–09)**

| | GDP | Employment |
|---|---|---|
| ***Services sector/total economy (%)*** <br> ***Subsectors as a % of the services sector*** | **59.2** | **73.5** |
| Electricity, gas and water | 3.5 | 1.2 |
| Retail | 18.7 | 27.6 |
| Hotels and restaurants | 4.6 | 3.9 |
| Transport, Communications | 12.9 | 8.1 |
| Financial intermediation | 7.9 | 2.4 |
| Real estate, renting and business | 23.4 | 9.7 |
| Public administration and defense | 8.5 | 9.7 |
| Education | 6.3 | 8.1 |
| Activities related to human health | 8.1 | 10.0 |
| Professional services and domestic household serv. | 6.1 | 19.2 |
| ***Sectors covered by SIS (a)/Total services sector*** | **52.5** | **33.0** |

(a) including real state.
Source: ECH-INE, BCU.

These subsectors were chosen using two criteria. First, knowledge-intensive services had to be well represented in the sample, in particular the high-tech ones (such as post and telecommunications, informatics, and research and development), the knowledge-intensive market services (air or water transportation, business services, and machinery and equipment rentals), and other knowledge-intensive services (activities related to human health). Second, the selection sought to include subsectors considered important for Uruguay's economic development, such as those related to tourism (restaurants and hotels, and transportation), and electricity, gas, steam, and hot water and water collection, purification, and distribution. It should be noted that the criteria used for selecting subsectors may have introduced a bias in the results obtained in terms of innovation.

## 3. Innovation in the Service Sector

In general, innovation policies have focused on the manufacturing sector, relegating services to second or third order of importance. Thus, the theoretical and empirical research on services innovation is still nascent.

Innovation in the service sector differs from innovation in the manufacturing sector. Innovation in services is often concerned with changes in organization, delivery, and variety, factors that are often linked to the adoption of ICTs. As a result, it is more difficult to clearly identify new products and to distinguish product innovations from process innovations in the service sector than in the manufacturing sector.

Two features distinguish many of the activities of the sector: their intangibility and their interactivity, in the sense that production and consumption occur simultaneously. Additionally, the sector is characterized as being particularly diverse in its composition, both in relation to the size and structure of the types of activities that firms carry out. These features permeate the process of innovation in the service sector, as well as its role as articulator in the global process of innovation.[3]

### *3.1 Conceptual Framework*

Measuring the process of innovation in the service sector is particularly difficult because of these peculiarities (Clayton, 2003). Moreover, due to the paucity of research in this area, the conceptual frameworks followed by services innovation surveys are based, methodologically and conceptually, on the frameworks used to analyze innovation in manufacturing, on which more theoretical and empirical research has been conducted.

Smith (2005) notes that the formats of innovation surveys for the service sector, although relatively illustrative of the process of innovation, are problematic and require further study. One problem worth mentioning is the underreporting of innovation in services, as indicated by Miles on R&D (Miles, 2004, 2005). Miles points out that, as distinct from manufacturing entrepreneurs, service entrepreneurs do not include their creative activities in that category (particularly product innovation). In addition, as Triplett and Bosworth (2003) note, (and previously Griliches, 1994) there are significant problems in service industries in measuring prices and estimating adjusted services outputs. The difficulty of specifying the concept of output limits the validity of deflators (Triplett and Bosworth, 2003). Griliches points out that in many of these industries, the transaction was not quite clear, and when it was, the transactions were so heterogeneous that they presented enormous quality change problems.

The literature has characterized innovation in different ways. Barras (1986) and OECD (2001b) characterize the process of service innovation as a "reverse product cycle."[4] in which a

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[3] As Miles (2001) notes, research on innovation in the service sector can shed light on the process of innovation throughout the entire economy.

[4] Reverse product cycle refers to the "standard product cycle theory" of Utterback and Abernathy (1975) of manufacturing firms. These authors provide a model to understand the pattern of many industrial innovation processes. They suggest that when a new technological paradigm emerges, manufacturing firms introduce new

firm first adopts new technology (e.g., ICT) to improve the efficiency of an existing process; next, the improved process generates a significant improvement in the quality and delivery of the services provided; and finally, the new technology provides the basis for an entirely new service, usually in a different field.

Gallouj (1997) distinguishes among four types of innovation: product innovation, process innovation, organizational innovation, and market innovation. Gallouj, among others, highlights the latter two as being most pronounced in the service sector. In particular, many view organizational innovation as being more prominent in services than in manufacturing.

This paper classifies innovation in the service sector as either product innovation or process, or organizational, innovation (the latter category is referred to herein as process innovation, for simplicity) as Aboal et al. (2011) have done for the manufacturing sector.

As in Aboal et al. (2011), we will use the model presented by Harrison et al. (2008). In this model, employment growth is determined by (i) the rate of change in efficiency in the production of old products (which affects it negatively), (ii) the rate of growth of production of old products (positive effect), (iii) the expansion in the production due to new products (positive effect), and iv) the change in efficiency due to process innovation (negative effect).

$$(1) \quad l = \alpha_0 + \alpha_1 d + g_1 + \beta g_2 + \mu$$

where

$l$: employment growth rate

$d$: dummy variable indicating process innovation

$g_1$: nominal growth rate of sales due to old products

$g_2$: nominal growth in sales due to new products (computed as new sales to total sales of previous period)[5]

$\alpha_0$: parameter, (minus) average efficiency growth in the production of old products

$\alpha_1$: parameter, average efficiency growth for process innovations

$\beta$: parameter, relative efficiency of the production of old and new products

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products strongly driven by the demand for new product features. After the emergence of a dominant design and increasing market demand, process innovations are stimulated while product innovation activity diminishes.

[5] By definition, all the sales of the previous period are old in the current period. Therefore, it is not possible to compute the growth rate of nominal sales of new products.

$\mu$: unobserved disturbance; which includes productivity shocks, change in prices of old products, change in prices of new prices with respect to old ones, and change in production of new products. This equation has already been transformed (see Harrison et al., 2008) in order to use nominal sales, which are the usual available variables in innovation surveys.[6] Notice that the variable $g_1$ has a coefficient equal to 1 and can thus be subtracted from $l$ on the left-hand side of the equation for estimation, being the new dependant variable $l$-$g_1$. This implies that we are estimating a net employment effect.

The three key parameters of interest are $\alpha_0$, $\alpha_1$ and $\beta$. Identification and consistency depend on the lack of correlation of the variables representing innovation (*g2* and *d*) and the error term, or on the availability of instruments uncorrelated with the error term.

As in Harrison et al. (2008), even though we cannot control for firm-level prices because this information is not available, we can probably do better than estimating equation (1) without controlling for any prices by at least finding a good proxy for the growth rate of old product, and in this way to avoid problems generated by this variable being included in the error term of (1).

It is possible to control for the change in prices of old products by subtracting the industry price growth index ($\pi$) (as a proxy for the rate of increase of prices of old products) from the nominal sales growth of old products; the dependent variable in this case will be: $l-(g_1 - \pi)$.[7] The value of the estimated constant will be an estimate of the average real productivity growth in the production of old products between the two periods. To compute price growth rates, we use implicit GDP prices. Hence, the model to be estimated will be:

$$(1') \quad l-(g_1-\pi)=\alpha_0+\alpha_1 d+\beta g_2+\upsilon$$

The relationship between employment and innovation is very complex. It has the potential to affect both the quantity and the composition of employment. Indeed, innovation might change the required skill composition of the labor force.

To study the effect of innovation (process and product) on the composition of employment, we can estimate equation (1') for each type of labor; that is, we can estimate:

$$(2) \quad l^j-(g_1-\pi)=\alpha_0^j+\alpha_1^j d+\beta^j g_2+\upsilon \qquad j=s,u$$

[6] Harrison et al. (2008) transform the original model in real terms to include the sales in nominal terms. This generates an additional problem: the unobserved disturbance includes prices of the new products that are correlated with $g_2$. In any case, the bias here is an attenuation bias.

[7] If this variable is a good proxy for rate of increase of prices of old products, then the error term $\nu$ will not include the change in prices of old products.

where $l^j$ is the employment growth rate for the $j$ type of labor ($j$=$s,u$; $s$=skilled and $u$=unskilled) and the rest of the variables are the same as in the previous section. This equation provides the estimates of the impact of innovation on each type of employment.

Endogeneity could arise because innovation decisions depend on the productivity of the firm and unobservable productivity shocks. As explained by Harrison et al. (2008), since the equation is in differences, the productivity fixed effects are not present in the equation. But the unobservable productivity shocks are still in the error term $\mu$ and could be correlated with the innovation variables. This correlation will depend on the timing of productivity shocks and investment decisions. Hence, we will control for the possible endogeneity using the instrumental variables approach.

### *3.2 Data and Descriptive Statistics*

In Uruguay, currently there are two waves of innovation surveys in the service sector (SIS), which cover the periods 2004–06 and 2007–09. The data was collected in parallel with the Economic Activity Survey (EAS) (same sample and statistical framework). The inclusion of all firms with more than 49 workers is mandatory. Units with 20 to 49 employees and with fewer than 19 workers are selected using simple random sampling within each economic sector at the ISIC 2-digit level up to 2005. After that year, random strata are defined as units with fewer than 50 workers within each economic sector at the ISIC 4-digit level. The number of firms included in the 2004–06 and 2007–09 samples are 900 and 1046, respectively.

Both surveys have been matched with the EAS. We matched both SIS surveys with the 2004 and 2007 EAS because we needed to retrieve information on sales and employment for the beginning of the period for each survey. That is, we are taking employment and sales information for the end of year for the reference period from SIS (i.e., 2006 and 2009), and the same figures from the EAS for 2004 and 2007. This information was used to calculate the corresponding growth rates. When matching the 2004–07 SIS with the 2004 EAS 76 firms were lost, but the problem was bigger when we did the same for the 2007–09 SIS and the 2007 EAS. An important number of firms that participated in the SIS survey in 2009 are not in the 2007 EAS. In this case, 697 firms were lost due to the change in the sampling of the EAS. The final number of firms included reached 982, including 659 from the first survey and 323 from the second.[8]

Table 2 shows descriptive statistics for the service sector. The mean size of a firm is 188 employees, in contrast with the manufacturing sector, where the mean average size of a firm is much smaller. Data on annual employment growth shows that the mean is positive for all types of firms, driven by innovators. Employment growth averaged 10 percent between 2004 and 2009, while in the manufacturing sector average annual growth was 4.9 percent for the same period. The annual sales growth rate was positive for all firms and larger than in the manufacturing sector, especially for innovating firms. Among product innovators, this growth is explained by the sales of innovations in new products (39 percent versus -26.6 percent for innovators in old products).

From the upper panel of the table we can see that 48 percent of the firms are innovators. These figures are similar to the manufacturing sector (52 percent). One difference is that there are more process-only innovators or organizational change-only (nonproduct innovator), 24 percent, than in the manufacturing firm sample (19 percent). Production innovations are less frequent among service firms (24 percent versus 32 percent in manufacturing). As mentioned, this could be because service entrepreneurs do not tend to identify product innovations as creative activities (Miles, 2004). Table B.1 in the Appendix shows these figures for the sample of small firms (those with fewer than 50 employees). There are 475 firms in that sample. Thirty-seven percent of the firms are innovators (product or process or organizational). Of these firms, 18 percent are process-only or organizational change-only innovators (nonproduct innovators) and 19 percent are production innovators.

As shown herein, innovation in the service sector varies considerably by firm size, but also by sector. Table B.2 in the Appendix presents basic descriptive statistics by sector. The first thing to notice is the different innovation intensity across sectors. While in IT and related activities 78 percent of the firms in the sample innovate, in hotel and restaurant firms only 27 percent conduct innovation activities. There is also heterogeneity in the way the sectors introduce innovations. While in IT and related activities, and research and development 68 and 44 percent

[8] Firms with missing information on sales or employment were also excluded, as were the percentile 1 and 99 of variables $l$ and $g$ to avoid outliers, and negative values of the variable $g_2$.

respectively are product innovators, only 11 percent of hotel and restaurant firms are product innovators.

**Table 2. Descriptive Statistics for the Service Sector - Period 2004–09 Pooled Surveys**

| | Mean | Median | Standard | Minimum | Maximum |
|---|---|---|---|---|---|
| **Number of observations** | 984 | | | | |
| **Distribution of firms (%)** | | | | | |
| Non-innovators (no process or product | 0.52 | | | | |
| Process only innovators (non-product innovators) | 0.24 | | | | |
| Product innovators | 0.24 | | | | |
| *(of which product and process innovators-of the* | 0.83 | | | | |
| **Number of employees at the beginning of (each)** | 188.3 | 44 | 567.3 | 1 | 6400 |
| **Foreign ownership (10% or more)** | 0.1 | 0 | 0.3 | 0 | 1 |
| **Located in the capital of the country** | 0.8 | 1 | 0.4 | 0 | 1 |
| **Employment growth (%) (yearly rate)** | | | | | |
| *All firms* | 10.4 | 7.7 | 19.5 | -50.6 | 85.7 |
| Non-innovators (no process or product | 7.4 | 5.7 | 19.8 | -50.6 | 85.7 |
| Process only innovators (nonproduct innovators) | 14.2 | 10.4 | 18.2 | -36.1 | 83.9 |
| Product innovators | 13.1 | 9.4 | 19.0 | -28.0 | 80.5 |
| **Growth wage bill per worker (%) (yearly rate)** | Na | na | na | na | na |
| **Sales growth (%)**[1] (nominal growth) (yearly rate) | | | | | |
| *All firms* | 11.0 | 10.4 | 23.8 | -96.8 | 121.3 |
| Non-innovators (no process or product | 9.1 | 9.7 | 26.0 | -96.8 | 121.2 |
| Process only innovators (nonproduct innovators) | 13.6 | 12.0 | 20.6 | -87.6 | 121.3 |
| Product innovators | 12.4 | 10.0 | 21.1 | -45.5 | 117.5 |
| *of which:* | | | | | |
| Old products | -26.6 | -31.4 | 24.2 | -50.0 | 55.1 |
| New products | 39.0 | 36.3 | 29.2 | 0.0 | 167.5 |
| **Labor productivity growth (%)**[1] (yearly rate) | | | | | |
| *All firms* | -0.6 | 2.9 | 26.3 | -140.1 | 144.8 |
| Non-innovators (no process or product | 1.8 | 3.6 | 27.6 | -140.1 | 144.8 |
| Process only innovators (nonproduct innovators) | -0.6 | 2.9 | 23.3 | -94.2 | 70.2 |
| Product innovators | -0.6 | 0.9 | 26.1 | -89.5 | 124.7 |
| **Prices growth (%)** [2] | | | | | |
| *All firms* | 5.4 | 7.7 | 9.4 | -30.0 | 14.5 |
| Non-innovators (no process or product | 5.8 | 7.7 | 8.9 | -30.0 | 14.5 |
| Process only innovators (nonproduct innovators) | 5.5 | 7.7 | 9.2 | -30.0 | 14.5 |
| Product innovators | 4.4 | 8.3 | 10.8 | -30.0 | 14.5 |

The salient heterogeneity observed above is in partly due to knowledge-intensive business services (commonly known as KIBS), which behave similarly to technology-intensive manufacturing firms in terms of effort in R&D and technological intensity (Hipp et al., 2000) (see Table B.6 in the Appendix for some evidence for Uruguay on similarities in their innovation behavior). These are services and business operations heavily reliant on professional knowledge. They are mainly concerned with providing knowledge-intensive support for the business processes of other organizations. In this work, we codiy as KIBS within the CIIU Rev. 3 the post and telecommunications, IT and related activities, research and development, and business services subsectors.

Table B.3 of the Appendix presents descriptive statistics for the firms in the KIBS. There are 409 firms in that sample, and 53 percent of them are innovators (product, process, or organizational). This percentage is larger than that of the total sample. Of these firms, 23 percent are process-only or organizational change-only innovators (nonproduct innovators), and 29 percent are product innovators. All of these figures are larger than in the entire sample and are similar to those in the manufacturing sector. Employment growth figures are very positive, even more so than in the complete sample. The same is true for the sales growth figures.

### *3.3 Relationship between Innovation and Employment Quantity in the Service Sector*

*Naive OLS Regression*

The naïve estimations (not based on equation 1') show how the average employment growth rates differ among innovators and non-innovators after controlling for the growth in sales of existing products, foreign ownership, and industry and time effects. As shown in the descriptive statistics section, although growth rates for non-innovators and innovators are positive, for innovators they are significantly higher than for non-innovators. This is true for the complete sample, the small firm sub-sample, and the KIBS.

Table 3 shows naive regressions on the effects of innovation on employment quantity, using the pooled sample of service firms of the two SIS available at the moment and for the subsample of small firms and KIBS. The estimations include as independent variables: real sales growth of unchanged (or existing) products, fixed effects by sector of activity (at 2-digit level), temporal fixed effects, and a dummy variable that indicates foreign ownership of the firm.

## Table 3. Effect of Innovation on Employment Quantity

| Sector | | Services | | | Small firms in services | | | KIBS | |
|---|---|---|---|---|---|---|---|---|---|
| Regression | OLS | OLS | OLS | OLS | OLS | OLS | OLS | OLS | OLS |
| Constant | 7.254*** | 6.109*** | 6.111*** | 2.722** | 1.367 | 1.396 | 6.588*** | 5.457*** | 5.458*** |
| | (0.835) | (0.879) | (0.879) | (1.172) | (1.199) | (1.208) | (1.375) | (1.495) | (1.496) |
| TPP (product or process innovator) | 6.586*** | | | 8.344*** | | | 9.301*** | | |
| | (1.337) | | | (2.035) | | | (2.229) | | |
| Process innovator (only) | | 5.760*** | 5.753*** | | 9.917*** | 9.907*** | | 7.495*** | 7.493*** |
| | | (1.448) | (1.449) | | (2.380) | (2.383) | | (2.218) | (2.221) |
| Product innovator | | 10.241*** | | | 10.586*** | | | 12.239*** | |
| | | (1.848) | | | (2.636) | | | (3.012) | |
| Product innovator only | | | 11.226*** | | | 15.626*** | | | 12.528** |
| | | | (3.665) | | | (4.652) | | | (5.013) |
| Product & process innovator | | | 10.060*** | | | 9.202*** | | | 12.175*** |
| | | | (1.899) | | | (2.743) | | | (3.154) |
| Real sales growth *(g1-Π)* | 0.157*** | 0.178*** | 0.179*** | 0.170*** | 0.174*** | 0.180*** | 0.159*** | 0.172*** | 0.172*** |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) | (0.02) |
| Foreign owned (10% or more) | 4.809*** | 3.897** | 3.901** | 5.253* | 3.487 | 3.453 | 5.685** | 4.483* | 4.485* |
| | (1.739) | (1.762) | (1.764) | (3.008) | (3.039) | (3.062) | (2.302) | (2.349) | (2.353) |
| 2-digit industry dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time dummies | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R squared | 0.098 | 0.113 | 0.113 | 0.130 | 0.156 | 0.159 | 0.109 | 0.121 | 0.121 |
| Standard error | 18.65 | 18.50 | 18.51 | 18.24 | 18.00 | 17.97 | 19.43 | 19.33 | 19.35 |
| Number of firms | 982 | 982 | 982 | 475 | 475 | 475 | 409 | 409 | 409 |

*Source:* Authors calculations.

*Notes:* **1-** Robust standard errors in parentheses. **2-** * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance. **3.** Small firms are those with up to 50 employees. **4**. Period 2004–2009. Innovation Survey 2004–2006 and 2007–2009.

As column 1 of Table 3 shows, the results indicate that innovation (process or product) has a positive impact on employment growth. Column 2 shows that even after introducing separate dummies for process only and product innovation (product or product and process) there is still a positive effect on employment growth. If we go further and separate process innovation only, product innovation only and product and process innovation, the positive effect is still maintained for all types of innovation (column 3). In column 3 we cannot reject statistically that the coefficient of the product innovation only dummy is the same as the one for process and product innovation, but they are bigger than the one indicating process innovation only. Therefore, the results appear to indicate that product innovation is the most important driver of employment growth for all types of firms. When process innovation is carried out without product innovation, the positive effects become smaller, but when carried out with product innovation, it is equally important. The dummy indicating foreign ownership is positive, and significantly different from zero. The coefficient of real sales growth of existing products is always significantly different from zero, positive, and less than one. This result suggests that the elasticity of employment with respect to sales of existing products is far less than one. The exercises for the small firms subsample and the KIBS show similar results.

When the estimations for KIBS are compared to the total sample, some heterogeneity is found. The coefficients on the innovation dummies are bigger for the KIBS sectors than for the total sample of firms, indicating that innovation appears to have a bigger positive impact on firms in the KIBS sector.

### *3.4 Estimation of the Core Model*

Here variants of the basic model in equation (1') are replicated, where the dependent variable is the employment growth rate minus the real sales growth rate ($l-(g_1-\pi)$) in the service sector. All of the specifications in Table 4 include the process innovation dummy, *d*, the new products sales growth rate, $g_2$, the foreign ownership dummy, and a constant. The estimations also include industry fixed effects (at 2-digit level) and time effects.

In Table 4, column 1 shows the basic OLS estimation. In the next columns we analyze the sensitivity of results using instrumental variables (IV), assuming that $g_2$ is endogenous (column 2), and that $g_2$ and *d* are endogenous variables (column 3).

The strategy relies on the choice of instrumental variables that can be considered to be uncorrelated with both price differences (new vs. old products) and productivity shocks, and that must be highly correlated with the growth in sales of new products ($g_2$), the potentially endogenous variable (in the robustness checks section below, the variable *d* is also instrumented).

The preferred instrument of Harrison et al. (2008) is an increased range of goods and services indicator, which assesses the impact of innovation on the increase in the range of goods produced by firms. The same instruments are used in the current study and for the same reasons. The questionnaire also asks whether the innovation helped to improve the quality of the goods, and contains questions related to the reduction of the costs of production and changes in the production function. We take the increased range of goods as the innovation helping to develop new products associated with an increase in demand for reasons other than changes in product prices and quality. Hence, we expect this variable to be uncorrelated with changes in the price of new products compared to old products. This variable is coded between 0 and 3: 0 = irrelevant impact, 1= low, 2= medium, and 3 = high impact). The indicator was included as a set of dummies because of evidence of a nonlinear effect in the first-stage regressions.

The dummy indicating process-only innovation is not significantly different from zero in all specifications for the total sample (columns 1 to 3), but it is significantly different from zero and positive for the small firms subsample (at 10 percent level, in two out of three regressions). Hence, in the total sample, process innovation has no effect on employment. When the model is estimated by IV, the positive impact of this variable on labor growth is increased but still remains non-significant.

When estimating by OLS, the coefficient on the growth rate of sales of new products ($g_2$) is significant, positive, and lower than one. Since this coefficient measures the relative efficiency of old and new products, it suggests that new products are produced more efficiently than old products. As noted before, this coefficient could be downward biased because of the presence of endogeneity.

In columns 2, 3, 5, and 6, we control for the possible presence of endogeneity, considering $g_2$ as endogenous, and $g_2$ and $d$ as endogenous. The coefficient of $g_2$ increases when estimated by IV. We cannot reject the hypothesis of the coefficient in $g_2$ being equal to one in all cases. That is, the efficiency in the production of old and new products is the same in both cases.

The Davidson-MacKinnon test of exogeneity rejects the null hypothesis of exogeneity for the variable $g_2$, which indicates that endogeneity is indeed a problem and that instrumental variables techniques are required (see columns 2 and 3). When including the estimation assuming d as an endogenous variable (column 3), the Davidson-MacKinnon test of exogeneity does not reject the null hypothesis for the variable, hence this variable can be considered an exogenous variable.

The results of the Sargan test indicate no problems with respect to the validity of the instruments. Their validity is accepted in all cases at 5 percent confidence level for the complete sample. The F-test for the instruments of $g_2$ is greater than 10, confirming the validity of these instruments in all cases. In the case of small firms, we cannot reject that both $g_2$ and $d$ are exogenous variables (columns 5 and 6).

**Table 4. Innovation and Employment Quantity, Service Sector**

| | **All services** | | | **Service small firms** | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **Regression** | **OLS** | **IV** | **IV** | **OLS** | **IV** | **IV** |
| Constant | 5.262*** | 4.135*** | 6.439*** | 3.020* | 3.011 | 5.006** |
| | (1.181) | (1.323) | (2.210) | (1.677) | (1.851) | (2.524) |
| Process innovation only *(d)* | 0.033 | 1.209 | -9.653 | 6.926* | 6.937* | -9.436 |
| | (1.899) | (2.149) | (8.533) | (3.593) | (3.588) | (14.063) |
| Sales growth due to new products *(g2)* | 0.856*** | 0.954*** | 0.975*** | 0.826*** | 0.827*** | 0.922*** |
| | (0.048) | (0.075) | (0.078) | (0.073) | (0.122) | (0.149) |
| Foreign owned (10% or more) | 5.889** | 6.783 | 6.292** | 6.785 | 6.783 | 8.849* |
| | (2.431) | (4.524) | (2.677) | (5.049) | (4.524) | (4.979) |
| Ho: g2=1 p value | 0.00 | 0.61 | 0.84 | 0.02 | 0.29 | 0.95 |
| 2-digit industry dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| R squared | 0.415 | 0.337 | 0.313 | 0.336 | 0.257 | 0.212 |
| Standard error | 25.72 | 25.76 | 26.22 | 27.54 | 27.45 | 28.27 |
| Number of firms | 982 | 982 | 982 | 475 | 475 | 475 |
| F test, g2 | | 125.5*** | 19.74*** | | 63.43*** | 12.81** |
| F test, d | | | 15.43*** | | | 8.318*** |
| g2 Exogeneity (Davidson-McKinnon) | | 3.38** | 5.28** | | 0.45 | 2.36 |
| d Exogeneity (Davidson-McKinnon) | | | 2.00 | | | 2.16 |
| Sargan test | | 1.798 | 0.000904 | | 4.528 | 2.800* |
| Degrees of freedom | | 2 | 1 | | 2 | 1 |

*Sources:* Authors' calculations.

*Notes:* **1-** Robust standard errors in parentheses. **2-** All regressions include 2-digit industry dummies. **3-** * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance. **4-** $g_2$ instrumented by indicators of "increased range of good". This indicator was included as a set of dummies because the evidence of a nonlinear effect in the first-stage regressions. **5-** F test denotes de F of excluded instruments in the first-stages regressions. **6-** Exogeneity denotes Davidson-MacKinnon test of Exogeneity. **7-** Sargan test denotes over-identifying restrictions test.

Table 5 shows the results of replicating the above-described exercise for KIBS. While *d* is not significantly different from zero in any specification, $g_2$ is always significantly different from zero, and positive. When estimating by OLS we cannot reject that it is lower than one; instead, when using IV techniques, we cannot reject that the coefficient is equal to one. Sargan and F statistics show no problems of weak and valid instruments, while the test of exogeneity show that $g_2$ can be treated as endogenous (the test does not reject the hypotheses at 10 percent of confidence), and d is an exogenous variable.

**Table 5. Innovation and Employment Quantity. KIBS**

| | | **KIBS** | |
|---|---|---|---|
| | 1 | 2 | 3 |
| **Regression** | **OLS** | **IV** | **IV** |
| Constant | 5.786*** | 3.293 | 8.440* |
| | (1.989) | (2.349) | (4.597) |
| Process innovation only *(d)* | -0.918 | 1.515 | -22.680 |
| | (2.963) | (3.650) | (18.520) |
| Sales growth due to new products *(g2)* | 0.849*** | 1.029*** | 1.041*** |
| | (0.057) | (0.118) | (0.127) |
| Foreign owned (10% or more) | 3.094 | 2.345 | 4.505 |
| | (3.219) | (3.642) | (4.212) |
| Ho: g2=1 p value | 0.01 | 0.81 | 0.75 |
| 2-digit industry dummies | Yes | Yes | Yes |
| R squared | 0.456 | 0.342 | 0.250 |
| Standard error | 27.41 | 27.62 | 29.50 |
| Number of obs | 409 | 409 | 409 |
| F test, g2 | | 45.81*** | 7.62** |
| F test, d | | | 4.926** |
| g2 Exogeneity (Davidson-McKinnon) | | 3.17* | 4.812** |
| d Exogeneity (Davidson-McKinnon) | | | 2.036 |
| Sargan test | | 4.82* | 2.431 |
| Degrees of freedom | | 2 | 1 |

*Sources:* Authors' calculations.

*Notes:* **1-** Robust standard errors in parentheses. **2-** All regressions include 2-digit industry dummies. **3-** * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance. **4-** $g_2$ instrumented by indicators of "increased range of good". This indicator was included as a set of dummies because of the evidence of a non-linear effect in the first-stage regressions. **5-** F test denotes de F of excluded instruments in the first-stages regressions. **6-** Exogeneity denotes Davidson-MacKinnon test of Exogeneity. **7-** Sargan test denotes overidentifying restrictions test.

Another robustness check is performed. In the Appendix, Table B.4, we allow for a change in the slope of product innovation if these innovations are introduced together with process innovations. For this, we will introduce an interaction term between g2 and a dummy that is equal to one if product innovation occurs together with process innovation. As we can see, there is no evidence of a change in slope. In other words, there is no evidence that the positive impact on labor growth of the introduction of new products is weaker or stronger when this innovation is introduced together with a process innovation.

### *3.5 Employment Growth Decomposition*

In this section we compute the decomposition of employment growth for the whole sample and for the small firms sample using the proportional averages from Tables 2 and A.1 (all firms and small firms respectively), and the estimated coefficients of equation (1) in the above table (taking out control variables). We use the parameters estimated in the basic model (with $d$ and $g_2$ as regressors). The decomposition is performed with the parameters of the specifications estimated by OLS and IV.

Considering the whole period, average employment growth was 10.4 percent for the whole sample and 7.7 percent for the small firms. OLS and IV estimations yield very similar results. For the whole sample the productivity improvement in the production of existing products is an important source of employment growth (ranging from 6.1 to 4.7). In all the estimations, individual process innovations account for only small employment changes (0.1). The sales growth of old products explains some of the positive rate of growth of employment in the period (3.7 percent).

Finally, product innovation is the most important driver of the positive growth in employment. The decomposition shows that the effect of new product sales, net of the substitution of existing products, ranges from 7.8 percent to 9 percent in the whole sample in the period 2004–09. Product innovation is on average the most important driver of employment growth and compensates for the negative effect of the contribution of old products. In the decomposition of employment growth for small firms we observe a similar salient effect of product innovations. The difference is that old product also provides a positive growth rate, while the productivity trend of old products is negative. In the case of KIBS, product innovation is by far the most important driver of employment growth; at the same time, the productivity trend in the production of old products contributes negatively to growth.

When the results for the total sample and the small firms sample are compared with those obtained for the manufacturing sector in Aboal et al. (2011), there are some important differences. In the first place, for services the productivity trend in production of old products is important in explaining firm employment growth. However, this is not true for manufacturing, where the contribution of this factor is close to zero in the case of the OLS estimation and negative in the case of the IV estimation. Second, for small service firms, the net contribution of product innovation is the single most important factor explaining employment growth in the period, while for small manufacturing firms, the most important contribution comes from the output growth of old products. The contribution of product innovation is very modest.

**Table 6. Contribution of Innovation to Employment Growth. Service Sector, 2004–09**

| | **All services** | | **Small services** | | **KIBS** | |
|---|---|---|---|---|---|---|
| **Contributions of innovation to employment growth** | OLS | IV | OLS | IV | OLS | IV |
| ***Firms employment growth*** | 10.4 | 10.4 | 7.7 | 7.7 | 11.2 | 11.2 |
| Productivity trend in production of old products | 6.1 | 4.7 | -2.1 | -2.8 | -5.1 | -7.8 |
| Gross effect of process innovation in production of old products | 0.1 | 0.4 | 0.9 | 1.1 | -0.2 | 0.4 |
| Output growth of old products contribution | 3.7 | 3.7 | 1.6 | 1.6 | 3.8 | 3.8 |
| **Net contribution of product innovation** | 0.5 | 1.6 | 7.2 | 7.8 | 12.6 | 14.7 |
| Contribution of old products by product innovators | -7.3 | -7.3 | 1.1 | 1.1 | 2.9 | 2.9 |
| Contribution of new products by product innovators | 7.8 | 9.0 | 6.1 | 6.7 | 9.7 | 11.8 |

*Notes:* Decomposition based on estimations reported on Table 2 without controls. Yearly growth rates for the whole period 2004–09.

### *3.6 Relationship between Innovation and Employment Quality in the Service Sector*

The average share of skilled labor in the sample is 25 percent. This contrasts with the manufacturing sector, where this share is on average 10 percent. As can be seen in Table 7, product innovators have the highest share of the skilled labor force, averaging 34 percent.

In order to estimate equation (2), we need to calculate the employment growth rate of each type of labor. Since there are only two available surveys, and the share of skilled labor is only available for the final year of each SIS survey, we can only get one data point for each firm that is present in both surveys, leaving us with only 220 observations.

**Table 7. Descriptive Statistics for the Service Sector – Skilled vs. Unskilled Labor by Type of Firm**

| | Mean | Median | Standard deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| **Share of skilled labor** | | | | | |
| *All firms* | 24.7 | 12.0 | 27.5 | 0.0 | 100.0 |
| Non-innovators (no process or product innovations) | 19.9 | 8.0 | 26.3 | 0.0 | 100.0 |
| Process only innovators (nonproduct innovators) | 25.6 | 15.0 | 26.0 | 0.0 | 100.0 |
| Product innovators | 34.3 | 27.0 | 29.2 | 0.0 | 100.0 |
| **Employment (total) growth (%)** | | | | | |
| *All firms* | 10.4 | 7.7 | 19.5 | -50.6 | 85.7 |
| Non-innovators (no process or product innovations) | 7.4 | 5.7 | 19.8 | -50.6 | 85.7 |
| Process only innovators (nonproduct innovators) | 14.2 | 10.4 | 18.2 | -36.1 | 83.9 |
| Product innovators | 13.1 | 9.4 | 19.0 | -28.0 | 80.5 |
| **Skilled labor growth (%)** | | | | | |
| *All firms* | 2.6 | 2.7 | 35.4 | -112.0 | 154.1 |
| Non-innovators (no process or product innovations) | -1.0 | 0.0 | 39.9 | -112.0 | 154.1 |
| Process only innovators (nonproduct innovators) | 7.2 | 7.6 | 32.4 | -93.9 | 67.9 |
| Product innovators | 3.7 | 7.1 | 29.6 | -102.7 | 87.6 |
| **Unskilled labor growth (%)** | | | | | |
| *All firms* | 5.6 | 2.3 | 26.3 | -159.2 | 200.8 |
| Non-innovators (no process or product innovations) | 7.3 | 2.3 | 24.2 | -39.9 | 127.0 |
| Process only innovators (nonproduct innovators) | 2.8 | 1.6 | 14.5 | -42.1 | 37.8 |
| Product innovators | 5.9 | 3.6 | 38.6 | -159.2 | 200.8 |

*Notes:* Yearly averages for the period 2004–09.

*Sources:* Innovations Survey waves 2004–06, 2007–09.

Table 8 presents the results for the extended model in equation (2), where the dependent variable is the employment growth rate of the labor type *j* minus sales growth rate ($l^j-(g_1-\pi)$). All the specifications include the process innovation dummy, *d*, sales growth rate of new products, $g_2$, and a constant. All the estimations include industry fixed effects (at 2-digit level), and control for foreign ownership of the firm. Regressions 3 and 4 test the endogeneity of g2, and regressions 5 and 6 assume that both, g2 and d are endogenous.

The dummy indicating process-only innovation is not significantly different from zero in all the specifications for skilled labor, but it is negative and significant for unskilled labor growth in regressions 2 and 4. In contrast, the coefficient on the growth rate of sales of new products ($g_2$) is significantly different from zero in all specifications. For unskilled labor the coefficient is positive and lower than unity, indicating that innovation allows an increase in the efficiency in the production of new products, while we cannot reject that it is equal to one for skilled labor, implying that there is no efficiency gain in the production of new products relative to old ones.

The Davidson-MacKinnon test of exogeneity does not reject the null hypothesis of exogeneity of variables $g_2$ and $d$, which indicates that OLS estimation gives consistent estimations.

We do not present results for the subsample of small firms, since the sample size is reduced to only 33 firms. This is because we are only including firms present in both surveys. These are generally large firms, since their inclusion in the SIS survey is mandatory.

Table 9 presents results for the KIBS sector. Process innovation is never statistically significant while, on the contrary, g2 is significant and positive. Again, while the coefficient on g2 for skilled labor is never rejected to be equal to one, is lower than unity for unskilled labor.

In Table B.5 of the Appendix, we allow for a change in the slope of product innovations if they are introduced together with process innovations. As in the previous section, we will introduce an interaction term between g2 and a dummy that is equal to one if product innovation occurs together with process innovation. As we can see, there is no evidence that the positive impact on labor growth of the introduction of new products is weaker or stronger when this innovation is introduced together with a process innovation.

## Table 8. Relationship Employment-Labor Composition - OLS and IV Estimation Total Sample for Service Sector

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| **Sector** | | | **Services sector** | | | |
| **Regression** | **Skilled-OLS** | **Unskilled-OLS** | **Skilled IV** | **Unskilled IV** | **Skilled IV** | **Unskilled IV** |
| Constant | -2.724 | 6.224** | -2.812 | 8.404*** | -2.748 | 9.075 |
| | 224 | 224 | (4.101) | (3.211) | (7.334) | (5.747) |
| Process innovation only *(d)* | 5.954 | -7.746** | 6.036 | -9.781** | 5.819 | -12.088 |
| | (5.736) | (3.558) | (5.965) | (4.703) | (21.732) | (17.027) |
| Sales growth due to new products *(g2)* | 0.983*** | 0.801*** | 0.989*** | 0.631*** | 0.989*** | 0.629*** |
| | (0.116) | (0.081) | (0.198) | (0.155) | (0.201) | (0.156) |
| Foreign owned (10% or more) | 1.504 | 0.548 | 1.504 | 1.504 | 1.526 | 0.547 |
| | (7.838) | (4.661) | (7.519) | (7.573) | (7.860) | (5.928) |
| 2-digit industry dummies | yes | Yes | yes | yes | yes | yes |
| Standard error | 36.49 | 28.35 | 36.23 | 28.36 | 36.23 | 28.38 |
| Number of observations | 224 | 224 | 224 | 224 | 224 | 224 |
| Ho: g2=1 p value | 0.880 | 0.015 | 0.96 | 0.02 | 0.96 | 0.02 |
| F test, g2 | | | 20.72*** | 20.72*** | 19.77*** | 19.77*** |
| F test, d | | | | | 2.424** | 2.424** |
| g2 Exogeneity (Davidson-McKinnon) | | | 0.00 | 1.94 | 0.00 | 1.20 |
| d Exogeneity (Davidson-McKinnon) | | | | | 0.00 | 0.02 |
| Sargan | | | 4.265 | 3.260 | 4.265 | 3.234 |
| Degrees of freedom | | | 5 | 5 | 4 | 4 |

*Notes:* **1-** Robust standard errors in parentheses. **2-** All regressions include 2-digit industry dummies. **3-** * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance. **4-** g2 instrumented by indicators of "increased range of good" and "development of new markets". All these indicators were included as a set of dummies because the evidence of a nonlinear effect in the first-stages regressions. **5-** F test denotes de F of excluded instruments in the first-stages regressions. **6-** Exogeneity denotes Davidson-MacKinnon test of Exogeneity. **7-** Sargan test denotes of overidentifying restrictions test.

**Table 9. Relationship Employment-Labor Composition - OLS and IV Estimation, KIBS**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| **Sector** | | | | **KIBS** | | |
| **Regression** | **Skilled-OLS** | **Unskilled-OLS** | **Skilled IV** | **Unskilled IV** | **Skilled IV** | **Unskilled IV** |
| Constant | -0.944 | 7.741** | -1.468 | 6.178 | -0.871 | 13.431 |
| | (7.017) | (3.407) | (7.068) | (4.468) | (13.268) | (9.333) |
| Process innovation only *(d)* | -10.653 | -5.221 | -10.213 | -10.234 | -12.596 | -39.216 |
| | (12.210) | (3.843) | (11.569) | (7.454) | (46.392) | (32.635) |
| Sales growth due to new products *(g2)* | 0.837*** | 0.744*** | 0.876*** | 0.403** | 0.868*** | 0.304 |
| | (0.191) | (0.105) | (0.286) | (0.181) | (0.329) | (0.227) |
| Foreign owned (10% or more) | 5.265 | 2.769 | 5.326 | 5.326 | 5.553 | -4.850 |
| | (12.473) | (5.514) | (11.749) | (11.973) | (12.712) | (7.570) |
| 2-digit industry dummies | yes | yes | yes | yes | yes | yes |
| | | | | | | |
| Standard error | 42.54 | 27.50 | 41.75 | 26.40 | 41.76 | 29.38 |
| Number of observations | 85 | 85 | 85 | 85 | 85 | 85 |
| Ho: g2=1 p value | 0.397 | 0.016 | 0.67 | 0.00 | 0.69 | 0.00 |
| F test, g2 | | | 12.78*** | 12.78*** | 13.47*** | 13.47*** |
| F test, d | | | | | 1.08 | 0.816 |
| g2 Exogeneity (Davidson-McKinnon) | | | 0.04 | 4.16** | 0.04 | 3.01* |
| d Exogeneity (Davidson-McKinnon) | | | | | 0.00 | 0.08 |
| Sargan | | | 3.327 | 7.847 | 3.323 | 5.461 |
| Prob. value | | | 0.650 | 0.165 | 0.505 | 0.243 |
| Degrees of freedom | | | 5 | 5 | 4 | 4 |

*Source:* Authors calculations.
*Notes:* **1-** Robust standard errors in parentheses. **2-** All regressions include 2-digit industry dummies. **3-** * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance. **4-** g2 instrumented by indicators of "increased range of good" and "development of new markets". All these indicators were included as a set of dummies because the evidence of a nonlinear effect in the first-stages regressions. **5-** F test denotes de F of excluded instruments in the first-stages regressions. **6-** Exogeneity denotes Davidson-MacKinnon test of Exogeneity. **7-** Sargan test denotes of overidentifying restrictions test.

To conclude, process innovation has no effect on either skilled or unskilled employment growth for KIBS; however, it has a negative effect on unskilled labor growth for the entire sample. Instead, the sales of new product are always significant, but have a differential impact on skilled and unskilled labor. Innovation allows an increase in the efficiency of the production of new products with unskilled labor, while there is no efficiency gain in the production of new products relative to old ones with skilled labor. This is true both for the entire sample of firms and for KIBS firms. The point estimates of the coefficients of g2 are lower for the KIBS sector, indicating a bigger effect in terms of efficiency gain in the production of new products relative to old ones in the KIBS.

### *3.7 Innovation Strategies - Employment Quality Relationship in the Service Sector*

Product and process innovations are the result of different innovation strategies undertaken by firms. Firms can innovate by investing in R&D or training, acquiring embodied technologies, and purchasing knowledge. The innovation literature has broadly categorized the strategies into two types: produce technology itself (make) or source technology externally (buy). Hence, we will distinguish how firms acquire and develop new technology (the make and/or buy decision) to assess their possibly different impact on employment.

It is well known that in the service sector, R&D, the primary source of the make strategy, is less developed. Empirical studies have made it clear that expenditure on R&D is only one element of firms' expenditures on innovation. Even in manufacturing, R&D generally amounts to only a small fraction of total investment in innovation; in services, the share is even smaller. Other components of innovation appear more important for services; most innovation is linked to changes in processes, organizational arrangements, and markets.

**Table 10. Innovation Strategies**

| | |
|---|---|
| **MAKE** | |
| **Internal R & D:** All creative work undertaken within the company in a systematic way in order to increase the stock of knowledge and use this knowledge to develop or significantly improve new applications, such as goods / services or processes. Includes basic research, strategic and applied research and experimental development. Does not include market research. | |
| **BUY** | |
| **External R & D: S**ame activities as in internal R&D, but made by other companies (including companies in the same group) or other research organizations, public or private. | **Acquisition of Capital Assets:** Acquisition of advanced machinery and equipment specifically designed to introduce changes, improvements and/or innovations in products (goods or services), processes, organizational techniques and/or marketing. |
| **Engineering and Industrial Design:** Industrial design for the production and distribution of goods or services not included in R&D. Includes maps and charts for defining procedures, technical specifications and operational characteristics; installation of machinery, engineering necessary for production. | **Transfer of Technology and Consulting:** Acquisition of rights to use patents, unpatented inventions, licenses, trademarks, designs, know-how, technical assistance, consulting and other scientific and technical services contracted to third parties (which are not included in external R&D). |
| **Organizational Design and Management:** Design and implementation of organization of production that significantly modify the company's organizational structure (eg., the division of labor, departmentalization, the control scheme and / or coordination). Programs to improve management and organization of production, distribution logistics and marketing. | **Acquisition of Hardware and Software:** Purchasing hardware specifically designed to make changes, improvements and / or product innovations (goods or services), processes, organizational techniques and / or marketing. |
| **Training:** internal or external training of company staff. It includes both technological and management training. | |

We define make and/or buy strategies by distinguishing between internal and external knowledge acquisition in the innovation strategy. Firms can develop new products or processes in-house through their own R&D spending. This is known as “internal R&D”. Or they can acquire technology through external means, by acquiring “external” R&D, or by acquiring capital goods, hardware and software or technology transfer and consultancy, or by training, engineering and industrial design, organization, and management design. As in Aboal et al. (2011), we will define make and buy strategies according to the type of innovations the firm does. Table 10 shows the definitions of each type of innovation and how they were categorized into buy or make strategies.

Table 11 shows how firms acquire and develop new technology: the make or buy decision. In the sample, 68 percent of the innovating firms buy technology as their only strategy. This figure is larger than for manufacturing firms (55 percent). Two percent of firms make their technology in-house, and the remaining 29 percent use a combined strategy consisting of both buying technology externally and developing it in-house. Among process innovators, the majority buy the innovation externally, while product innovators tend to use a combined strategy.

The importance of firm size can be appreciated in Table 11. Large firms are more likely to innovate. Of the firms with fewer than 50 employees, only 37 percent innovate compared to 48 percent of firms in the whole sample. Twenty-seven percent of the firms only buy technology, while 1 percent of them have undertaken a make-only strategy, and the other 9 percent a combined strategy. Small firms that innovate are more likely to restrict themselves to a simple innovation strategy.

KIBS present a pattern similar to the total sample. Thirty percent of firms prefer the buy-only strategy, while 20 percent have conducted a combined strategy. Process-only innovators tend to follow the buy-only strategy, while product innovators apply both the buy-only and the combined strategy.

**Table 11. Descriptive Statistics for Strategies - Period: 2001–09, Service Sector**

| Share of firms pursuing each type of strategy by type of firm (%) | Make only | Buy only | Make and Buy |
|---|---|---|---|
| **All service sector** | | | |
| *All firms* | 0.01 | 0.33 | 0.14 |
| Non-innovators (no process or product innovations) | 0.00 | 0.00 | 0.00 |
| Process only innovators (nonproduct innovators) | 0.01 | 0.84 | 0.14 |
| Product innovators | 0.03 | 0.52 | 0.45 |
| **Small firms** | | | |
| *All firms* | 0.01 | 0.27 | 0.09 |
| Non-innovators (no process or product innovations) | 0.00 | 0.00 | 0.00 |
| Process only innovators (nonproduct innovators) | 0.00 | 0.87 | 0.13 |
| Product innovators | 0.04 | 0.59 | 0.37 |
| **KIBS** | | | |
| *All firms* | 0.02 | 0.30 | 0.20 |
| Non-innovators (no process or product innovations) | 0.00 | 0.00 | 0.00 |
| Process only innovators (nonproduct innovators) | 0.02 | 0.79 | 0.19 |
| Product innovators | 0.07 | 0.39 | 0.54 |

*Sources:* Innovations Survey of manufacturing sector waves 2001–03, 2004–06, 2007–09.
*Notes:* Yearly averages for the period 2001–09.

As in Aboal et al. (2011), the empirical strategy will be based on equations (1') and (2). A reduced form will be substituting $g_2$ by the innovation strategies dummies, make only, buy only, and make & buy, the equation to estimate will be the following:

$$(4)\quad l^j - (g_1 - \pi) = \alpha_0 + \alpha_1 make + \alpha_2 buy + \alpha_3 make \ \& \ buy + \varepsilon$$

Reconciling with the core model, we specify two different equations: one that explains product innovation from the inputs strategies of make only, buy only and make and buy, and the second equation, which is the usual labor employment growth equation from the quantity model (1') where now g2 is replaced by its predicted value from the first equation. This is a normal instrumental variables approach where the instruments for g2 are the make only, buy only and make and buy strategies. The same is done for process innovation (d), in which case now the first equation is estimated as a probit. In this case, we follow Wooldridge (2002: 623–25). The author suggests estimating a probit using the instruments as explicative variables, and then using the predicted variable as the instrument in the first-stage regression of the instrumental variable estimation.

The working hypothesis is that since innovation strategies are the firm's control variables, they should be influenced by the relative factor endowments of the place where they are implemented. If this is true, and given that capital intensity is higher in frontier technology countries, imported innovations should have a more damaging effect on employment than the locally generated ones. In other words, make strategies should be more labor generating (and less skill intensive) than buy innovation strategies.

Table 12 shows the results for total employment growth. Columns 3 and 6 show the OLS estimation (or reduced form estimation) on make only, buy only, and make and buy strategies, and a constant. The buy-only and the combined strategy are significantly different from zero and positive, in both the total sample and the small firms subsample. Instead, the make-only strategy is not statistically significant in the total sample. The lowest coefficient corresponds to the buy-only strategy, indicating that this is the strategy with the smallest effect on employment growth. These results go in the same direction as the working hypothesis. The table also presents a test for the extra beneficial effects from the combined strategy with respect to the two only strategies; we test if the coefficient on the combined strategy is bigger than the sum of the other two only strategies. As we can see, this is rejected in the small firms sample, while not in the total sample where the make only strategy appears to have no significant effect.

Columns A and B in the first panel of Table 12 show the first-stage regressions for $g_2$ and d. Column A shows the results for first-stage estimations when we only instrument $g_2$. Column B shows the results of the probit for the process innovation variable (d). As we can see, all the strategies have a significant and positive effect over $g_2$. On the contrary, none of the strategies has a significant effect on the probability of process innovation. In the subsample of small firms, the make only strategy is omitted from the estimation because we have very few observations of small firms undertaking this strategy.

Table 12 presents the estimation of the equation (1') after applying instrumental variables to $g_2$ in column 1, and $g_2$ and $d$ in column 2. In both cases, the coefficients on $g_2$ are positive, and near unity. d is never significant, with the exception of the subsample of small firms when instrumenting only for $g_2$.

## Table 12. Innovation Strategies - OLS All Firms Service Sector

| **Sector** | | **Service sector** | | | | **Small firms service sector** | | |
|---|---|---|---|---|---|---|---|---|
| **First equation** | **A** | **B** | **C** | **Red Form** | **A** | **B** | **C** | **RedForm** |
| **Regression** | OLS | OLS | Probit | OLS | OLS | OLS | Probit | OLS |
| **Dependent variable** | g2 | g1-π | d | l-(g1-Pi) | g2 | g1-π | d | l-(g1-Pi) |
| Constant | 0.031 | 3.359** | -5.702 | 3.807*** | -1.929 | 0.998 | -5.667 | 0.885 |
| | (0.898) | (1.307) | (105.032) | (1.249) | (1.362) | (2.276) | (145.903) | (2.197) |
| Make only | 13.554** | -5.175 | 5.079 | 2.744 | | | | 43.235** |
| | (5.861) | (8.533) | (105.033) | (11.504) | | | | (19.257) |
| Buy only | 15.044*** | -11.015*** | 6.035 | 16.529*** | 17.210*** | -15.081*** | 6.000 | 22.168*** |
| | (1.373) | (1.999) | (105.032) | (2.230) | (1.853) | (3.096) | (145.903) | (3.607) |
| Make & Buy | 28.310*** | -24.785*** | 5.037 | 31.185*** | 28.799*** | -22.127*** | 5.086 | 31.385*** |
| | (1.897) | (2.762) | (105.032) | (3.003) | (2.956) | (4.939) | (145.903) | (4.856) |
| Time dummies | yes | yes | yes | yes | yes | yes | yes | yes |
| 2-digit industry dummies | yes | yes | yes | yes | yes | yes | yes | yes |
| Standard error | 18.94 | 27.58 | | 29.72 | 17.10 | 17.10 | | 29.69 |
| Number of firms | 979 | 979 | 979 | 979 | 474 | 474 | 470 | 474 |
| Test: make+buy <= b&m p-value | | | | 0.84 | | | | 0.04 |
| **Second equation** | **(1)** | **(2)** | | | **(1)** | **(2)** | | |
| **Regression** | IV | IV | | | IV | IV | | |
| **Dependent variable** | **l-(g1-Pi)** | **l-(g1-Pi)** | | | **l-(g1-Pi)** | **l-(g1-Pi)** | | |
| Constant | 3.652*** | 3.639*** | | | 2.733 | 2.153 | | |
| | (1.231) | (1.247) | | | (2.177) | (2.223) | | |
| g2 | 1.027*** | 1.112*** | | | 1.002*** | 0.995*** | | |
| | (0.055) | (0.116) | | | (0.088) | (0.215) | | |
| d (dummy) | 2.542 | -0.551 | | | 8.958** | 8.731 | | |
| | (2.079) | (4.218) | | | (3.530) | (8.675) | | |
| Time dummies | yes | yes | | | yes | yes | | |
| 2-digit industry | yes | yes | | | yes | yes | | |
| Standard error | 25.95 | 26.29 | | | 27.74 | 27.57 | | |
| Number of firms | 979 | 979 | | | 474 | 470 | | |
| F test, g2real | 371.10*** | 67.33*** | | | 211.0*** | 53.44*** | | |
| F test, d | | 179.79*** | | | | 106.42*** | | |
| Davidson-MacKinnon | 19.30*** | 4.34** | | | 9.59*** | 0.48 | | |
| Davidson-MacKinnon | | 0.718 | | | | 0.002 | | |
| Sargan | 2.894 | 3.547 | | | 0.889 | 0.0147 | | |
| Degrees of freedom | 2 | 2 | | | 2 | 1 | | |

*Notes:* **1-** Robust standard errors in parentheses. **2-** All regressions include 2-digit industry dummies. **3-** * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.

The coefficient is positive, showing positive effects from process innovation. The Davidson McKinnon test of exogeneity does not reject the null hypothesis of exogeneity of the process innovation variable, while the contrary happens for $g_2$. The F and the Sargan test indicate no problems of valid and weak instruments. Similar results are found for KIBS (Table 13).

**Table 13. Innovation Strategies –KIBS**

| **Sector** | | **KIBS** | | |
|---|---|---|---|---|
| **First equation** | **A** | **B** | **C** | **Red Form** |
| **Regression** | OLS | OLS | Probit | OLS |
| **Dependent variable** | g2 | g1-π | d | l-(g1-Pi) |
| Constant | 0.881 | 3.760* | -5.724 | 3.062 |
| | (1.624) | (2.263) | (172.349) | (2.179) |
| Make only | 14.606** | | 4.882 | 4.884 |
| | (7.006) | | (172.350) | (12.797) |
| Buy only | 16.483*** | -9.490*** | 6.024 | 17.050*** |
| | (2.489) | (3.471) | (172.349) | (3.721) |
| Make & Buy | 27.218*** | -23.744*** | 4.950 | 33.425*** |
| | (2.943) | (4.110) | (172.350) | (4.458) |
| Time dummies | yes | yes | yes | Yes |
| 2-digit industry dummies | yes | yes | yes | Yes |
| Standard error | 21.37 | 29.80 | | 31.76 |
| Number of firms | 407 | 397 | 407 | 407 |
| Test: make+buy <= b&m p-value | | | | 0.84 |
| **Second equation** | **(1)** | **(2)** | | |
| **Regression** | IV | IV | | |
| **Dependent variable** | **l-(g1-Pi)** | **l-(g1-Pi)** | | |
| Constant | 2.101 | 1.505 | | |
| | (2.092) | (2.270) | | |
| g2 | 1.055*** | 1.291*** | | |
| | (0.086) | (0.189) | | |
| d (dummy) | 2.513 | -6.735 | | |
| | (3.455) | (7.485) | | |
| Time dummies | yes | yes | | |
| 2-digit industry dummies | yes | yes | | |
| Standard error | 27.46 | 29.31 | | |
| Number of firms | 407 | 407 | | |
| F test, g2real | 32.98*** | 24.69*** | | |
| F test, d | | 67.15*** | | |
| Davidson-MacKinnon test of exog | 7.29** | 6.00** | | |
| Davidson-MacKinnon test of exog d | | 2.129 | | |
| Sargan | 4.149 | 2.043 | | |
| Degrees of freedom | 2 | 2 | | |

*Notes:* **1-** Robust standard errors in parentheses. **2-** All regressions include 2-digit industry dummies. **3-** * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.

The next exercise analyzes the effect of innovation on the skill composition of the labor force. Table 14 shows the results for the growth rate of skilled (columns 1 to 3) and unskilled employment (columns 4 to 6). Very similar results to the ones obtained for the manufacturing sector were found. In the third column of each panel we have used the reduced form estimation, the OLS estimation of equation 4. The buy only and the make and buy strategies are significantly different from zero and positive, indicating a positive effect on the employment growth of skilled or unskilled labor. Instead the make only strategy has no effect on the growth rate of skilled labor, and negative effects on the growth of unskilled labor. For both type of labor, it cannot be rejected the hypothesis that the combined strategy has larger effects than the sum of the other two for skilled labor growth.

The coefficient on the make & buy and buy only strategy variable are greater for the skilled than for the unskilled labor growth rates. We can interpret this as a differential impact, having more positive effects on the skilled labor force.

The first-stage equation for $g_2$ shows significant and positive coefficients for the make and buy and buy-only strategies. However, no strategy is sufficient to explain the probability of undertaking process innovations only. The second-stage estimations show that the coefficient on $g_2$ is significant, positive, and slightly higher than unity for the skilled labor, while below unity for unskilled labor. This means that innovation has more positive effects on productivity using unskilled than skilled labor. Meanwhile, *d* is never significant.

To conclude, the combined strategy, where firms produce in-house and also buy knowledge externally, has the biggest positive effect on employment growth. The buy-only strategy is, in general, second in the ranking. The effects of the strategies are larger for the skilled labor force. Product innovation has a differential impact on labor composition, having larger positive effects on skilled labor. Process innovation appears to have no effect on employment.

## Table 14. Innovation Strategies – Labor Skills - OLS All Service Sector Firms

| **Service sector** | | **Skilled** | | | | **Unskilled** | | |
|---|---|---|---|---|---|---|---|---|
| **First equation** | **A** | **B** | **C** | **Red Form** | **A** | **B** | **C** | **Red Form** |
| **Regression** | OLS | OLS | Probit | OLS | OLS | OLS | Probit | OLS |
| **Dependent variable** | g2 | g1-π | d | l-(g1-Pi) | g2 | g1-π | d | l-(g1-Pi) |
| Constant | 0.043 | 2.305 | -5.700 | -3.636 | 0.043 | 2.305 | -5.700 | 5.617** |
| | (1.932) | (2.43) | (221.09) | (3.939) | (1.932) | (2.434) | (221.096) | (2.670) |
| Make only | 2.980 | -0.261 | 5.700 | 14.932 | 2.980 | -0.261 | 5.700 | -16.582** |
| | (14.009) | (17.64) | (221.09) | (11.483) | (14.009) | (17.647) | (221.098) | (8.402) |
| Buy only | 14.282*** | - | 6.088 | 17.384*** | 14.282** | -11.122*** | 6.088 | 8.236* |
| | (2.882) | (3.63) | (221.09) | (6.228) | (2.882) | (3.630) | (221.096) | (4.968) |
| Make & Buy | 24.527*** | - | 5.158 | 34.756*** | 24.527** | -25.522*** | 5.158 | 18.470*** |
| | (4.054) | (5.10) | (221.09) | (7.222) | (4.054) | (5.107) | (221.096) | (5.995) |
| Time dummies | yes | Yes | yes | yes | yes | yes | yes | yes |
| 2-digit industry | yes | Yes | yes | yes | yes | yes | yes | yes |
| Standard error | 19.24 | 19.24 | | 39.93 | 19.24 | 19.24 | | 33.05 |
| Number of firms | 224 | 224 | 224 | 224 | 224 | 224 | 224 | 224 |
| Test: make+buy <= b&m p-value | | | | 0.58 | | | | 0.75 |
| **Second equation** | **(1)** | **(2)** | | | **(1)** | **(2)** | | |
| **Regression** | IV | IV | | | IV | IV | | |
| **Dependent variable** | **l-(g1-Pi)** | **l-(g1-Pi)** | | | **l-(g1-Pi)** | **l-(g1-Pi)** | | |
| Constant | -3.403 | -3.600 | | | 5.381* | 5.372* | | |
| | (3.625) | (3.823) | | | (2.818) | (2.824) | | |
| g2 | 1.055*** | 1.448*** | | | 0.873*** | 0.891*** | | |
| | (0.165) | (0.436) | | | (0.128) | (0.322) | | |
| d (dummy) | 6.904 | -4.633 | | | -6.843 | -7.377 | | |
| | (5.834) | (13.243) | | | (4.535) | (9.783) | | |
| Time dummies | yes | Yes | | | yes | yes | | |
| 2-digit industry | yes | Yes | | | yes | yes | | |
| Standard error | 36.26 | 38.19 | | | 28.19 | 28.21 | | |
| Number of firms | 224 | 224 | | | 224 | 224 | | |
| F test, g2 | 84.59*** | 15.89** | | | 84.59*** | 156*** | | |
| F test, d | | 53.11*** | | | | 17.69** | | |
| Davidson-MacKinnon test of exog g2 | 0.43 | 1.34 | | | 0.32 | 0.31 | | |
| Davidson-MacKinnon test of exog d | | 1.032 | | | | 0.31 | | |
| Sargan | 1.355 | 0.245 | | | 0.565 | 0.560 | | |
| Degrees of freedom | 2 | 1 | | | 2 | 1 | | |

*Source:* Authors' calculations.

*Notes:* **1-** Robust standard errors in parentheses. **2-** All regressions include 2-digit industry dummies. **3-** * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.

## 4. Summary

The empirical evidence presented sheds light on the employment impact of innovation in the heterogeneous universe of the service sector. In the first step we considered the effects of product and process innovation on total employment. Our results show that the impact of product innovation on employment is positive, while process innovation appears to have, in general, no effect. Nevertheless, the effect varies according to the skill level of the labor force, across sectors, and the type of innovation strategy pursued by firms.

Product innovation is on average the most important driver of employment growth in the period considered, and it compensates the negative effect of the contribution of old products. For small firms and KIBS, we observed a similar salient effect of product innovations. The difference is that for these two subsamples, the productivity trend of old products is negative.

In a second step, we considered the impact on employment composition in terms of skills or types of worker. Our results show that while process innovation has no effect on the employment growth of skilled labor, it tends to have a negative effect on the employment growth of unskilled labor. In the case of KIBS, this variable is not always significant. Sales of new product are always significant but have a differential impact on skilled and unskilled labor. Innovation allows an increase in the efficiency in the production of new products in the case of unskilled labor, while there is no efficiency gain in the production of new products relative to old ones with skilled labor.

Our results suggest that there is an even more important skill bias in the service sector than in manufacturing industries. The differential impact of innovation on skilled and unskilled labor appears in the whole sector and particularly in traditional services. These results show the relevance of implementing training policies for unskilled labor in traditional services to compensate for this tendency.

Finally, we analyzed the impact of different innovation strategies: produce technology (make) and/or source technology externally (buy). The evidence indicates that buying technology has a generally positive impact on employment, while the combined strategy, where firms produce in-house and also buy knowledge externally, has in general the strongest positive effects, both for skilled and unskilled employment. Innovation policymakers should take into account, when designing innovation policy instruments, that the combined innovation strategy is more "employment friendly".

When the results for services are compared with those obtained for manufacturing firms (Aboal et al., 2011), some interesting conclusions emerge. Even though in general similar results are found for both service and manufacturing firms, there are at least a couple of noticeable differences. First, for manufacturing firms (total sample), process innovation has a negative effect on employment growth, while for services it has a null effect. Second, producing in-house technology has the biggest positive impact on employment growth in manufacturing (total sample), but has no impact on services, where the strategy with the biggest positive impact is the combined one (make & buy).

We would like to end this paper with a note of caution. The results found here cannot be interpreted as applying to the entire service sector, but only to those subsectors covered by the SIS in Uruguay. The criteria used for selecting subsectors may have introduced a bias in the results obtained in terms of innovation. For example, the exclusion of retail might lead to an overestimation of innovation rates, just as the exclusion of finance activities might lead to underestimation.

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# Appendix A. Definitions

## A.1 Definition of Variables and Information available for Manufacturing Firms

| | | | | |
|---|---|---|---|---|
| Innovation surveys | | SIS | | 2004–2006, 2007–2009 |
| Economic activity surveys | | EAS | | 2004, 2006, 2007 |
| **Variables** | **Description** | **Source** | **Availability** | **Definition** |
| *turn_fin* | Sales end of period | IS, EAS | All surveys | For year 2006 and 2009 we used IS: sales of goods and services produced or commercialized by the firm at the end year of each survey. For years 2000, 2003 we used EAS. |
| *turn_init* | Sales beginning of period | EAS | All surveys | Revenue from sales of goods and services produced or commercialized. |
| *lnsales* | Log of sales | IS, EAS | All surveys | Logarithm of turn fin. |
| *g* | Sales growth rate | | | Average annual sales growth, calculated by (ln(turn_fin)−ln(turn_init))/2*100 |
| *employ_fin* | Total employment end of period | IS, EAS | All surveys | For year 2006 and 2009 we used IS: Number of people employed on average in the final year of the survey, including professionals, technicians without a dependent relationship, owners and business associates working in the firm, and not paid family workers. |
| *employ_init* | Total employment beginning of period | EAS | All surveys | Total employment including only dependent workers, owners and business associates working in the firm, and not paid family workers. |
| *l* | Employment growth rate | | | Average annual employment growth, calculated by (ln(employ_fin)−ln(employ_init))/2*100. |
| *pindex_fin* | Implicit prices in GDP | INE | Years 2006, 2009 | Index of prices is computed on the basis of the Implicit prices in GDP for the services. |
| *pindex_init* | Implicit prices in GDP | INE | Years 2004, 2007 | |
| *gprices* | Prices growth rate | | | Average annual prices growth rate, calculated by (ln(pindex_fin)−ln(pindex_init))/2*100. |
| *foreign_own* | Foreign ownership | IS | | =1 if of foreign capital is bigger than 10 percent. |
| *small* | Small firms | IS | All surveys | Dummy that defines firms with up to 50 employees at the end of the survey. |
| typefirm=1 | *Non (process or product)* | | All surveys | Firm does not report innovation in product or process. |
| typefirm=2 | *Process only innovators* | | All surveys | Firm introduced new or significantly improved technology or production methods that substantially changed the production or firms introduced new or substantially modified forms of organization and management of the establishment or local changes in the organization of the production process. Includes innovation in commercialization: methods for the marketing of products (goods or services) new, new methods of delivery of existing products or changes in packaging. |
| typefirm=3 | *Product innovators* | IS | All surveys | Firm introduced new or significantly improved goods or services to the market. |
| *d* | Process or organizational innovation | IS | All surveys | Dummy of process innovation only or organizational innovation only: = 1 if the firm introduced new or improved technology or methods that substantially changed the production or if the firm has made innovation in commercialization: methods for the marketing of products (goods or services) new, new methods of delivery of existing products or changes in packaging and / or packaging. |
| *innovation* | Percentage of sales that are product innovation | IS | All surveys | Share of total sales with new products. Percentage of sales to local market and exports of a product that is technologically novel or significantly improved. |

| | | | | |
|---|---|---|---|---|
| *g2* | Sales growth rate of new products | | | g2=innovation*(1+g/100). |
| *g1* | Sales growth rate of old products | | | g1=g-g2. |
| *rdcont* | Continuos R&D | IS | All surveys | =1 if firms declare having invested in R&D continuously. |
| *share_fin* | Share of skilled labor | IS | 2006, 2009 | Percentage of professionals and technicians working in the last year of the survey for the firm. |
| *lskill_employ* | Log of skilled employment | IS | 2006, 2009 | lskill_employ=ln(share_fin*employ_fin/100). |
| *lunskill_employ* | Log of unskilled employment | IS | 2006, 2009 | lunskill_employ=ln((100-share_fin)*employ_fin/100). |
| *ls* | Growth rate of skilled labor | | | ls=(lskill_employ-l.lskill_employ)/3*100. |
| *lu* | Growth rate of unskilled labor | | | lu= (lunskill_employ-l.lskill_employ)/3*100. |
| *range* | Increased range of goods and services | IS | All surveys | Assesses the impact of innovation on the increase in the range of goods produced by firms. The variable indicates the impact on a scale of 0 to 3 (0 = irrelevant impact, 1= low, 2= medium, and 3 = high impact). |
| *newmkt* | Impact of innovation on development of new markets | IS | All surveys | Coded between 0 to 3 (0 = irrelevant impact, 1= low, 2= medium, and 3 = high impact). |
| *Make* | Make only dummy | IS | All surveys | =1 if firm reports in-house development: internal R&D. |
| *Buy* | Buy only dummy | IS | All surveys | =1 if firm reports external R&D, acquisition of capital goods, hardware and software or technology transfer, consultancy, training, engineering and industrial design, or organization and management design. |
| *Bnm* | Make&buy dummy | IS | All surveys | =1 if firm reports both activities. |

## Appendix B. Tables

### Table B.1 Descriptive Statistics – Service Sector Small Firms

| | Mean | Median | Standard deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| **Number of observations** | 475 | | | | |
| | | | | | |
| **Distribution of firms (%)** | | | | | |
| Non-innovators (no process or product | 0.63 | | | | |
| Process only innovators (nonproduct | 0.18 | | | | |
| Product innovators | 0.19 | | | | |
| *(of which product and process innovators-* | 0.75 | | | | |
| | | | | | |
| **Number of employees at the beginning of** | 20.51 | 17 | 14.35 | 1 | 103 |
| **Foreign ownership (10% or more)** | 0.12 | 0 | 0.32 | 0 | 1 |
| **Located in the capital of the country** | 0.79 | 1 | 0.41 | 0 | 1 |
| | | | | | |
| **Employment growth (%) (yearly rate)** | | | | | |
| *All firms* | 7.7 | 5.6 | 19.2 | -50.6 | 72.8 |
| Non-innovators (no process or product | 5.0 | 4.2 | 18.9 | -50.6 | 71.4 |
| Process only innovators (nonproduct | 14.4 | 11.2 | 19.3 | -36.1 | 66.1 |
| Product innovators | 10.1 | 6.9 | 18.6 | -28.0 | 72.8 |
| | | | | | |
| **Growth wage bill per worker (%) (yearly** | na | na | na | na | Na |
| | | | | | |
| **Sales growth (%)**[1] (nominal growth) (yearly | | | | | |
| *All firms* | 8.9 | 8.1 | 26.7 | -96.8 | 121.3 |
| Non-innovators (no process or product | 8.2 | 8.6 | 27.7 | -96.8 | 121.2 |
| Process only innovators (nonproduct | 9.7 | 7.9 | 26.4 | -87.6 | 121.3 |
| Product innovators | 10.5 | 7.9 | 23.2 | -45.5 | 117.5 |
| *of which:* | | | | | |
| Old products | -29.0 | -35.6 | 23.2 | -50.0 | 31.9 |
| New products | 39.5 | 38.9 | 28.7 | 0.0 | 167.5 |
| | | | | | |
| **Labor productivity growth (%)**[1] (yearly rate) | | | | | |
| *All firms* | 1.2 | 2.2 | 28.8 | -98.0 | 144.8 |
| Non-innovators (no process or product | 3.2 | 3.9 | 28.6 | -98.0 | 144.8 |
| Process only innovators (nonproduct | -4.7 | -2.2 | 28.7 | -90.1 | 70.2 |
| Product innovators | 0.3 | -2.4 | 29.1 | -74.5 | 124.7 |
| | | | | | |
| **Prices growth (%)** [2] | | | | | |
| *All firms* | 4.9 | 7.7 | 7.8 | -30.0 | 14.5 |
| Non-innovators (no process or product | 5.4 | 7.7 | 8.0 | -30.0 | 14.5 |
| Process only innovators (nonproduct | 4.0 | 5.4 | 6.6 | -17.5 | 14.5 |
| Product innovators | 4.5 | 7.7 | 8.3 | -30.0 | 14.4 |

## Table B.2 Descriptive Statistics by Sector in Services

| | Provision of electricity, gas, steam and hot water | Collection, purification and water distribution | Hotels and restaurants | Land transport. | Water transport. | Air transport. | Transport activities | Post and tele-communications | Renting of machinery and equipment | IT and related activities | R&D | Services provided to companies | Health-related activities |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Number of observations** | 7 | 4 | 107 | 38 | 11 | 8 | 186 | 71 | 18 | 41 | 16 | 281 | 194 |
| Number of employees at the beginning of (each) survey | 1863.1 | 2231.5 | 115.2 | 298.9 | 91.2 | 94.4 | 44.7 | 278.6 | 25.6 | 36.4 | 73.3 | 124.8 | 368.1 |
| Foreign ownership (10% or more) | 0.7 | 0.3 | 0.2 | 0.0 | 0.3 | 1.0 | 0.1 | 0.3 | 0.1 | 0.3 | 0.2 | 0.1 | 0.0 |
| Employment growth (%) (yearly rate) | 11.7 | -4.3 | 4.8 | 4.0 | 9.0 | 4.5 | 9.8 | 11.6 | 11.5 | 20.5 | 10.4 | 9.7 | 14.0 |
| Sales growth (%) (nominal growth) (yearly rate) | 10.0 | 9.5 | 14.2 | 24.0 | 12.4 | -1.6 | 4.4 | 13.2 | 19.1 | 10.0 | 5.0 | 11.7 | 11.7 |
| of which old products | -24.9 | -49.5 | -25.8 | -36.3 | -23.1 | -50.0 | -28.7 | -19.4 | -20.0 | -31.8 | -24.2 | -26.2 | -24.6 |
| of which new products | 37.9 | 53.7 | 38.1 | 62.7 | 38.8 | 54.9 | 33.6 | 31.8 | 42.8 | 43.3 | 43.5 | 40.5 | 36.9 |
| **Knowledge/ innovation** | | | | | | | | | | | | | |
| R&D/sales | 4.8E-10 | 8.7E-10 | 2.6E-10 | 2.2E-09 | 1.3E-09 | 5.9E-10 | 4.1E-10 | 6.1E-09 | 8.9E-09 | 2.8E-08 | 6.2E-07 | 4.9E-09 | 9.9E-10 |
| Innovation expenditures /sales | 0.03 | 0.02 | 0.01 | 0.03 | 0.07 | 0.22 | 0.05 | 0.02 | 0.01 | 0.05 | 0.78 | 0.01 | 0.02 |
| Non-innovators (no process or product innovations) | 0.29 | 0.50 | 0.73 | 0.47 | 0.55 | 0.63 | 0.56 | 0.39 | 0.72 | 0.22 | 0.50 | 0.53 | 0.46 |
| Process only innovators (nonproduct innovators) | 0.43 | 0.25 | 0.16 | 0.34 | 0.09 | 0.00 | 0.27 | 0.24 | 0.06 | 0.10 | 0.06 | 0.26 | 0.28 |
| Product innovators | 0.29 | 0.25 | 0.11 | 0.18 | 0.36 | 0.38 | 0.17 | 0.37 | 0.22 | 0.68 | 0.44 | 0.21 | 0.25 |
| (of which product and process innovators-of the whole 100%) | 1.00 | 1.00 | 0.83 | 0.71 | 1.00 | 0.67 | 0.81 | 0.92 | 0.75 | 0.71 | 0.86 | 0.79 | 0.90 |

## Table B.3 Descriptive Statistics – KIBS

| | KIBS | | | | |
|---|---|---|---|---|---|
| | **Mean** | **Median** | **Standard** | **Minimum** | **Maximum** |
| **Number of observations** | 409 | | | | |
| **Distribution of firms (%)** | | | | | |
| Non-innovators (no process or product innovations) | 0.47 | | | | |
| Process only or organizational only innovators (non-product | 0.23 | | | | |
| product innovators | 0.29 | | | | |
| *(of which product and process innovators-of the whole 100%)* | 0.81 | | | | |
| Number of employees at the beginning of (each) survey | 140.6 | 56 | 397.1 | 2 | 5309 |
| Foreign Ownership (10% or more) | 0.2 | 0 | 0.4 | 0 | 1 |
| Located in the capital of the country | 0.9 | 1 | 0.3 | 0 | 1 |
| | | | | | |
| **Employment growth (%) (yearly rate)** | | | | | |
| *All firms* | 11.2 | 9.1 | 20.4 | -50.6 | 83.5 |
| Non-innovators (no process or product innovations) | 6.6 | 6.2 | 20.3 | -50.6 | 83.5 |
| Process only or organizational only innovators (non-product innovators) | 15.5 | 13.7 | 18.1 | -13.6 | 80.9 |
| Product innovators | 15.1 | 10.7 | 20.8 | -27.2 | 80.5 |
| | | | | | |
| **Sales growth (%)**[1] (nominal growth) (yearly rate) | | | | | |
| *All firms* | 11.5 | 10.5 | 26.2 | -96.8 | 121.2 |
| Non-innovators (no process or product innovations) | 8.0 | 9.2 | 30.0 | -96.8 | 121.2 |
| Process only or organizational only innovators (non-product | 16.0 | 13.9 | 20.1 | -52.1 | 66.8 |
| Product innovators | 13.5 | 10.4 | 23.3 | -45.5 | 110.9 |
| *of which:* | | | | | |
| Old products | -25.9 | -30.3 | 24.7 | -50.0 | 55.1 |
| New products | 39.4 | 37.4 | 31.1 | 0.0 | 160.9 |
| | | | | | |
| **Labor productivity growth (%)**[1] (yearly rate) | | | | | |
| *All firms* | 0.3 | 3.7 | 27.1 | -140.1 | 94.6 |
| Non-innovators (no process or product innovations) | 1.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| Process only or organizational only innovators (non-product innovators) | 0.4 | 7.7 | 10.6 | -30.0 | 12.8 |
| Product innovators | -1.6 | 7.7 | 12.0 | -30.0 | 12.8 |
| | | | | | |
| **Prices growth (%)** [2] | | | | | |
| *All firms* | 4.7 | 7.7 | 11.7 | -30.0 | 12.8 |
| Non-innovators (no process or product innovations) | 5.4 | 7.7 | 10.6 | -30.0 | 12.8 |
| Process only or organizational only innovators (non-product innovators) | 4.9 | 7.7 | 12.0 | -30.0 | 12.8 |
| Product innovators | 3.5 | 7.7 | 13.0 | -30.0 | 12.8 |

## Table B.4 Effect of Innovation on Employment Quantity –Robustness Checks

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| **Sector** | **Services** | | **Services small firms** | | **KIBS** | |
| **Regression** | **OLS** | **IV** | **OLS** | **IV** | **OLS** | **IV** |
| Constant | 5.225*** | 4.263*** | 2.074 | 2.768 | 4.008* | 3.931* |
| | (1.176) | (1.269) | (1.746) | (1.783) | (2.161) | (2.285) |
| Process innovation only *(d)* | 0.099 | 1.130 | 7.967** | 7.132** | 0.920 | 1.105 |
| | (1.896) | (2.105) | (3.649) | (3.589) | (3.055) | (3.641) |
| Sales growth d.t new products *(g2)* | 0.773*** | 0.770*** | 0.798*** | 0.636*** | 0.893*** | 0.909*** |
| | (0.110) | (0.164) | (0.110) | (0.163) | (0.106) | (0.230) |
| Sales growth d.t new products | 0.109 | 0.219 | -0.154 | 0.553 | -0.183 | -0.688 |
| x process and product inn | (0.112) | (0.157) | (0.153) | (0.641) | (0.130) | (0.660) |
| Foreign owned (10% or more) | 5.808** | 5.333** | 6.186 | 6.571 | 2.262 | 1.799 |
| | (2.428) | (2.535) | (5.035) | (4.602) | (3.206) | (3.744) |
| 2-digit industry dummies | yes | yes | yes | yes | yes | yes |
| Standard error | 25.71 | 25.71 | 27.46 | 27.85 | 27.46 | 27.46 |
| Number of observations | 982 | 982 | 475 | 475 | 475 | 475 |
| F test, g2 | | 34.58*** | | 4.234*** | | 8.72*** |
| g2 Exogeneity (Davidson-McKinnon) | | 0.01 | | 0.01 | | 0.65 |
| Sargan | | 2.971 | | 5.810 | | 5.541 |
| Degrees of freedom | | 5 | | 4 | | 4 |

*Notes:*

[1] - instrumenting d and g2 by "increased range of good"

[2] - instrumenting g2 and the interaction between g2 and the products & process innov. dummy.
Instrument used are "increased range of good", and the interactions of them with the products & process innov. dummy.

All regressions include industry and time dummies. F test denotes de F of excluded instruments in the first-stages regressions. Exogeneity denotes Davidson-MacKinnon test of Exogeneity. Sargan test denotes of overidentifying restrictions test. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

## Table B.5 Effect of Innovation on Employment Quality –Robustness Checks

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| **Sector** | **Service sector** | | | |
| | **Skilled** | | **Unskilled** | |
| **Regression** | **OLS** | **IV** | **OLS** | **IV** |
| Constant | -2.759 | -3.960 | 6.327** | 8.206*** |
| | (3.733) | (3.802) | (2.833) | (2.978) |
| Process innovation only (d) | 6.224 | 7.417 | -8.109** | -9.732** |
| | (5.714) | (5.757) | (3.614) | (4.509) |
| Sales growth d.t new products (g2) | 1.031*** | 0.972** | 1.091*** | 0.671** |
| | (0.271) | (0.411) | (0.355) | (0.322) |
| Sales growth d.t new products | -0.063 | 0.116 | -0.346 | -0.024 |
| x process and product inn | (0.293) | (0.419) | (0.376) | (0.328) |
| Foreign owned (10% or more) | -17.695 | -17.922 | 10.687* | 9.784 |
| | (11.145) | (13.086) | (6.360) | (10.248) |
| Fully foreign owned | 25.310** | 25.691* | -13.538* | -12.202 |
| | (12.671) | (14.192) | (7.204) | (11.115) |
| 2-digit industry dummies | yes | Yes | yes | yes |
| Standard error | 36.38 | 36.02 | 28.24 | 28.21 |
| Number of observations | 224 | 224 | 224 | 224 |
| F test, g2 | | 11.60*** | | 11.60** |
| g2 Exogeneity (Davidson- | | 0.758 | | 2.371 |
| Sargan | | 8.084 | | 15.91 |
| Degrees of Freedom | | 11 | | 11 |

*Notes:*
[1] - instrumenting d and g2 by "increased range of good" .
[2] - instrumenting g2 and the interaction between g2 and the products & process innov. dummy.
Instrument used are "increased range of good", and the interactions of them with the products & process innov. dummy.
All regressions include industry and time dummies. F test denotes de F of excluded instruments in the first-stages regressions. Exogeneity denotes Davidson-MacKinnon test of Exogeneity. Sargan test denotes of overidentifying restrictions test. Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

## Table B.6: Descriptive Statistics for the Services and the Manufacturing Sector (period 2004-09)

| | Manufacturing | | | Services | | |
|---|---|---|---|---|---|---|
| | Tot | High | Low | Tot | KIB | Traditio |
| **Number of observations** | 118 | 692 | 491 | 984 | 409 | 547 |
| **Distribution of firms (%)** | | | | | | |
| Non-innovators (no process or product innovations) | 49.7 | 44.8 | 56.6 | 52.0 | 47.4 | 54.8 |
| Process only or organizational only innovators (nonproduct | 22.1 | 24.1 | 19.1 | 24.1 | 23.5 | 25.6 |
| Product innovators | 28.2 | 31.1 | 24.2 | 23.7 | 29.1 | 19.6 |
| *(of which product and process innovators-of the whole* | 84.7 | 84.7 | 84.9 | 82.8 | 80.7 | 86.0 |
| Number of employees at the beginning of (each) survey | 97.0 | 110.3 | 78.2 | 188. | 140. | 231.1 |
| Foreign ownership (10% or more) (%) | 14.9 | 11.2 | 17.5 | 14.2 | 18.1 | 10.1 |
| Located in the capital of the country (%) | 81.6 | 87.2 | 77.6 | 78.7 | 88.8 | 70.2 |
| **Employment growth (%) (yearly rate)** | | | | | | |
| *All firms* | 4.9 | 5.6 | 3.7 | 10.4 | 11.2 | 9.8 |
| Non-innovators (no process or product innovations) | 2.0 | 2.5 | 1.3 | 7.4 | 6.6 | 7.8 |
| Process only or organizational only innovators (non- | 6.5 | 6.9 | 5.8 | 14.2 | 15.5 | 13.3 |
| Product innovators | 8.6 | 9.1 | 7.7 | 13.1 | 15.1 | 11.1 |
| **Sales growth (%)**[1] (nominal growth) (yearly rate) | | | | | | |
| *All firms* | 6.2 | 6.9 | 5.4 | 11.0 | 11.5 | 10.6 |
| Non-innovators (no process or product innovations) | 3.9 | 4.4 | 3.4 | 9.1 | 8.0 | 9.7 |
| Process only or organizational only innovators (nonproduct | 8.5 | 9.3 | 7.1 | 13.6 | 16.0 | 12.0 |
| Product innovators | 8.5 | 8.6 | 8.4 | 12.4 | 13.5 | 11.0 |
| *of which:* | | | | | | |
| Old products | - | -18.3 | -20.8 | - | - | -26.9 |
| New products | 27.7 | 26.9 | 29.3 | 39.0 | 39.4 | 38.0 |
| **Labor productivity growth (%)**[1] (yearly rate) | | | | | | |
| *All firms* | 1.4 | 1.2 | 1.6 | -0.6 | 0.3 | 0.7 |
| Non-innovators (no process or product innovations) | 2.0 | 1.8 | 2.1 | 1.8 | 1.5 | 2.0 |
| Process only or organizational only innovators (nonproduct | 2.0 | 2.4 | 1.3 | -0.6 | 0.4 | -1.3 |
| Product innovators | -0.1 | -0.5 | 0.7 | -0.6 | -1.6 | 0.0 |
| **Prices growth (%)** [2] | | | | | | |
| *All firms* | 1.0 | 0.4 | 1.4 | 5.4 | 4.7 | 6.1 |
| Non-innovators (no process or product innovations) | 0.8 | 0.2 | 1.4 | 5.8 | 5.4 | 6.4 |
| Process only or organizational only innovators (non- | 1.6 | 1.0 | 1.9 | 5.5 | 4.9 | 5.9 |
| Product innovators | 0.9 | 0.6 | 1.1 | 4.4 | 3.5 | 5.7 |

*Notes:*

- KIBS includes: post and telecommunications, IT and related activities, research and development (R&D), and business services.
- Traditional services includes: hotels and restaurants, transport –excluding air transports-, provision of electricity, gas and water, and health related activities.
- High or low-tech classification of the manufacturing subsectors is done by calculating the innovation expenditure over turnover. Those subsectors below or in the median are classified as low tech, while the rest are classified as high tech.