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INNOVATION, FIRM SIZE, TECHNOLOGY INTENSITY, AND EMPLOYMENT GENERATION IN URUGUAY: THE MICROECONOMETRIC EVIDENCE[1]

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Abstract

The aim of this paper is to analyze the relationship between innovation and employment, in terms of both its quantity and quality, in Uruguay. The effect of product and process innovation on employment growth and on employment composition in terms of skills was studied, using data from manufacturing firms' innovation surveys, matched against economic activity surveys. The impact of different innovation strategies was also analyzed, particularly producing technology vs. sourcing technology externally. The results revealed that product innovation is associated with employment growth. There is (weaker) evidence that process innovation displaces labor. Product innovation is not more complementary to skilled than to unskilled labor. Producing technology in-house has the biggest positive impact on employment, followed by the make-and-buy strategy. Similar results are found for small firms and firms belonging to the low- and high-tech sectors. Interviews carried out with innovation agents support the view that in general innovation does not lead to job losses and that it generates greater demand for a more qualified labor force.

Keywords: innovation, innovation strategies, firm size, employment quantity and quality, innovation surveys, Uruguay.
JEL codes: D2, J23, L1, O31, O33.

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1 Introduction

Innovation, or the introduction of new products and production processes, is essential for growth and employment generation. Latin American countries increasingly see innovation as a way to increase competitiveness, diversify their economies, and move to higher value-added activities (OECD, 2010).

Innovation is an important growth factor for several OECD countries (OECD, 2010). The growth of multifactor productivity linked to innovation explains much of the total productivity growth of these countries. Multifactor productivity differences also account for much of the disparity between advanced and emerging economies. Innovation is thus key to reducing the productivity gap between these two types of economies.

The characteristics of innovation and technological change in Latin American economies are different from those in more advanced and other emerging economies. Innovations in Latin America are based more on the replication of best practices or the adaptation of technologies developed abroad and less on the development of new technologies. Consequently, the relationship between innovation and employment could be potentially different. Additionally, the particular market structures, the higher proportion of informality, and the abundance of labor could imply different effects of innovation on employment in Latin American economies.

The Uruguayan economy is characterized by a large presence of small domestic companies and a few large firms with foreign capital. Smaller companies tend to develop less formalized and systematic innovation activities than larger companies, where the probability of carrying out research and development (R&D) activities is greater (Baldwin, 1997). Of course, not only the size matters; smalls firms in the most knowledge-intensive sectors (e.g. ICT) tend to develop more complex innovation processes and to demand more qualified human resources. However, as is the case in most Latin American countries, the weight of high-tech or more knowledge-intensive sectors in the Uruguayan economy is significantly lower than in most advanced economies. These characteristics of Uruguayan firms can potentially affect how innovation activities impact the quantity and quality of employment.

This study is the first attempt to understand the relationship between innovation and employment at the firm level, in both quantitative and qualitative terms, in Uruguay. To take into account the particular structure of the Uruguayan economy, we will analyze the impact of firm size and technology intensity of firms on the innovation-employment relationship.[3]

We employ the simple theoretical framework presented in Harrison et al. (2008) to quantify the employment effects of innovation using innovation survey data. As in Harrison et al. (2008), we pay special attention to endogeneity. A regression relating firms' employment growth to the introduction of process innovations and the two components of sales growth accounted for by "unchanged" and "newly introduced or substantially improved" products, respectively, is used. We use data of four waves of Manufacturing Firms Innovation Surveys (MIS) covering the period 1998-2009 and match them with the annual Economic Activity Surveys (EAS).

The results indicate that product innovations are an important source of firm-level employment growth, while process innovations, which are likely to be associated with price reductions, tend to have a negative or no effect on employment depending on the sub-sample of firms analyzed. Innovation is not more complementary to skilled than to unskilled labor. Different innovation strategies have different impacts on employment and employment composition, but in general they are all positive. The make technology in-house strategy has the biggest positive effect on employment. The results are in general similar for small firms and for firms belonging to the high- and low-tech sectors.

For the analysis of qualitative aspects, we conducted interviews with innovation and employment policymakers, academics, representatives of business chambers, trade union representatives, and selected firm representatives to get their views on the impact of innovation on employment. The interviews indicate that the effect of innovation on total firm employment depends on multiple firm characteristics and on the characteristics of the environment in which they operate. A common view was that the impact of innovation on employment quality (as well as quantity) depends on the way that work is organized inside the firm, on the proximity of the employees to the production process and firm decisions making, and on the way in which firms

[3] There are only a few studies analyzing the innovation process and adoption in Uruguay. In the most recent of them, Cassoni and Ramada (2010) analyze the determinants of innovation and the impact of innovation (particularly R&D) on productivity growth at firm level, using 3 waves of manufacturing innovation surveys. Among their findings are that innovation accelerates labor productivity gains, while different types of innovation (process vs. product) have different impacts on it. The other studies available (e.g. Angelelli et al., 2009; Arocena and Sutz, 2008; Bértola et al., 2005; Rubianes, 2005) are in general descriptive studies that do not attempt to analyze the consequences of the process of innovation carried out by Uruguayan firms.

interact with other participants in the national innovation system, including universities, the public sector, and other innovating firms.

The interviews led us to conclude that the impact of innovation on the quality of employment has been generally positive. The firms interviewed indicated that the impact of R&D activities on employment has been primarily qualitative. The innovation process generates the need for training and additional skills or redistribution of tasks inside the firm, and this seems to be more important for firms making in-house innovations. Many of those interviewed pointed out that Uruguayan legislation has introduced rigidities and generated significant problems and tensions in the innovation process.

The rest of this study is organized as follows. Section 2 presents the qualitative analysis, describing the Uruguayan system of innovation and the innovation policy map and summarizing the views of innovation agents about the innovation-employment relationship. Section 3 develops the quantitative analysis, describing the data used and discussing the results. Finally, in Section 4, conclusions and some policy implications are presented.

2 Qualitative Analysis

2.1 General Description

Uruguay is a relatively small South American country with a population of 3.3 million. Services make up almost 70 percent of the 2010 GDP, while the production of manufacturing goods and construction accounts for 20 percent, and the production of primary goods accounts for the remaining 10 percent. Most of the country's exports are commodities and tourism services.

During the past 25 years, Uruguay's average annual GDP growth rate was 2.5 percent. However, in the past five years, the growth rate rose significantly, reaching an average annual rate of 6.5 percent.

At the beginning of the present century, the Uruguayan economy entered a severe crisis, which led to a macro devaluation of its currency in 2002. In spite of the depth of the crisis, the economy recovered relatively quickly. In 2004, economic growth accelerated, marked by increases in investment, particularly FDI, increases in productivity, reduction of unemployment, and diversification of the economic base and its export markets.

In this context, employment rose significantly, and unemployment fell to the historically low rate of below 7 percent. In 2010, unemployment was about 7 percent, and the unemployment rate of workers with tertiary education was 4.2 percent. The participation of the latter group in the labor force has grown slowly, reaching the current level of 25 percent. In comparative terms, Uruguay has made less progress in human capital accumulation. The proportion of workers who have completed tertiary education has remained relatively stagnant, while in the rest of the MERCOSUR[4] countries it has grown steadily.

Since 2005, when Uruguay began the reform of its innovation promotion system, investment in R&D has grown substantially. According to the Network for Science and Technology Indicators (RICYT), the ratio of R&D investment to GDP rose from 0.36 percent in 2006 to 0.64 percent in 2008. Nevertheless, investment in innovation in Uruguay is still quite low. Two-thirds of all investment in innovation originates in the public sector. Only 30 percent of firms in Uruguay, including both the manufacturing and services sectors, engage in innovation. Investment in innovation is higher in the manufacturing sector (9.3 percent of the sector's GDP) than in the services sector (2.6 percent of the sector's GDP) (ANII, 2009a and ANII, 2009b).

2.2 Policy Landscape and Recent Evolution

In 2005, the Uruguayan government redesigned the entire innovation promotion system. In the 1990s, multiple agencies were responsible for the Uruguayan national innovation system, resulting in an inefficient administration of the scarce resources devoted to R&D and other innovation activities (Rubianes, 2005).

[4] The full members of the Common Market of the South (MERCOSUR) include Argentina, Brazil, Paraguay, and Uruguay.

Table 1: Evolution of the Main Variables in Relation to Employment and Innovation

Variable	1995	2000	2005 1/	2010 (or most recent year) 3/
GDP per capita (US$ PPP)	7012	8145	9695	14342
GDP growth **(between periods)** (1995-2000) (1995-2000) (2005-2010)		11.5%	0.9%	35.3%
Labor productivity growth **(growth between period averages)** (1995-2000) (2000-2005) (2006-2010)		11.6%	-0.2%	19.9%
Share of the population in the labor force	45.2%	45.8%	45.4%	50.5%
Share of tertiary educated as a proportion of the labor force	15.5%	17.1%	20.5%	24.6%
Unemployment	10.9%	13.6%	12.2%	6.8%
Unemployment of the tertiary educated	6.8%	10.0%	8.5%	4.2%
Innovation expenditures/GDP of the Sector		8.0% (manufacturing)	9.3% (manufacturing) 2.6% (services)	
Innovation expenditures/GDP 2/		0.9%	1.7%	
R&D/GDP	0.3%	0.2%	0.4%	0.6%
BERD/GDP	0.08%	0.09%		0.12%

Notes: 1. Innovation expenditures/GDP of the sector is for 2006. 2. For 2000, innovation expenditures are for the manufacturing sector only, and for 2006 they are for the manufacturing and services sectors only. 3. R&D/GDP and BERD/GDP are for 2008.
Sources: GDP per capita (US$ PPP): International Monetary Fund, World Economic Outlook Database, October 2010 / GDP growth: Central Bank of Uruguay (BCU) / Labor productivity growth: National Statistics Institute (INE) and BCU / Share of the population in the labor force, Share of tertiary educated as a proportion of the labor force, Unemployment, Unemployment of the tertiary educated: INE / Innovation expenditures/GDP of the Sector: National Research and Innovation Agency (ANII) / Innovation expenditures/GDP: ANII, INE and World Bank Database / R&D/GDP, BERD/GDP: The Network for Science and Technology Indicators—Ibero-American and Inter-American (RICYT).

Since 2005, the National Research and Innovation Agency (ANII) has supervised the national innovation system and has been in charge of innovation policy in Uruguay. The ANII's main objectives are the development, organization, and administration of programs and policy instruments with the purpose of promoting scientific and technological activities and strengthening innovation capacity in Uruguay. The agency has coordinates and promotes alliances among actors and institutions that produce and demand knowledge and innovation.

Other public institutions have roles that overlap with those of the ANII. Two examples are the Commission for Scientific Research (CSIC) of the University of the Republic of Uruguay, the largest university of the country, and the National Agricultural Research Institute (INIA), which conducts research and promotes innovation in the agricultural sector.

Although the ANII administers most of the innovation policy instruments in Uruguay, the COMAP, a commission in charge of applying the Uruguayan Investment Promotion Law,[5] also has some discretion to make recommendations to the Executive branch regarding incentives for innovation investment projects.[6] While the ANII is in charge of evaluating the projects that are seeking the incentives to undertake innovation projects provided by the law, the COMAP has the final say on whether the project will be recommended for tax exemptions.

Interactions between Policy Dimensions

National science, technology and innovation policies are defined by the Executive branch through the Ministerial Committee for Innovation (GMI), comprising the Ministries of Education and Culture, Economy and Finance, Industry, Energy and Mining, Agriculture, Public Health, and the Planning and Budget Office. The Ministry of Education and Culture chairs the GMI and supervises the ANII. The Executive branch approves the National Strategic Plan for Science, Technology, and Innovation. The Ministry of Labor and Social Security is not part of the GMI.[7] This explains, at least partially, the lack of coordination between innovation and employment policies in Uruguay.

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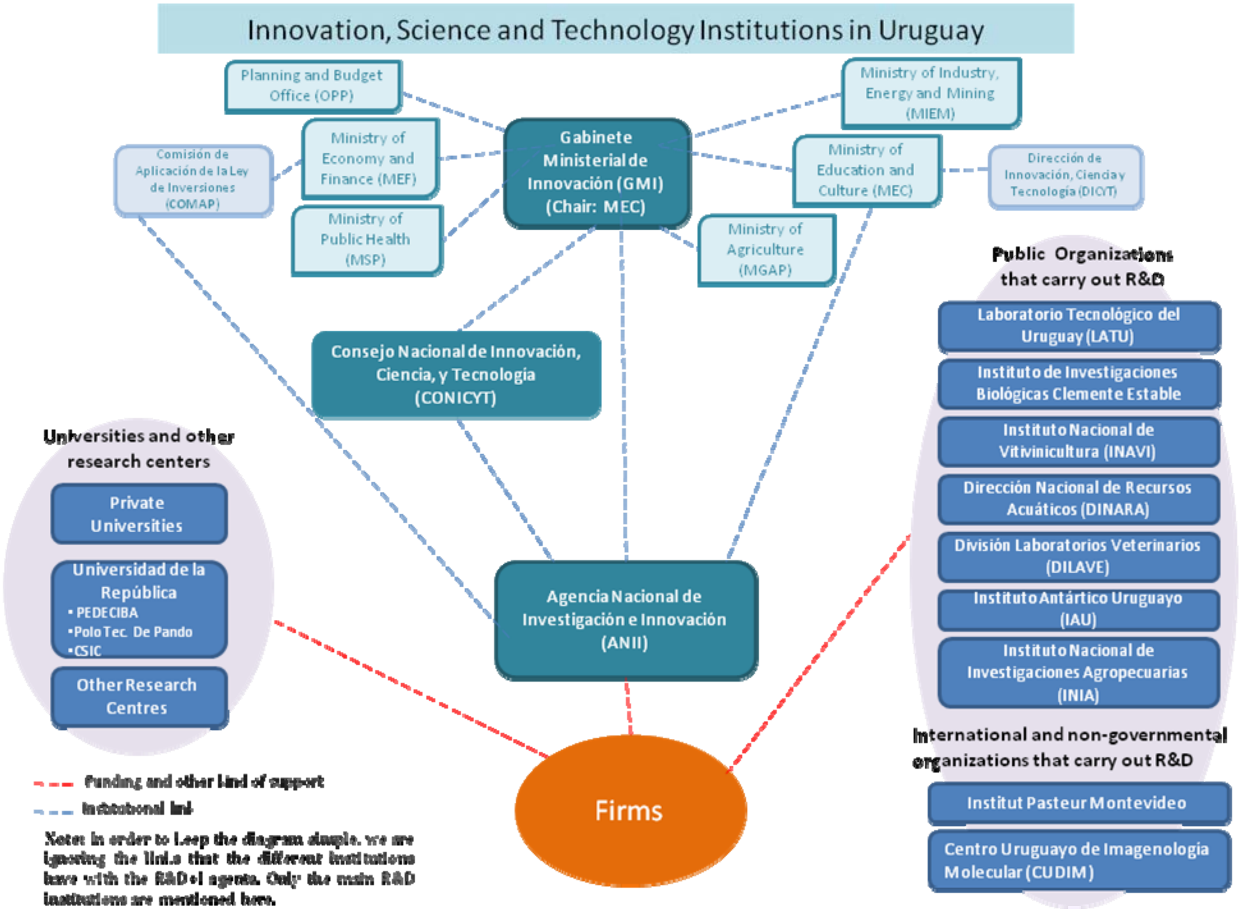
[5] Law 16.906.

[6] The investment promotion law provides tax incentives for investment projects that reach goals in terms of R&D and technological innovations in products and processes. Specifically, the law gives tax incentives to projects that include: machinery and equipment acquisition, consultancy and transference of new technologies, hardware and software directed to R&D acquisition, industrial design, and training.

[7] This Ministry is one of the main institutions responsible for the design of employment and training policies at the national level.

Figure 1. Innovation Institutional Framework in Uruguay



ANII interacts with the Executive branch via the GMI. In fact, five of the seven members of ANII's board of directors are nominated by the GMI. The other two are nominated by the National Council of Innovation, Science, and Technology (CONICYT).

The CONICYT articulates the interests of different institutions linked in one way or another to science, technology and innovation in Uruguay. The council has five representatives from the Executive branch, five from the business chambers, seven from the academic-scientific sector, one from the Congress of Mayors, one from the workers, one from the National Administration of Public Education, and one from the public sector companies. The president of the Council is chosen by the Council.

The CONICYT's main goals are to establish cooperation among its member organizations and to advise the Executive and the Legislative branches on science, technology, and innovation issues. ANII's policy instruments are decided in consultation with the CONICYT.

ANII's interactions with public sector companies have gained strength recently with the creation of sectoral funds directed at the promotion of innovation. One example is the Energy Innovation Fund, funded by two public companies. ANII also works in coordination with other public institutions, such as the Uruguayan Technological Laboratory and the Public Health Services Administration. However, the coordination of innovation policies with other public policies in the areas of employment, education, and training, is weak at best.

Based on the innovation strategy defined by the government and in consultation with the CONICYT, ANII has developed many innovation policy instruments and programs. ANII also has the operational capabilities to improve and develop any new instruments that may be required. However, some people interviewed for this study indicated that to improve the coordination of innovation policies with other public policies, ANII will need clearer guidelines from the Executive branch.

It is also interesting to notice that the Ministry of Labor and Social Security (MTSS) is not represented in the CONYCIT.

Public-private Partnerships

The private sector influences innovation policy through CONICYT and ANII. Many of CONICYT's members come from the private sector, and the private sector has two seats on ANII's board of directors. The private sector is indirectly involved as well, through instruments such as the Innova Award. This award is co-organized by ANII and many private institutions, including ENDEAVOR, CIU, Exporters Chamber, CUTI, CAF, and Uruguay XXI.

Policy Evaluation Mechanisms

ANII is mandated to carry out impact evaluation and monitoring of its own policy instruments and those of related entities within the system. Its Evaluation and Information Section is charged with generating evaluations prior to, during, and after program execution, in accordance with predetermined procedures. ANII has been monitoring programs and policy instruments at the implementation stage. The resulting monitoring reports have contributed to adjustments and changes in programs and policy instruments at this stage.

In terms of impact evaluation, the actions undertaken by ANII so far have been limited to the design of the strategy and survey information to facilitate the subsequent impact assessment of its programs. According to ANII's evaluation strategy, the impact evaluation of its own programs will begin this year.

ANII has also evaluated policy instruments and programs managed by other institutions in the system. This is one of the three main tasks of the Agency set out in its founding law.

There is no proper external evaluation in place at the moment. The Science, Technology and Innovation National Strategic Plan (PENCTI), defined by the GMI, has as one of its objectives the creation of the science, technology, and innovation observatory (GMI, 2007). Once in place, this observatory will have as one of its goals the evaluation of the innovation policies in Uruguay.

Innovation, Employment Creation, and the Upgrading of Skills of the Labor Force

As Table 2 illustrates, the degree of interaction between innovation, employment, and training policies in Uruguay is low. The organization charged with coordination of public policies on innovation and research is the GMI.

The interaction between the private sector and labor in the areas of employment policies and professional training is relatively strong. Both actors have representation and participation in the National Institute of Employment and Professional Training (INEFOP), a recently created agency responsible for implementing employment policies and training.[8] INEFOP is not focused on training skilled workers or on employment policies (where innovation processes might be more important), as can be seen from the list of its programs presented in Appendix B.

[8] The National Institute of Employment and Professional Training (INEFOP) was created by Law No. 18,406 of October 2008. Its main task is to run training programs and strengthen job skills for workers. It is run by a Governing Board composed of seven delegates, representing the Executive, the business sector, and labor unions.

Table 2. Challenges, Strengths and Actions in Relation to Innovation, Employment Creation, and the Upgrading of Skills of the Labor Force

Dimension	Responsible agency(ies)	Level of influence	Interactions and consultation mechanisms with other considered dimensions (use 4 point scale*)	Private- public partnerships. Participation of the private sector (use 4 point scale*)	Policy assessment mechanisms (use 4 point scale**)
Innovation	ANII	National	2	3	3
Employment policies (emphasis on R&D, skilled employment)	MTSS	National	2	3	2
Higher education (universities, vocational education)	MEC, Universidad de la República, ANEP (Formación docente)	National	2	2	2
Training policies (on the job, lifelong learning, etc.)	MTSS (DINAE-JUNAE) e INEFOP.	National	2	3 (INEFOP-JUNAE)	2

Note: * use following scale: 1: Non-existent; 2: Low; 3: High; 4: Very high. ** 1: Non-existent, 2: Some assessment (non compulsory) exist; 3: Assessments are inherent part but the results are not necessary taken into account in the (re)design of the program; 4: Assessments are made and results imply redesign/abandon of programs.

No mechanisms have been developed for evaluating the impact of most employment and training policies and programs in Uruguay. The INEFOP is currently defining a system of surveys as a basis for monitoring and evaluating programs. In the past, the MTSS carried out evaluations of individual programs at different times, but not in a systematic way. Currently, the MTSS has no monitoring and evaluation system in place.

2.3 Innovation and Employment: the Views of Different Agents

We interviewed innovation and employment policymakers, academics, business chambers representatives, trade union representatives, and selected firm representatives to get their views on the impact of innovation on employment.[9]

Most of those interviewed concurred that the effect of innovation on total firm employment depends on multiple firm characteristics as well as on the characteristics of the environment in which they operate. The type of economic activity, the type of production, the degree of exposure to international markets, the type of labor organization, the type of

[9] See appendix A for the list of the interviewees.

entrepreneur, the type of business organization, and management were among the reasons most cited for the heterogeneity of impact. Firm size and ownership structure (foreign vs. local) were not mentioned as relevant factors in determining the impact of innovation on employment.

The only discordant opinion was that of the trade union representative, who said that, in general, any type of innovation in almost any circumstances leads to job losses. However, many of those interviewed agreed that process innovation is likely to have a larger negative impact on employment.

With respect to employment quality, the views were unanimous: innovation increases the demand for better qualified and more highly trained workers, especially when firms introduce process innovations and new products. Most of the interviewees shared the view that innovation leads to more flexible labor contracts, particularly in terms of job duties. The interviewees also agreed that there is no gender bias in the effects of innovation on employment.

Another widely shared view among those interviewed was that the impact of innovation on employment quality (as well as quantity) depends on the model of work organization inside firm, on how close the employees are to the production process and firm decision making, and on the way in which firms interact with other participants in the national innovation system (including universities, the public sector, and other innovative firms).

According to the majority of those interviewed, the tensions that occur after innovations take place are mostly explained by communication problems between employers and employees. If changes are not adequately communicated and discussed, workers feel left out of the innovation process and threatened by it. Some said that Uruguayan entrepreneurs do not have a sufficiently developed "innovation culture" to take this type of problem into account when introducing innovations.

Finally, some of those interviewed pointed out that labor regulation in Uruguay is not flexible enough, particularly with respect to definitions of occupational categories. This rigidity limits the innovation process.

Table 3. Challenges, Strengths and Actions in Relation to Innovation, Employment Creation, and the Upgrading of Skills in the Labor Force

Dimension	Main challenges faced by the country	Challenges at the institutional/policy dimension	Main strengths	Actions taken/ to be taken
Innovation	Low level of innovation	Need for clear innovation policies Better promotion of innovation programs Better evaluation of innovation policies and programs	Increasing generation of knowledge and research Increase in resources devoted to innovation policies and programs Increase in the number of firms receiving support	ANII creation PENCTI
Employment creation	Low level of innovation related employment creation	Rigidities introduced by the labor market regulation affect innovation and employment	Strong product growth in the recent period	INEFOP
Upgrading of skills in the labor force	Shortage of graduates in S&T Low innovation capacity of entrepreneurs	Low degree of interaction between agencies working on innovation and technical and higher education. Governance structures too complex and fragmented.	Good quality and participation rates of basic education.	INEFOP Scholarship program. Subsidies for hiring qualified labor force

2.4 Innovation and Employment: the Views of Four Firms

In consultation with ANII and the Uruguayan Chamber of Industries, we selected four innovating firms to be interviewed: (i) Laboratorio Santa Elena, a high-tech sector manufacturing firm; (ii) Taxton S.A., a traditional manufacturing sector firm oriented to the domestic market; (iii) Bodegas Carrau, a traditional manufacturing firm oriented to the export market; and (iv) CUTCSA, a transport service firm.

All four are large firms according to the classification used in this paper (small firms are those with less than 50 employees). Only one, Laboratorio Santa Elena, belongs to the high-tech sector. Two of them—Laboratorio Santa Elena and Bodegas Carrau—follow mostly the "make" and buy strategy as part of their innovation activities while the other two follow mostly a "buy" strategy, incorporating technology developed abroad. This is important because these two alternative innovation strategies can have different impacts on employment quantity and quality. Other things equal, we expect the make (and the make and buy) to have a more positive effect on employment quantity and quality, since technology developed in-house can adapt better to the characteristics of firms' employees and tends to require a higher level of skills.

Of course, the characteristics of other firms or the environment in which they operate (e.g., unions' bargaining power) can also be important in terms of the impact of innovation on employment, as will be seen in the following sections.

Santa Elena Laboratory[10]

Santa Elena S.A. was founded in 1957 by Uruguayan technicians and entrepreneurs. It belongs to the Uruguayan high-tech sector. Its main activities include the development and implementation of veterinary biotechnologies and the production, distribution, and sale of veterinary supplies.

Santa Elena has about 100 workers, 50 percent of whom have completed tertiary education. Its products are sold both domestically and in other countries of the region, including Brazil, Colombia, Paraguay, and Bolivia. Sales in 2010 were estimated at US$8 million (70 percent in the domestic market, 30 percent exports).

According to Rafael Leaniz, advisor to Santa Elena's research, development, and innovation department, the vaccine development process entails a high level of technological and scientific development and a large investment in infrastructure and human capital. The firm has developed more than 60 products in its R&D laboratories. It was named one of the 100 Most Innovative Firms in Ibero-America.

Even though Leaniz recognizes the importance for innovation of being close to clients and of correctly interpreting their needs, he believes that the key to understanding innovation in Santa Elena is the incentives that are part of the firm's innovation policy, the scientific team, and the firm's alliances with academic and other institutions.

The impact of innovation on the quantity and quality of employment has been positive in the firm. According to Leaniz, the development of new research lines and technological innovation explains the growth of the firm. The innovation process not only required more people working in the firm, but also called for a more specialized work force. It also increased the need for human resources with skills that were different from those already existing in the firm. Innovation has also led to an increase in the demand for younger, more qualified workers.

[10] The interviewee was Rafael Leaniz, technical advisor in the area of research, innovation and development.

Resistance to change is a reality at Santa Elena, as it is in any other firm and group of people, says Leaniz. Horizontal organizational structures, teamwork, participation at all levels of the work force, and a favorable environment for knowledge transmission are the firm's strategies for introducing innovation in the most efficient way.

The labor regulation related to the categorization of workers generates rigidities and some tensions when innovation is introduced, according to Leaniz. In his view, this type of rigidity is especially incompatible with biotechnology innovation.

Bodegas Carrau Winery[11]

Bodegas Carrau is one of the largest and most innovative wineries in Uruguay. Since 1752, ten generations of the Carrau family have worked at the vineyard and produced wine. The winery exports about 40 percent of its annual production. Its main markets are Canada, the United States, Brazil, Germany, Holland, and Poland. It has about 50 permanent employees. During the harvest season, the company employs 100 people.

One of Bodegas Carrau's milestones in terms of innovation was the creation of its R&D unit in 1985. Since then, this unit has played an important role in the firm's strategy of improving the quality of the grapes. In 1985, in conjunction with the University of the Republic of Uruguay, the firm began to do research in the area of enological microbiology using local yeasts. This alliance with the university generated one of the leading research groups in enological science in the region. This research group has been able to solve complex biological and chemical problems.

Since 1995, the R&D unit of Bodegas Carrau has been working to recover the genetic heritage of Tannat, the most important and the trademark variety of grape in Uruguay. The objective is to recover its purity, particularly in its aromas. These developments, and others associated with biological pest control, low-intervention winemaking, and biodynamic vineyard management, make Bodegas Carrau one of the pioneers in the development of research at the wine industry level in Uruguay and the region.

With respect to the impact of innovation on employment, there has never been in the history of the company a reduction of the work force, according to Francisco Carrau, Director of Bodegas Carrau. The impact of R&D activities on employment has been primarily qualitative.

[11] The official interviewed was Francisco Carrau, director of Bodegas Carrau.

The innovation process generates the need for training and additional skills, especially of the research team. For example, as a result of the innovation process, the research team specialized in wine microbiology, clonal selection, and minimal intervention strategies.

According to Carrau, the firm's relationship with the union is good. The firm and the union have a long tradition of negotiating, going back to 1975. Carrau says that the employees are committed to the company's mission.

Bodegas Carrau has an annual program for staff training and innovation. The firm has also promoted innovation through, for example, an internal competition for innovative ideas, in which all the staff participated. This kind of initiative encouraged greater involvement of the staff in coming up with innovative ideas. It also had the dual purpose of generating greater understanding of the process of innovation and of teamwork, which in turn helps prevent future labor conflicts.

Carrau says that tensions among the employees are the result of labor legislation that is inadequate for an innovative firm that tries to adapt to a changing world. Again, like Leaniz of Santa Elena, he feels that the legislation that introduced rigidities to redistribute staff across employment categories generates significant problems and tensions when innovating.

CUTCSA (Compañía Uruguaya de Transporte Colectivo Sociedad Anónima)[12]

CUTCSA is a local firm, established in 1937, that provides bus transport services in Montevideo. It has 4,751 employees and 1,052 buses that travel an average of 260,000 km per day.

CUTCSA pioneered the introduction of buses adapted to facilitate the ascent and descent of people with physical disabilities through electro-hydraulic platforms. However, the firm considers that its main innovations were the adoption of ticket vending machines and the installation of GPS devices on buses. These technologies decrease cash management in buses, thus discouraging theft in transport as well as enabling better enforcement of frequencies.

According to Alvaro Santiago, deputy manager of CUTCSA, since the start of the innovation process, the company aimed to avoid layoffs. Consequently, the process of introducing the technology has been gradual.

[12] The official interviewed was Alvaro Santiago, deputy manager of CUTCSA.

The adoption of this technology required a significant effort and investment in staff training. The union played an active role in the technology adoption process as well as in the staff training process. A number of union delegates were part of the training team.

According to Santiago, the company's commitment not to lay off employees and the effort made to explain that the aim of the introduction of the technology was to improve working conditions were key to the acceptance of the innovation by the workers.

Santiago indicated that the tensions that emerged when the new technology was introduced were mainly the consequence of underestimating its complexity. The company considers the introduction of the new technology to have been successful, even though the process was slow. This judgment is based on the fact that there was no disruption of services, as there was in other cities when similar technology was introduced. The good communication with the union was cited as a key factor for this outcome.

Santiago said that the government should consider providing incentives to firms that invest in staff training, since this could speed up the adoption of new technology. He suggested that the government take a more active role in encouraging and making explicit the advantages to companies who take this path. It is interesting to note that Santiago was the only official interviewed who did not mention the labor regulation as a source of difficulties in the innovation process.

Taxton S.A.[13]

Taxton is a local firm, established in 1994. It produces leather footwear for the local market and has 90 employees. Presently, the firm is adapting European technology for design and cutting (CAD/CAM systems). This innovation is enabling the development of new products and the improvement of existing ones. The technology will also increase the labor productivity, reducing the effort needed in the design and testing of new prototypes and also reducing waste at the cutting stage.

According to Alvaro Molaguero, manager of the company, there have been no employment losses as a consequence of the introduction of the new technology. The company's objective is to increase production with the same number of employees. The resulting increase in

[13] The official interviewed was Alvaro Molaguero, company manager.

productivity is the only way that the firm can compete in the highly competitive footwear market, according to Molaguero. The search for greater productivity is also accompanied by a system of rewards and incentives.

With respect to employment quality, the impact of this innovation has been limited, since only two employees have been trained to operate the new system. However, the introduction of the new technology implied a redistribution of tasks among the firm's employees.

According to Molaguero, the relationship with the union is good. Although there were some initial concerns with the arrival of new technology, there were no major difficulties. Finally, Molaguero believes that the government should give greater priority to technical education.

Summary

From the four representatives interviewed, we can discern two clearly different situations related to the effects of innovation on employment. On the one hand, firms belonging to the high-tech and the export sectors have achieved increases, albeit small, in employment and substantial improvements in the quality of their labor force as a consequence of innovation activities. On the other hand, domestic market-oriented and service sector firms seem to have achieved significant productivity gains and cost reductions while maintaining the same number of employees. In the domestic market-oriented firm, the impact on the quality of employment was limited, while in the service sector firm, the impact was greater, especially with regard to staff training. Therefore, taking all these cases together, we can say that the innovation process did not lead to job losses and in general it implied improvements in the quality of the labor force.

Another issue that emerged frequently in the interviews is the possible endogeneity of innovation to the labor market regulation. While labor regulations were not presented as a real obstacle to innovation by the companies, they indicated that the rigidity of these rules makes the dynamics required to carry out innovation more complex. These difficulties probably come from the need for a tripartite negotiation (government, firms, and unions) by industry that ignores the particularities of each company and the particularities of their innovation processes.

Related to the previous discussion, the importance of a good relationship with the union, as well as good communication with and participation of workers in the innovation process as a way of achieving positive results can be highlighted as cross-cutting themes emerging from interviews with company representatives.

3. Quantitative Analysis

3.1 Theoretical framework

In general, we expect to find two predominant effects of innovation on employment at firm level. The first one is a job loss effect due to reduced input requirements per unit of product. The second is a positive compensation effect triggered by the expansion of sales and production. This second effect is linked to both the reduction of marginal costs (the reduction of prices generates an increase in demand) and the creation of new products that requires additional labor. These effects on employment may be more or less important according to market structure (of both goods and factors) and the sectors in which innovation takes place. The behavior of firms' managers and workers could also exacerbate or reduce the displacement effect and weaken or increase the compensation effects. For example, the firm's market power and workers' wage bargaining power could reduce the pass-through to prices of the cost savings due to innovation, and therefore weaken the positive employment effects of innovation.

In addition, there are also partial effects at the sectoral level (reallocation of output and employment between more and less innovative companies) and general equilibrium effects, when the interaction between different markets is considered. Finally, it is important to note that innovation affects not only the number of jobs created, but also their quality.

The model presented by Harrison et al. (2008) enables a disentangling of some of the theoretical employment effects of innovation and is highly applicable in analyzing firm-level employment impacts of innovation activities using the specific information provided by innovation survey data. The share of sales due to product innovations serves as the key output indicator. One interesting aspect of the approach is that it establishes a theoretical relationship between the employment growth rate and innovation output in terms of sales growth stemming from innovative products. The latter will be directly calculated by means of the available innovation survey data for Uruguayan manufacturing and services firms.

The model is based on the idea that firms can produce different products. At the beginning of the reference period, a firm *i* produces one or more products which are aggregated to one product. This aggregate product is called the "old product". In the period under consideration, the firm can decide to launch one or more new (or significantly improved) products: "new products". Firms are observed for two periods, t = 1 and t = 2, and innovation occurs between these two periods (if it occurs at all).

To produce the different outputs, it is assumed that firms use identical separable production technology that has constant returns to scale in capital, labor, and intermediate inputs or materials. Each production technology has an associated efficiency parameter that can change between the two periods. New products can be made with higher or lower efficiency with respect to old products, and the firm can affect the efficiency of its production over time through investments in process innovation.

Employment growth is going to be 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 production due to new products (positive effect), and (iv) the change in efficiency due to process innovation (negative effect).

The first equation to be estimated here will be:

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

where

l: employment growth rate

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)[14]

d: dummy variable indicating process innovation

α_0: parameter, (minus) average efficiency growth in the production of old products

α_1: parameter, average efficiency growth for process innovations

β: parameter, relative efficiency of the production of old and new products

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

μ: 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.[15] Notice that the variable g_1 has a coefficient equal to one and can thus be subtracted from l on the left-hand side of the equation for estimation, being the new dependent variable l-g_1. This implies that we are estimating a net employment effect.

The three parameters of interest are α_0, α_1 and β. 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.

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 μ, and could be correlated with the innovation variables. This correlation will depend on the timing of productivity shocks and investment decisions.

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 avoid problems generated by this variable being included in the error term of (1).

We can control for the change in prices of old products by subtracting the industry price growth index (π) (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: $l-(g1 - \pi)$.[16] 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

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[15] Harrison (2008) transformed 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.

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

producer price indices (IPPN: Producer Price Index of National Products) on a 4-digit ISIC level.[17]

Hence, the model to be estimated in this case is:

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

The relationship between employment and innovation is very complex. Not only does it have the potential to affect the quantity, but also its composition. Indeed, innovation might change the demanded 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:

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

where l^{q_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 us with estimates of the impact of innovations on each type of employment.

As before, endogeneity could arise because innovation decisions depend on the productivity of the firm and unobservable productivity shocks. Hence, we are going to control for the possible endogeneity using instrumental variables approach.

3.2 Manufacturing Sector

3.2.1 Data Availability and Descriptive Statistics

For the empirical analysis of the relationship between employment and innovation, we are using the four waves of Manufacturing Firms Innovation Surveys (MIS) currently available (1998-2000, 2001-03, 2004-06, and 2007-09) and the annual Economic Activity Surveys (EAS) for the period 1998-2007. The MIS data is collected by the National Bureau of Statistics (INE) in parallel with the EAS (same sample and statistical framework). Therefore, both surveys have the same firm identification code.

[17] With the exception of some sectors for which we did not have information, we used 2-digit level prices instead.

The same sampling model is used in both surveys. For the MIS, all firms with more than 49 workers are of mandatory inclusion. Units with 20 to 49 employees and with fewer than 19 workers are selected using simple random sampling within each economic sector at ISIC 2-digit level up to 2005. Random strata are then defined for those units with fewer than 50 workers within each economic sector at the ISIC 4-digit level. The response rate is nearly 90 percent. The number of firms included in the samples for the 1998-2000, 2001-03, 2004-06 and 2007-09 surveys were 761, 814, 839, and 941 respectively.

The main reason to match the MIS with the EAS is the need to collect sales and employment data for the first year of the period of reference for each of the four MIS waves.[18] The problem is that even though we have sales and employment figures for the final year of the reference period of each MIS for the last three MISs, we do not have this information for the first MIS (1998-2000). Therefore, we cannot use the employment figures of the previous MIS to compute growth rates for this variable.

The matching with the EAS was not without limitations for the period after 2006. In that year, INE modified the sample of the EAS, reducing the number of surveyed firms (from about 3,400 in 2005 to 1,700 in 2006). Moreover, the 2004-06 MIS was performed with the same sampling frame as 2005. This means that a significant number of firms that were surveyed in the 2004-06 MIS did not participate in the 2006 EAS. This is a problem, particularly when we need to use variables that are only available in the EAS. This is the case of the wage bill per worker, which is used as control variable in some regressions.

A similar problem arises when matching the 2007-09 MIS (which is a subsample of the 2009 EAS) and the 2007 EAS. Approximately half of the firms that participated in the MIS survey in 2009 are not in the 2007 EAS. Therefore, we lose a significant number of firms in the latest innovation survey (about 470). At the same time, the 2009 EAS is not yet available. Therefore, in models where variables coming from the EAS are used (e.g., wage bill) we lose all the observations of the last MIS survey.

Some additional firms were lost because of the impossibility of linking them between two EAS or between MIS and EAS for other reasons. For example, from the total number of firms

[18] In the 1998-2000 MIS, the percentage of exports, which is necessary information to build some innovation variables, is not available, so the EAS is necessary. Also, the wage bill per worker, which is used as control variable in some models, is only available in the EAS.

belonging to the 2001-03 MIS sample, we have almost 130 companies that are in the 2001-03 MIS and 2003 EAS but are not in the 2001 EAS.

The final number of observations (firm/period) used in the estimations is 2532:[19] 722 from the 1998-2000 MIS, 627 from the second MIS, 737 from the third one, and 446 from the last available survey.

Table C.1, in the Appendix, shows the definition, source and availability of each variable described in the paper. Table 4 shows descriptive statistics for the manufacturing sector. The mean size of a firm is 91 employees; 13 percent of these firms are owned by foreign capital. Fifty-one percent of the firms in the sample innovated in process or product. Thirty-two percent are product innovators, of which 87 percent (with respect to the whole sample) are both product and process (or organizational) innovators. Twenty percent are process-only or organization-only innovators (non-product innovators). From now on we refer to process innovators as those that do only process-only innovations or organizational change-only innovations.

Data on yearly employment growth shows that the mean is negative. This figure is being driven by the non-innovating firms.[20] While the non-innovators show negative growth rates, process innovators (non-product innovators) and product innovators showed moderated positive growth rates. The wage bill per worker grew at a mean rate of almost 5 percent during the first three surveys (information for the last one is not available).

The yearly sales growth rate was positive for almost all firms. While non-innovators (no process or product innovators) showed a zero growth rate, process innovators and product innovators showed positive figures. Within the latter, this figure is explained by the sales growth of innovators in new products (30 percent, versus -21 percent for innovators in old products).

Nominal labor productivity grew for all types of firms, especially for the process innovators. The same occurred with price growth. In real terms, labor productivity decreased for

[19] Firms with missing information on sales or employment were also excluded (704 firms). Also excluded were the percentile 1 and 99 of variables l and g to avoid outliers, and 3 negative values of the variable g_2 (97 firms).

[20] This figure is the result of a simple averaging of the annual growth rate of the whole sample (i.e., across years and firms). This implies that all firms are equally weighted, with small and large firms weighted the same. Hence, this percentage is not the real average growth rate of employment in the manufacturing sector. It is also worth noting that this average hides large heterogeneities between surveys, which are highly correlated to the economic cycle (-6.5 percent in 1998-2000, -6.6 percent in 2001-02, 6.4 percent for the period 2004-06 and 2.8 percent in 2007-09). At the same time, this simple average underestimates the average growth due to loss of observations in the last survey (2007-09), a period of strong employment growth. Total employment growth between 1998 and 2009 for the entire sample was 2.3 percent.

all type of innovators, with the exception of the organizational change innovators and product innovators.

In the Appendix (table C.2) we show descriptive statistics for the small firm sample, i.e. firms with less than 50 employees (1,353 cases). The biggest differences with respect to the whole sample figures can be found in the numbers referring to innovation variables. Thirty-seven percent are innovators, 14 percent are process innovators and 23 percent are product innovators.

Table 4. Descriptive Statistics - Manufacturing Firms
Pooled Surveys for the Period 1998-2009

	Mean	Median	Standard deviation	Minimum	Maximum
Number of observations	2532				
Distribution of firms (%)					
Non-innovators (no process or product innovations)	48.14				
Process only or organizational only innovators (non product innovators)	19.39				
Product innovators	32.46				
(of which product and process innovators-of the whole 100%)	87.96				
Number of employees at the beginning of (each) survey	91.20	47.50	156.85	1.00	2353.00
Foreign Ownsership (10% or more)	0.13	0.00	0.34	0.00	1.00
Located in the capital of the country	0.81	1.00	0.39	0.00	1.00
Employment growth (%) (yearly rate)					
All firms	-0.7	0.0	15.1	-71.8	47.1
Non-innovators (no process or product innovations)	-3.4	-1.3	15.9	-71.8	47.1
Process only or organizational only innovators (non product innovators)	1.7	1.6	14.5	-65.8	44.4
Product innovators	1.8	1.6	13.4	-62.0	45.8
Growth wage bill per worker (%) (yearly rate)	5.1	5.0	13.2	-57.2	77.7
Sales growth (%)[1] (nominal growth) (yearly rate)					
All firms	5.5	5.7	21.7	-79.9	70.5
Non-innovators (no process or product innovations)	1.7	3.0	22.9	-79.9	69.1
Process only or organizational only innovators (non product innovators)	9.6	7.4	21.2	-67.7	70.5
Product innovators	8.7	7.2	18.9	-49.3	69.5
of which:					
Old products	-21.2	-20.1	21.9	-50.0	59.3
New products	29.9	23.2	22.5	0.1	115.0
Labor productivity growth (%)[1] (yearly rate)					
All firms	6.2	5.4	21.2	-88.4	93.1
Non-innovators (no process or product innovations)	5.1	4.1	22.4	-88.4	81.9
Process only or organizational only innovators (non product innovators)	7.9	6.5	21.8	-79.4	93.1
Product innovators	6.9	5.7	18.8	-56.1	82.3
Prices growth (%) [2]					
All firms	6.83	2.45	11.10	-14.65	40.68
Non-innovators (no process or product innovations)	6.84	2.45	10.99	-14.65	40.68
Process only or organizational only innovators (non product innovators)	6.79	2.66	11.10	-14.65	40.68
Product innovators	6.83	2.55	11.26	-14.65	34.52

Notes: If not stated otherwise, the period is 1998-2009. 1/ Sales growth for each type of firm is the average of variable g; averages for old and new products are the averages of variables g_1 and g_2, respectively. 2/ Period 2001-09. 3/ Period 1998-2006. 4/ Prices computed for a set of industries and assigned to firms according to their activity.

Finally, another sectoral splitting has been made: high or low-tech sectors. The division is done by calculating the innovation expenditure over turnover. Those sectors below or in the median are classified as low tech, while the rest are classified as high tech.

In Appendix C (Table C.3) we present some basic descriptive statistics. Fifty-eight percent of the firms in the sample are defined as high-tech firms. Low-tech firms tend to innovate less than high-tech firms and, among the innovators, high-tech firms tend to be more product innovators. Another difference between both sectors is that firms in the high-tech sector are larger on average. The employment growth figure show that the negative growth rate in the whole sample is driven by the low-tech sector, while the high-tech sector shows slightly positive figures.

3.2.2 Analysis of the Relationship between Innovation and Employment Quantity

Naïve OLS Regression

As a first approach to analyzing the impact of innovation on employment, we present naïve estimations based on OLS regressions using direct measures of product and process innovation (and therefore not based on equation (1')). They show how the average labor growth rates differ among innovators and non-innovators after controlling for the growth of total sales of existing products and industry and time effects. As shown in the descriptive statistics section, non-innovating firms have negative employment growth rates; meanwhile innovating firms have positive growth rates in the sample period. In the sub-sample of small firms, although growth rates are not positive for both innovators and non-innovators, for innovators they are significantly larger than for non-innovators.

Tables 5a and 5b show naïve regressions on the effects of innovation on employment quantity, using the pooled sample of manufacturing firms of the four MIS available at the moment and for the sub-sample of small firms. 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.

As column 1 of Table 5a 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). Column 3 also shows that the coefficient of the product innovation only dummy is bigger than the one for process and product innovation, and the latter is 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 (with or without product innovation), the positive effects become smaller. The dummy indicating foreign ownership is never 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.

Table 5b replicates the exercise for the small firms sub-sample, defined as firms having fewer than 50 employees at the end of the period of reference of each survey. Similar results are found for the innovation variables. The coefficients on the innovation dummies are larger for the sub-sample of small firms than for the whole sample estimation, indicating that innovation seems to have a bigger positive impact on small firms.

Results remain qualitatively similar to those commented above for the total sample, when we split the sample between high-tech and low-tech sectors (see Tables 6a and 6b); i.e., product innovation continues to have the biggest positive impact on employment in both sectors.

When the estimation for high-tech and low-tech are compared some heterogeneity is found. The coefficients on the innovation dummies are bigger for the low-tech sector than for the high-tech sector, indicating that innovation appears to have a bigger positive impact on firms in the low-tech sector.

Table 5a. Effect of Innovation on Employment Quantity – OLS (robust errors) Estimation

Dependent variable: *l*

Sector	**Manufacturing**			
Regression	**1-OLS**	**2-OLS**	**3-OLS**	**4-OLS**
Constant	-2.530***	-2.641***	-2.819***	-2.641***
(se)	(0.38)	(0.40)	(0.40)	(0.40)
Product or process innovator	7.242***			
(se)	(0.61)			
Process only innovator (non product)		3.286***		3.280***
(se)		(0.71)		(0.71)
Process innovator			6.671***	
(se)			(0.61)	
Product only innovator (non process)			10.525***	11.516***
(se)			(1.38)	(1.40)
Product innovator		9.931***		
(se)		(0.73)		
Product & process innovator				9.714***
(se)				(0.75)
Real sales growth *(g1-Π)*	0.146***	0.183***	0.145***	0.183***
(se)	(0.02)	(0.02)	(0.02)	(0.02)
Foreign owned (10% or more)	0.531	0.819	0.710	0.846
(se)	(0.88)	(0.87)	(0.88)	(0.88)
2-digit industry dummies	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes
R squared	0.231	0.247	0.230	0.247
Standard error	13.280	13.150	13.290	13.150
Number of firms	2,532	2,532	2,532	2,532

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.

Table 5b. Effect of Innovation on Employment Quantity – OLS Estimation – Small Firms

Dependent variable: *l*

Sector	**Small firms in Manufacturing**			
Regression	**1-OLS**	**2-OLS**	**3-OLS**	**4-OLS**
Constant	-4.434***	-4.617***	-4.830***	-4.614***
(se)	(0.53)	(0.55)	(0.55)	(0.55)
Product or process innovator	7.491***			
(se)	(0.94)			
Process only innovator (non product)		2.764**		2.751**
(se)		(1.10)		(1.10)
Process innovator				
(se)				
Product only innovator (non process)			7.020***	13.476***
(se)			(0.93)	(2.12)
Product innovator		11.259***	12.305***	
(se)		(1.13)	(2.08)	
Product & process innovator				10.881***
(se)				(1.18)
Real sales growth *(g1-Π)*	0.178***	0.218***	0.182***	0.219***
(se)	(0.02)	(0.02)	(0.02)	(0.02)
Foreign owned (10% or more)	-1.650	-1.042	-1.469	-1.115
(se)	(1.99)	(1.93)	(1.97)	(1.93)
2-digit industry dummies	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes
R squared	0.219	0.242	0.225	0.243
Standard error	14.190	13.980	14.140	13.980
Number of firms	1,353	1,353	1,353	1,353

Source: Authors' calculations.

Notes: Idem Table 5a.

Table 6a. Effect of Innovation on Employment Quantity – OLS Estimation – High-Tech Sector

Sector	**HighTech-Manufacturing**			
Regression	**1-OLS**	**2-OLS**	**3-OLS**	**4-OLS**
Constant	-1.723***	-1.646***	-1.782***	-1.646***
(se)	(0.52)	(0.56)	(0.56)	(0.56)
Product or process innovator	6.694***			
(se)	(0.79)			
Process only innovator (non product)		2.978***		2.975***
(se)		(0.93)		(0.93)
Process innovator			5.791***	
(se)			(0.79)	
Product only innovator (non process)			8.745***	9.648***
(se)			(1.68)	(1.69)
Product innovator		8.485***		
(se)		(0.92)		
Product & process innovator				8.354***
(se)				(0.94)
Real sales growth *(g1-Π)*	0.139***	0.168***	0.131***	0.168***
(se)	(0.02)	(0.02)	(0.02)	(0.02)
Foreign owned (10% or more)	0.502	0.883	0.728	0.900
(se)	(1.00)	(1.00)	(1.01)	(1.00)
2-digit industry dummies	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes
R squared	0.218	0.224	0.210	0.224
Standard error	12.770	12.730	12.850	12.730
Number of firms	1,464	1,464	1,464	1,464

Source: Authors calculations.
Notes: Idem, Table 5a.

Table 6b. Effect of Innovation on Employment Quantity – OLS Estimation – Low-Tech Sector

Sector	LowTech - Manufacturing			
Regression	**1-OLS**	**2-OLS**	**3-OLS**	**4-OLS**
Constant	-3.652***	-3.937***	-4.197***	-3.943***
(se)	(0.55)	(0.57)	(0.57)	(0.57)
Product or process innovator	8.028***			
(se)	(0.96)			
Process only innovator (non product)		3.451***		3.451***
(se)		(1.12)		(1.12)
Process innovator			7.901***	
(se)			(0.96)	
Product only innovator (non process)			12.992***	14.124***
(se)			(2.27)	(2.33)
Product innovator		12.144***		
(se)		(1.20)		
Product & process innovator				11.796***
(se)				(1.25)
Real sales growth *(g1-Π)*	0.152***	0.201***	0.159***	0.201***
(se)	(0.02)	(0.03)	(0.02)	(0.03)
Foreign owned (10% or more)	0.604	0.647	0.735	0.685
(se)	(1.77)	(1.71)	(1.75)	(1.71)
2-digit industry dummies	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes
R squared	0.243	0.275	0.254	0.275
Standard error	13.930	13.640	13.830	13.640
Number of firms	1,068	1,068	1,068	1,068

Source: Authors' calculations.
Notes: Idem, Table 5a.

The Basic Model: OLS and IV

Table 7a presents the estimation results for three variants of the basic model presented in equation (1'), where the dependent variable is the employment growth rate minus the real sales growth rate ($l-(g_1 - \pi)$). All the specifications include the innovation dummy, d, sales growth rate of new products, g_2, and a constant. The estimations also include industry fixed effects (at 2-digit level) and time fixed effects (see definition at the bottom of table 7a). Column 1 shows the basic OLS estimation without controls, while in the next columns we add, one by one, a dummy indicating foreign ownership of the firms and the wage bill growth rate.

The last three columns of table 7a aim to analyze the sensitivity of results using instrumental variables (IV) for both, the entire sample and the small firm sample.

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 must be highly correlated with the growth in sales of new products (g_2) and 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. We are going to use the same instrument in our study and for the same reasons. The questionnaire also asks whether the innovation helped to improve the quality of the goods, and about 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. As an additional instrument, we are using the variable "new markets", which assesses the impact of innovation on the development of new markets for the firm. On the questionnaire, firms are asked if the innovation helped maintain or increased market share. The latter variable could be related to a change in price, while the opening up of new markets is expected to be related to the development of new products and an increase in demand for reasons other than changes in product prices and quality.

Therefore, the instruments used to control for potential endogeneity of the innovation variable (g_2) are: (i) *Increased range of goods and services* indicator, which assesses the impact of innovation on the increase in the range of goods produced by firms (scale of 0 to 3: 0 = irrelevant impact, 1= low, 2= medium, and 3 = high impact); and (ii) *New markets*. This variable assesses the impact of innovation on the development of new markets for the firms (coded between 0 to 3: 0 = irrelevant impact, 1= low, 2= medium, and 3 = high impact). These indicators were included as a set of dummies because of evidence of a nonlinear effect in the first-stage regressions.

It should be noted that columns 3 and 6 were estimated using a smaller sample because of the limitations of information on wage bills (it excludes about half of the 2004-06 MIS sample and all observations of the 2007-09 survey).

According to the model, the constant indicates the negative average efficiency growth in the production of old products. Results presented in Table 7a show that the constant (α_0) is significantly different from zero, and positive in all specifications. Hence, this result is in contrast to what theory predicts.

The dummy indicating process-only innovation is negative and significantly different from zero in all regressions, indicating that process innovation is associated with a reduction in the growth rate of labor. This also means that there is a gain in productivity in the production of old products (given the interpretation of the parameter α_1 in the Harrison et al. 2008 model). When the model is estimated by IV, the negative impact of this variable on labor growth is reduced.

In contrast, the coefficient (β) on the growth rate of sales of new products (g_2) is positive, significant, and lower than 1 in all OLS regressions. β measures the relative efficiency of old and new products. This result goes in the same direction as theory predicts, and since it is lower than 1 it suggests that new products are produced more efficiently than old ones. As noted before, this coefficient could be biased because of the presence of endogeneity due to unobserved price changes or correlation with non-technological productivity shocks. Any endogeneity, as shown by Harrison et al. (2008), is likely to produce a downward bias in this coefficient, overstating the productivity gains associated with the production of new products. This is confirmed by the IV regressions where the parameter β is not significantly different from 1, implying that there is no efficiency gain in the production of new products relative to old ones.

The dummy indicating foreign ownership is not significant in all the regressions and does not affect the other coefficients. Columns 3 and 6 show the results of adding the wage bill growth variable. The coefficient of this variable is significantly different from zero, negative, and less than 1 in absolute value. Hence, we found a positive and lower than unity relationship between per worker wage bill growth and labor productivity. In addition, the inclusion of this variable increases the value of the constant of the model significantly, showing a high correlation between the productivity growth of old products and the wage bill growth.

The Davidson-MacKinnon test of exogeneity rejects the null hypothesis of exogeneity for the variable g_2 in all cases, which indicates that the effect of the endogenous regressor on the estimates is meaningful and instrumental variables techniques are in fact required. Since we used more than one instrument, table 7a shows also the results of the Sargan test (test for overidentifying restrictions). Results indicate that the validity of the instruments is accepted in all cases at 1 percent confidence level. The F test for g_2 in the first stage of the IV estimation is significant, confirming the validity of these instruments.

Results in Table 7b, for the small firms, are in general very similar to those in Table 7a in terms of magnitude and sign of coefficients. The biggest difference now is the level of significance of the variable *d*. When the equations are estimated by IV, only in one case the variable is significant, and only at the 10 percent level of confidence. Also, when estimated by IV, the constant is not significant in two out of three cases. We arrive also, as in the whole sample, at the conclusion that g_2 is likely to be endogenous and that the instruments are valid.

In Tables 8a and 8b, results are presented for firms in the high and low-tech sectors, respectively. As can be seen there, again, we have similar results to those of Table 7a in terms of the magnitude and sign of coefficients. For firms of the low-tech sector, when equation (1') is estimated by IV, in two out of three cases the constant and the variable *d* are not significantly different from zero.

Summarizing the results found in Tables 7a to 8b, it can be said that product innovation is complementary to labor, but in general, process innovation displaces labor. This displacement effect seems to be somehow weaker in the case of small firms and firms belonging to the low-tech sector.

Table 7a. Effect of Innovation on Employment Quantity – OLS and IV Estimations

Dependent variable: *l -(g1-π)*

Sector	Manufacturing					
	OLS			IV		
Regression	1	2	3	1	2	3
Constant	2.854***	2.662***	6.945***	1.544**	1.402**	5.983***
(se)	(0.54)	(0.56)	(0.65)	(0.65)	(0.66)	(0.77)
Process innovation only *(d)*	-3.894***	-4.002***	-4.628***	-2.610**	-2.716**	-3.607***
(se)	(1.06)	(1.06)	(1.24)	(1.10)	(1.10)	(1.23)
Sales growth due to new products *(g2)*	0.855***	0.853***	0.857***	0.964***	0.961***	0.931***
(se)	(0.02)	(0.02)	(0.02)	(0.04)	(0.04)	(0.04)
Foreign owned (10% or more)		1.655	0.833		1.371	0.66
(se)		(1.18)	(1.27)		(1.19)	(1.28)
Growth wage bill per worker			-0.547***			-0.554***
(se)			(0.04)			(0.03)
2-digit industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F test, g2				171.9	170.8	116.7
p-value				0.0000	0.0000	0.0000
g2 Exogeneity (Davidson-McKinnon)				10.702	10.387	4.625
p-value				0.0011	0.0013	0.0317
Sargan test				2.78	2.643	0.877
p-value				0.734	0.755	0.972
R squared	0.440	0.441	0.553	0.419	0.420	0.534
Standard error	19.460	19.460	17.310	19.54	19.53	17.34
Observations	2,532	2,532	1,698	2,532	2,532	1,698
Number of ISIC (2 digit)	22	22	22	22	22	22

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. Instruments: g_2 was instrumented by "*increased range of good*" and "*development of new markets*". These indicators were included as a set of dummies because of evidence of a nonlinear effect in the first-stage regressions. 4. F test is the F test of excluded instruments in the first-stage regressions. 5. Exogeneity is the Davidson-MacKinnon test of Exogeneity. 6**.** Sargan test is the overidentifying restrictions test.

Table 7b. Effect of Innovation on Employment Quantity – OLS and IV Estimations
Small Firms

Dependent variable: *l -(g1-Π)*

Sector	**Small firms in Manufacturing**					
	OLS			**IV**		
Regression	**1**	**2**	**3**	**1**	**2**	**3**
Constant	1.563**	1.757**	6.804***	0.064	0.267	5.646***
(se)	(0.78)	(0.78)	(1.02)	(0.89)	(0.91)	(1.25)
Process innovation only *(d)*	-4.225**	-4.127**	-5.283**	-2.696	-2.595	-3.952*
(se)	(1.68)	(1.69)	(2.07)	(1.77)	(1.77)	(2.03)
Sales growth due to new products *(g2)*	0.825***	0.826***	0.842***	0.997***	0.998***	0.974***
(se)	(0.03)	(0.03)	(0.03)	(0.06)	(0.06)	(0.07)
Foreign owned (10% or more)		-3.048	-1.999		-3.162	-2.072
(se)		(2.51)	(2.50)		(2.50)	(2.71)
Growth wage bill per worker			-0.535***			-0.548***
(se)			(0.05)			(0.05)
2-digit industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F test, g2				89.68	89.62	57.43
p-value				0.0000	0.0000	0.0000
g2 Exogeneity (Davidson-McKinnon)				10.681	10.661	5.793
p-value				0.0011	0.0011	0.0163
Sargan test				4.323	4.21	3.192
p-value				0.504	0.52	0.67
R squared	0.369	0.369	0.494	0.338	0.338	0.459
Standard error	20.990	20.990	18.730	21.15	21.14	18.82
Observations	1353	1353	857	1,353	1,353	857
Number of ISIC (2 digit)	12	12	12	22	22	22

Source: Authors' calculations.

Notes: Idem, Table 7a.

Table 8a. Effect of Innovation on Employment Quantity – OLS and IV Estimations High-tech Sector

Sector	Manufacturing - High-Tech					
	OLS			IV		
Regression	1	2	3	1	2	3
Constant	3.345***	3.079***	6.846***	1.870**	1.670*	5.653***
(se)	(0.71)	(0.73)	(0.84)	(0.92)	(0.93)	(1.06)
Process innovation only *(d)*	-4.169***	-4.336***	-4.457***	-2.721*	-2.897**	-3.178**
(se)	(1.32)	(1.32)	(1.54)	(1.40)	(1.41)	(1.57)
Sales growth due to new products *(g2)*	0.846***	0.844***	0.838***	0.962***	0.958***	0.927***
(se)	(0.02)	(0.02)	(0.03)	(0.06)	(0.06)	(0.06)
Foreign owned (10% or more)		1.889	1.059		1.646	0.865
(se)		(1.41)	(1.51)		(1.37)	(1.45)
Growth wage bill per worker			-0.530***			-0.539***
(se)			(0.05)			(0.04)
2-digit industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F test, g2				82.56	81.97	54.92
p-value				0.0000	0.0000	0.0000
g2 Exogeneity (Davidson-McKinnon)				5.766	5.496	3.017
p-value				0.0165	0.0192	0.0827
Sargan test				3.724	3.58	1.49
p-value				0.59	0.611	0.914
R squared	0.440	0.441	0.547	0.418	0.419	0.521
Standard error	18.870	18.860	16.610	18.94	18.93	16.63
Observations	1,464	1,464	990	1,464	1,464	990
Number of ISIC (2 digit)	10	10	10	10	10	10

Source: Authors' calculations.
Notes: Idem, Table 7a.

Table 8b. Effect of Innovation on Employment Quantity – OLS and IV Estimations Low-tech Sector

Sector	Manufacturing - Low-Tech					
	OLS			IV		
Regression	1	2	3	1	2	3
Constant	2.208***	2.109**	7.225***	1.178	1.115	6.620***
(se)	(0.84)	(0.86)	(1.04)	(0.93)	(0.94)	(1.13)
Process innovation only *(d)*	-3.474*	-3.504*	-5.301**	-2.498	-2.524	-4.678**
(se)	(1.79)	(1.79)	(2.08)	(1.81)	(1.81)	(2.06)
Sales growth due to new products *(g2)*	0.864***	0.863***	0.877***	0.957***	0.956***	0.927***
(se)	(0.03)	(0.03)	(0.03)	(0.06)	(0.06)	(0.06)
Foreign owned (10% or more)		1.218	0.153		0.844	0.013
(se)		(2.17)	(2.30)		(2.26)	(2.54)
Growth wage bill per worker			-0.566***			-0.570***
(se)			(0.05)			(0.05)
2-digit industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F test, g2				95.05	94.37	64.32
p-value				0.0000	0.0000	0.0000
g2 Exogeneity (Davidson-McKinnon)				4.379	4.318	1.176
p-value				0.0366	0.0380	0.2785
Sargan test				3.388	3.349	2.987
p-value				0.64	0.646	0.702
R squared	0.440	0.441	0.561	0.423	0.423	0.549
Standard error	20.280	20.290	18.310	20.31	20.31	18.25
Observations	1,068	1,068	708	1,068	1,068	708
Number of ISIC (2 digit)	12	12	12	12	12	12

Source: Authors' calculations.

Notes: Idem, Table 7a.

Robustness Checks

In this sub-section we will again estimate equation (1') in the four variants (or samples) presented in Tables 7a to 8b, but this time under two alternative strategies. First, the variable *d*, which could potentially be correlated with productivity shocks that are in the error term, will also be instrumented using the same set of instruments used for g2 (see columns under the label A in the four tables below). Second, we will 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 1 if product innovation occurs together with process innovation (see columns under the label B in the four tables below).

The first thing to notice is that we cannot reject the null hypothesis of *d* being exogenous in any of the regressions under the label A in Tables 9a to 10b. Therefore, we can remain relatively confident in the results found in the previous sub-section.

With respect to the change in the slope, we have (weak) evidence of a change (see regressions under the label B). For small firms and firms belonging to the low-tech sector there is no evidence of change in slope. For the whole sample and the sample of firms belonging to the high-tech sector, we find some evidence of a negative effect that does not completely offset the positive effect of product innovation on labor growth. In other words, there is some weak evidence that the positive impact on labor growth of the introduction of new products is weaker when this innovation is introduced together with a process innovation. Process innovation only continues to have in general a negative impact on labor growth, but in some cases the coefficient is not significantly different from zero (this is the case in regression 2 for small firms, and regressions 1 and 2 for low-tech firms). This result is similar to what was found before.

Table 9a. Effect of Innovation on Employment Quantity – IV Estimations Robustness Checks

Dependent variable: *l -(g1-π)*

Sector	Manufacturing					
	A[1]			B[2]		
Regression	**1**	**2**	**3**	**1**	**2**	**3**
Constant	1.806*	1.684	6.448***	1.678***	1.510**	6.097***
(se)	(1.09)	(1.07)	(1.30)	(0.64)	(0.65)	(0.78)
Process innovation only *(d)*	-3.951	-4.231	-6.215	-2.751**	-2.867***	-3.760***
(se)	(4.58)	(4.62)	(5.96)	(1.09)	(1.09)	(1.23)
Sales growth due to new products *(g2)*	0.964***	0.962***	0.932***	1.137***	1.137***	1.052***
(se)	(0.04)	(0.04)	(0.04)	(0.13)	(0.13)	(0.16)
Sales growth d.t. new products x product & proces inn				-0.211*	-0.214*	-0.149
(se)				(0.13)	(0.13)	(0.15)
Foreign owned (10% or more)		1.487	0.837		1.564	0.834
(se)		(1.24)	(1.34)		(1.19)	(1.28)
Growth wage bill per worker			-0.549***			-0.554***
(se)			(0.03)			(0.03)
2-digit industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F test, d	20.71	20.41	9.76			
p-value	0.0000	0.0000	0.0000			
F test, g2	157.01	156.43	105.26	152.61	151.76	105.84
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
d Exogeneity (Davidson-McKinnon)	0.091	0.114	0.200			
p-value	0.7628	0.7357	0.6548			
g2 Exogeneity (Davidson-McKinnon)	7.460	7.430	3.338	10.075	9.856	3.339
p-value	0.0063	0.0064	0.0677	0.0015	0.0017	0.0677
Sargan test	2.687	2.526	0.674	5.017	4.784	3.874
p-value	0.612	0.64	0.954	0.93	0.941	0.973
Standard error	19.55	19.54	17.37	19.58	19.58	17.35
Observations	2,532	2,532	1,698	2,532	2,532	1,698
Number of ISIC (2 digit)	22	22	22	22	22	22

Notes:

[1] Instrumenting d and g2 by "increased range of good" and "development of new markets" indicators.

[2] Instrumenting g2 and the interaction between g2 and the products and process innovation dummy. Instrument used are "increased range of good", "development of new market" and the interactions of them with the products and process innovation 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 overidentifying restrictions test. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 9b. Effect of Innovation on Employment Quantity – IV Estimations Small Firms - Robustness Checks

Sector	Small firms in Manufacturing					
	A[1]			B[2]		
Regression	1	2	3	1	2	3
Constant	-0.422	-0.147	4.641***	0.298	0.497	6.094***
(se)	(1.34)	(1.32)	(1.71)	(0.89)	(0.90)	(1.24)
Process innovation only *(d)*	1.248	0.901	5.228	-2.951*	-2.843	-4.414**
(se)	(8.29)	(8.21)	(10.72)	(1.76)	(1.76)	(2.01)
Sales growth due to new products *(g2)*	0.981***	0.983***	0.935***	1.025***	1.032***	0.801***
(se)	(0.07)	(0.07)	(0.08)	(0.19)	(0.19)	(0.21)
Sales growth d.t. new products x product & proces inn.				-0.066	-0.074	0.148
(se)				(0.19)	(0.19)	(0.20)
Foreign owned (10% or more)		-3.404	-2.396		-3.222	-2.024
(se)		(2.56)	(2.76)		(2.51)	(2.69)
Growth wage bill per worker			-0.561***			-0.542***
(se)			(0.05)			(0.05)
2-digit industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F test, d	11.30	11.47	6.23			
p-value	0.0000	0.0000	0.0000			
F test, g2	77.41	77.35	48.32	80.92	80.92	51.72
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
d Exogeneity (Davidson-McKinnon)	0.237	0.19	0.778			
p-value	0.6263	0.6631	0.3776			
g2 Exogeneity (Davidson-McKinnon)	2.893	3.075	0.350	7.607	7.684	1.649
p-value	0.0890	0.0795	0.5539	0.0058	0.0056	0.1991
Sargan test	4.081	4.018	2.363	7.916	7.64	5.672
p-value	0.395	0.404	0.669	0.721	0.745	0.894
Standard error	21.17	21.15	19.02	21.11	21.10	18.72
Observations	1,353	1,353	857	1,353	1,353	857
Number of ISIC (2 digit)	22	22	22	22	22	22

Notes: Idem Table 9a.

Table 10a. Effect of Innovation on Employment Quantity – IV Estimations
High-tech Sector - Robustness Checks

Sector	Manufacturing - High-Tech					
	A[1]			B[2]		
Regression	**1**	**2**	**3**	**1**	**2**	**3**
Constant	2.828*	2.646*	6.829***	2.229***	1.978**	6.127***
(se)	(1.56)	(1.52)	(1.73)	(0.85)	(0.88)	(1.02)
Process innovation only *(d)*	-6.967	-7.516	-9.219	-3.068**	-3.279**	-3.773**
(se)	(5.75)	(5.85)	(7.11)	(1.36)	(1.37)	(1.51)
Sales growth due to new products *(g2)*	0.962***	0.956***	0.923***	1.301***	1.302***	1.059***
(se)	(0.06)	(0.06)	(0.06)	(0.20)	(0.20)	(0.21)
Sales growth d.t. new products x product & proces inn				-0.406**	-0.412**	-0.19
(se)				(0.19)	(0.19)	(0.20)
Foreign owned (10% or more)		2.1	1.384		2.016	1.163
(se)		(1.49)	(1.58)		(1.38)	(1.45)
Growth wage bill per worker			-0.519***			-0.533***
(se)			(0.05)			(0.04)
2-digit industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F test, d	11.42	11.18	6.05			
p-value	0.0000	0.0000	0.0000			
F test, g2	75.64	75.51	50.1	87.1	86.71	60.72
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
d Exogeneity (Davidson-McKinnon)	0.583	0.666	0.771			
p-value	0.4452	0.4144	0.3799			
g2 Exogeneity (Davidson-McKinnon)	5.576	5.545	3.498	4.845	4.585	1.292
p-value	0.0182	0.0185	0.0614	0.0277	0.0322	0.2557
Sargan test	3.113	2.883	0.7	9.671	9.226	9.742
p-value	0.539	0.578	0.951	0.56	0.601	0.554
Standard error	19.02	19.02	16.80	19.01	18.99	16.62
Observations	1,464	1,464	990	1,464	1,464	990
Number of ISIC (2 digit)	10	10	10	10	10	10

Notes: idem Table 9a.

Table 10b. Effect of Innovation on Employment Quantity – IV Estimations Low-tech Sector - Robustness Checks

Sector	Manufacturing - Low-Tech					
	A[1]			B[2]		
Regression	**1**	**2**	**3**	**1**	**2**	**3**
Constant	0.62	0.568	6.020***	1.307	1.24	6.599***
(se)	(1.43)	(1.43)	(1.98)	(0.93)	(0.95)	(1.17)
Process innovation only *(d)*	1.148	1.09	-0.92	-2.616	-2.638	-4.659**
(se)	(7.24)	(7.25)	(10.34)	(1.81)	(1.81)	(2.09)
Sales growth due to new products *(g2)*	0.952***	0.951***	0.922***	0.891***	0.891***	0.919***
(se)	(0.06)	(0.06)	(0.06)	(0.17)	(0.17)	(0.23)
Sales growth d.t. new products x product & proces inn				0.065	0.064	0.011
(se)				(0.16)	(0.16)	(0.21)
Foreign owned (10% or more)		0.768	-0.053		0.837	0.001
(se)		(2.27)	(2.55)		(2.26)	(2.54)
Growth wage bill per worker		-0.572***				-0.570***
(se)		(0.05)				(0.05)
2-digit industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
F test, d	10.49	10.46	4.23			
p-value	0.0000	0.0000	0.0000			
F test, g2	86.52	85.92	57.65	69.93	69.52	48.09
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
d Exogeneity (Davidson-McKinnon)	0.27	0.265	0.137			
p-value	0.6032	0.6068	0.7112			
g2 Exogeneity (Davidson-McKinnon)	1.602	1.589	0.189	2.985	2.974	0.769
p-value	0.2056	0.2075	0.6635	0.0840	0.0846	0.3806
Sargan test	3.106	3.072	2.835	6.491	6.445	5.021
p-value	0.54	0.546	0.586	0.839	0.842	0.93
Standard error	20.35	20.34	18.30	20.29	20.29	18.26
Observations	1,068	1,068	708	1,068	1,068	708
Number of ISIC (2 digit)	12	12	12	12	12	12

Notes: Idem Table 9a.

Employment Growth Decomposition

Using equation (1) (see Harrison et al., 2008) the employment growth of each firm can be represented by the following equation:

$$(3)\ \ l = \sum_{j}\left(\hat{\alpha}_0 + \hat{\alpha}_{0j}\right) ind_j + \hat{\alpha}_1 d + \left[1 - 1(g_2 > 0)\right](g_1 - \pi) + 1(g_2 > 0)\ (g_1 - \pi + \hat{\beta} g_2) + \hat{\upsilon}$$

where ind_j indicates industry dummies (at 2-digit level). The first component on the left-hand side $\sum_j (\hat{\alpha}_0 + \hat{\alpha}_{oj}) ind_j$ measures the change in employment due to the productivity trend in production of old products (this component is computed as a residual in table 11a). On the right-hand side, the term $[1 - 1(g_2 > 0)](g_1 - \pi_1)$ is the estimate of the employment change associated with output growth of old products for firms that do not introduce new products and $1(g_2 > 0)\ (g_1 - \pi_1 + \hat{\beta} g_2)$ is the net contribution of product innovation after allowing for any substitution of old products for new products. Finally, $\hat{\upsilon}$ is a zero-mean residual.

Table 11a presents the decomposition for the whole sample and for the small firms sample using the proportion averages from table 4 and A.2 (all firms and small firms, respectively) and the estimated coefficients of equation (1'). The decomposition is performed with the parameters of each of these samples estimated by OLS and IV (without any control variables). OLS and IV estimations yield similar, though not identical, results.

Considering the whole period, the average employment growth was -0.7 percent for whole sample, -3.7 percent for the small firms, 0.3 percent for the firms belonging to the high-tech sector, and -2.1 percent for the firms belonging to the low-tech sector.

For the whole sample, the productivity improvement in the production of old products is an important source of increase in employment (2.2 percent). In all the estimations, process innovations account for only small (negative) employment changes. The sales growth of old products is the most important factor that explains the negative rate of growth of employment in the period for all types of firms (-1.9 percent in the whole sample). The net contribution of product innovation for the whole sample was -0.8 percent in the case of the OLS estimation and 0.3 percent in the IV one. This net contribution is the result of very negative contribution of old products and a very positive contribution of new products. This result is similar across sub-samples.

In the decomposition of employment growth for small firms and firms belonging to the low-tech sector, we observe a more negative contribution of old product output growth, explaining most of the negative performance of these types of firms. In the case of the small firms, the more negative net contribution of product innovation and the smaller growth of the productivity trend in the production of old products are also important in explaining the highly negative annual growth rate.

The above-mean performance of the firms belonging to the high-tech sector is explained mostly by the above-mean productivity trend in the production of old products and the output growth of old products.

Table 11a. Contribution of Innovation to Employment Growth Manufacturing, 1998-2009[1]

	all firms		small firms		high tech		low tech	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Firms employment growth	*-0.7*	*-0.7*	*-3.7*	*-3.7*	0.3	0.3	-2.1	-2.1
Productivity trend in production of old products [2]	2.2	1.1	1.7	0.3	2.6	1.4	1.7	0.8
Gross effect of process innovation in production of old produc	-0.3	-0.2	-0.2	-0.1	-0.3	-0.2	-0.2	-0.1
Output growth of old products contribution	-1.9	-1.9	-3.8	-3.8	-1.2	-1.2	-2.9	-2.9
Net contribution of product innovation	-0.8	0.3	-1.5	-0.2	-0.8	0.4	-0.7	0.1
Contribution of old products by product innovators	-9.1	-9.1	-7.8	-7.8	-9.3	-9.3	-8.9	-8.9
Contribution of new products by product innovators	8.4	9.4	6.3	7.6	8.5	9.6	8.2	9.0

Notes: 1. Decomposition based on (yearly) rates of growth for the whole period. 2. This component is obtained by subtracting the sum of the other components from average employment growth.

Table 11b reports the same exercise for the period 2004-09 (i.e., the period of recovery and growth after the 2002-03 crisis in Uruguay). We found that process innovations have a negligible effect and that the productivity trend in production of old products generates a displacement effect on employment in almost all the cases (with the exception of the OLS estimation for whole sample and the high-tech sector). Product innovation appears as the second most important factor for employment growth in the period 2004-09, after the output growth of old products.

Table 11b. Contribution of Innovation to Employment Growth Manufacturing, 2004-09[1]

	all firms		small firms		high tech		low tech	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Firms employment growth	*4.9*	*4.9*	*1.9*	*1.9*	5.6	5.6	3.7	3.7
Productivity trend in production of old products [2]	0.2	-1.2	-2.4	-3.6	1.2	-0.6	-1.0	-1.8
Gross effect of process innovation in production of old produc	-0.1	0.1	0.0	0.1	-0.3	0.0	0.1	0.1
Output growth of old products contribution	3.1	3.1	3.5	3.5	3.1	3.1	3.0	3.0
Net contribution of product innovation	1.6	2.9	0.7	1.8	1.6	3.1	1.6	2.4
Contribution of old products by product innovators	-5.7	-5.7	-3.7	-3.7	-6.0	-6.0	-5.2	-5.2
Contribution of new products by product innovators	7.3	8.5	4.4	5.5	7.6	9.1	6.8	7.6

Notes*:* 1. Descomposition based on (yearly) rates of growth for the whole period. 2.This component is obtained by subtracting the sum of the other components from average employment growth.

3.2.3 The Relationship between Employment Quality and Innovation

Here we estimate equation (2) controlling for fixed effects at the industry level. Still, non-observable characteristics can be correlated with innovation variables; hence, we are going to use an instrumental variables approach, as in the previous section. The instruments used are the same ones that were used in the previous section. Again, all the indicators (instruments) were included as a set of dummies because of evidence of a nonlinear effect in the first-stage regressions.

Data availability

We define the share of skilled labor force in a given firm as the percentage of professionals and technicians working for that firm in a certain period. The share of skilled labor is available only for the last three MIS surveys and it is not available in the EAS survey. Therefore, we will be using the share of skilled labor at end of period of each of the last three MIS surveys: 1,810 firms in total. The next table shows descriptive statistics for the available data on the share of skilled workers, distinguishing by type of innovative firm. We can see that the mean share of skilled labor in the manufacturing sector is 9.5 percent. While non-innovators have the lowest share of skilled labor (7.4 percent), product innovators have the highest (12.5 percent).

In order to estimate equation (2), we need to compute the growth rate for each type of labor. Since we have the end-of-period data for three MIS surveys, we compute the growth rate between two consecutive innovation surveys. That is, we calculate the growth rate of employment between 2009 and 2006, and between 2006 and 2003. Hence, we will only have two data points for each firm. We also need to note that the growth rate will only be available for the firms that are present in two consecutive surveys. The next table shows statistics for the nominal and real growth rates for each type of labor by type of firm. We do not have data on the firms' capital, which means that we cannot control for complementarities in the use of skilled labor and capital.

Table 12. Employment Composition - Descriptive Statistics for 2001-2009 Manufacturing Sector

Share of skilled labor	Mean	Median	Standard Deviation	Minimum	Maximum
All Firms	9.5	5.2	12.4	0.0	100.0
Non-innovators (no process or product innovations)	7.4	3.4	11.9	0.0	100.0
Process only innovators (non product innovators)	10.4	6.0	12.0	0.0	78.0
Product innovators	12.5	8.1	12.7	0.0	95.0
Employment (total) growth (%)					
All Firms	9.5	5.2	12.4	0.0	100.0
Non-innovators (no process or product innovations)	3.3	3.9	12.5	-51.0	53.6
Process only innovators (non product innovators)	6.2	5.7	11.1	-34.1	76.8
Product innovators	7.6	7.4	10.3	-39.5	36.4
Skilled labor growth (%)					
All Firms	10.2	5.8	29.2	-79.7	153.5
Non-innovators (no process or product innovations)	6.3	0.0	28.6	-75.3	153.5
Process only innovators (non product innovators)	13.4	11.2	31.0	-77.8	99.4
Product innovators	14.1	12.0	27.9	-79.7	88.0
Unkilled labor growth (%)					
All Firms	5.1	4.5	16.3	-122.1	154.7
Non-innovators (no process or product innovations)	4.1	3.5	19.6	-122.1	154.7
Process only innovators (non product innovators)	5.2	4.4	12.4	-45.0	73.2
Product innovators	6.8	6.8	12.4	-45.9	66.4

Source: Authors' calculations using Innovations Survey waves 2001-03, 2004-06, and 2007-09.
Notes: Yearly averages for the period 2001-09.

The positive annual mean growth rate in employment during the period 2001-09 is explained by positive growth rates in both skilled and unskilled labor. For all types of firms, skilled labor grows at faster rates than unskilled labor. The most significant growth rates for skilled labor are for the organizational change occurring in innovators and product innovators.

Results

Table 13 presents the estimation results for the model in equation (2), where the dependent variables are the employment growth rate of type q_j labor minus sales growth rate ($l^{qj}-(g_1 - \pi)$) (for s= skilled and u = unskilled labor). The specifications include the process innovation dummy, d, sales growth rate of new products, g_2, a dummy controlling for the foreign ownership of the firm, and a constant. The estimations also include industry fixed effects (at 2-digit level).

The table presents results for the total sample (columns 1 and 2) and the sub-sample of small firms (columns 3 and 4).

The dummy indicating process-only innovation is not significantly different from zero in most of the specifications. The exception is for unskilled labor, in which is significant and negative. This variable controls for the additional increase in the productivity of old products and the displacement effect on each type of employment, due to the innovation in process only. Hence, there is evidence of displacement effects in the case of unskilled labor, although not for skilled labor.

In contrast, the coefficient on the growth rate of sales of new products (g_2) is significant, positive, and lower than one for both skilled and unskilled labor. As indicated in the previous section, this coefficient measures the relative efficiency of old and new products produced by each type of labor, indicating that new products are produced more efficiently than the old ones.

The dummy indicating foreign ownership is significant and positive for the sample of all firms, indicating positive effects on total employment of skilled and unskilled labor if the firm has foreign ownership.

For the sub-sample of small firms, the results are very similar. Process innovation is not significantly different from zero in any specification. The growth rate of the production of new products is significantly different from zero, and less than unity. The foreign ownership dummy is significantly different from zero and negative for the growth rate of skilled labor, while it is not significantly different from zero for the growth rate of unskilled labor. This means that foreign ownership has a differential impact on the growth rate of the two types of labor.

The coefficient of the growth rate of new products is similar for skilled and unskilled labor, indicating no differential impact for both, the whole sample, and the small firm sample.

Table 13. Relationship Employment- Labor Composition - OLS Estimation

	(1)	(2)	(3)	(4)
Sector	**Manufacturing**		**Small Manufacturing**	
Regression	**Skilled-OLS**	**Unskilled-OLS**	**Skilled-OLS**	**Unskilled-OLS**
Constant	5.302***	0.923	5.354***	-0.420
(se)	(1.414)	(0.965)	(1.915)	(1.376)
Process innovation only *(d)*	-0.151	-4.120***	3.122	-4.014
(se)	(2.683)	(1.578)	(5.396)	(2.711)
Sales growth due to new products *(g2)*	0.853***	0.860***	0.687***	0.812***
(se)	(0.064)	(0.034)	(0.108)	(0.065)
Foreign owned (10% or more)	10.218**	8.406***	22.204***	2.330
(se)	(4.828)	(2.629)	(6.444)	(4.680)
Fully foreign owned	-6.821	-2.809	-37.843***	6.003
(se)	(5.527)	(3.192)	(10.184)	(7.536)
2-digit industry dummies	yes	yes	yes	yes
Ho: g2=1 p-value	0.021	0.000	0.004	0.004
Standard error	33.33	21.09	34.63	22.88
Number of observations	1037	1037	443	443

Source: Authors' calculations.
Notes: 1. All regressions include 2-digit industry dummies. 2. Robust standard errors in parentheses. 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.

As discussed above, the coefficient on g_2 could be biased because of the presence of endogeneity. Any endogeneity is likely to produce a downward bias in this coefficient, overstating the productivity gains associated with the production of new products.

The estimations presented in Table 14 aim to analyze the robustness of results when using instrumental variables (IV). Panel A shows the estimates assuming g2 as endogenous, while panel B assumes that both g2 and d are endogenous variables. The instrumental variables used are the same as in the previous section. The results show that the coefficient of g_2 increases when estimated by IV. For both types of labor the coefficient increases, and we cannot reject the hypothesis of them being equal to 1.

The Davidson-MacKinnon test of exogeneity does not reject the null hypothesis of exogeneity of the variable d in all the cases. Instead, for g_2 we reject the hypothesis of exogeneity for skilled labor in the total firms sample, when assuming d as exogenous. Hence, in general, the evidence rejects the hypothesis of the process innovation variable being endogenous, while for g_2

this is true for the unskilled labor growth regression and not for the skilled rate of growth. The F-tests give evidence that there is no problem of weak instruments, while the Sargan test does not reject the hypothesis of valid instruments.

To summarize, results do not indicate an important differential impact of innovation on the composition of the labor force for the whole sample, but they do indicate that sales of new products show a positive and asymmetric impact on the productivity of skilled and unskilled labor in the case of small firms.[21] Finally, it is important to note that this sample is different from the one in the previous section. Here, we are only including those firms that are present in at least two consecutive innovation surveys, and we only have information for two points in time, 2009 vs. 2006 and 2006 vs. 2003.

[21] These results are taken from the OLS estimations since IV estimations indicate no problem of endogeneity of the innovation variable in most of the cases.

Table 14. Relationship Employment - Labor Composition - IV Estimation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sector	Manufacturing				Small Manufacturing			
	Panel A		Panel B		Panel A		Panel B	
Regression	Skilled IV	Unskilled IV	Skilled IV	Unskilled IV	Skilled IV	Unskilled IV	Skilled IV	Unskilled IV
Constant	2.934*	0.225	2.169	0.567	3.418	-1.132	1.055	-0.231
(se)	(1.748)	(1.100)	(2.807)	(1.766)	(2.282)	(1.500)	(3.645)	(2.373)
Process innovation only *(d)*	2.379	-3.373*	5.845	-4.923	5.116	-3.281	24.631	-10.723
(se)	(2.822)	(1.780)	(10.319)	(6.490)	(4.965)	(3.278)	(23.641)	(15.465)
Sales growth due to new products *(g2)*	1.087***	0.929***	1.090***	0.928***	0.970***	0.916***	0.907***	0.940***
(se)	(0.120)	(0.075)	(0.120)	(0.076)	(0.196)	(0.129)	(0.213)	(0.139)
Foreign owned (10% or more)	8.888*	8.888*	8.024	8.400**	21.396	21.396	13.476	5.053
(se)	(5.354)	(5.365)	(5.903)	(3.713)	(13.623)	(13.688)	(16.733)	(10.894)
Fully foreign owned	-5.947	-2.551	-5.169	-2.899	-34.890**	7.089	-29.814*	5.153
(se)	(6.128)	(3.856)	(6.526)	(4.105)	(16.121)	(10.593)	(17.469)	(11.373)
Ho: g2=1 p-value	0.468	0.348	0.457	0.341	0.882	0.514	0.540	0.760
2-digit industry dummies	yes	yes	yes	yes	yes	yes	yes	yes
Standard error	33.49	21.08	33.52	21.08	34.73	22.82	35.34	23.01
Number of observations	1037	1037	1037	1037	443	443	443	443
F test, g2	64.87	64.87	61.27	61.27	32.52	32.52	29.38	29.38
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F test, d			10.88	10.88			2.859	2.859
p-value			0.00	0.00			0.00	0.00
g2 Exogeneity (Davidson-McKinnon)	5.37	1.16	3.24	1.11	3.17	0.81	0.23	1.28
P-Value	0.02	0.28	0.07	0.29	0.08	0.37	0.63	0.26
d Exogeneity (Davidson-McKinnon)			0.12	0.06			1.48	0.49
P-Value			0.73	0.80			0.22	0.49
Sargan (m)	10.43	6.017	10.28	5.950	7.666	3.420	6.690	3.120
Prob. Value	0.0640	0.305	0.0359	0.203	0.176	0.635	0.153	0.538

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. Dependant variable in columns 1 and 3 is $l^{skilled}$-g_1-π and in 2 and 4 is $l^{unskilled}$-g_1-π. 4. All regressions include 2-digit industry dummies. 5. Instruments: 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. 6. F test denotes de F of excluded instruments in the first-stages regressions. 7. Exogeneity denotes Davidson-MacKinnon test of Exogeneity. 8. Sargan test denotes overidentifying restrictions test.

In the next table we replicate the above-described exercise for high- and low-tech sectors. The results are very similar to those obtained from the complete sample of firms. When estimating by OLS, the coefficient on g2 is smaller than unity, which we cannot reject when assuming g2 as an endogenous variable. The process innovation variable is not significant in most cases, but it is significantly different from zero and negative for unskilled labor in the high-technology sectors. This indicates a displacement effect of the innovation process.

When comparing the coefficient of g2 under instrumental variables, we can see that the coefficient for skilled labor is lower in the low-tech sectors, while higher for unskilled labor. This means that in the low-tech sectors for skilled labor, product innovation has a greater effect than in the high-tech sectors.

Table 15. Relationship Employment – High-Low Tech Sectors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Sector	**Manufacturing High Tech**						**Manufacturing Low Tech**					
	OLS		**Instrumenal variables**				**OLS**		**Instrumenal variables**			
Regression	**Skilled**	**Unskilled**	**Skilled**	**Unskilled**	**Skilled**	**Unskilled**	**Skilled**	**Unskilled**	**Skilled**	**Unskilled**	**Skilled**	**Unskilled**
Constant	6.388***	1.448	2.418	0.758	0.066	0.571	3.633*	0.280	3.181	-0.240	4.931	0.723
(se)	(1.971)	(1.203)	(2.523)	(1.472)	(3.898)	(2.256)	(1.972)	(1.594)	(2.364)	(1.631)	(3.669)	(2.525)
Process innovation only *(d)*	-0.134	-5.781***	4.118	-5.043**	13.813	-4.271	0.114	-1.587	0.581	-1.050	-8.642	-6.127
(se)	(3.425)	(2.031)	(3.820)	(2.237)	(12.726)	(7.364)	(4.324)	(2.514)	(4.235)	(2.936)	(15.243)	(10.544)
Sales growth due to new products *(g2)*	0.873***	0.835***	1.223***	0.896***	1.245***	0.898***	0.817***	0.894***	0.872***	0.957***	0.892***	0.968***
(se)	(0.072)	(0.042)	(0.165)	(0.096)	(0.168)	(0.097)	(0.122)	(0.059)	(0.170)	(0.118)	(0.175)	(0.120)
Foreign owned (10% or more)	8.490	9.983***	6.427	6.427	3.181	9.366**	13.884*	5.790	13.559	13.559	14.139	5.736
(se)	(5.988)	(3.304)	(6.696)	(6.718)	(7.882)	(4.561)	(7.958)	(4.216)	(9.126)	(9.171)	(9.237)	(6.358)
Fully foreign owned	-5.531	-5.936	-4.015	-5.673	-1.267	-5.454	-9.400	4.083	-9.248	4.258	-10.235	3.714
(se)	(6.848)	(3.885)	(7.529)	(4.394)	(8.337)	(4.824)	(8.955)	(5.537)	(10.837)	(7.477)	(11.026)	(7.589)
2-digit industry dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Ho: g2=1 p-value	0.08	0.00	0.181	0.273	0.153	0.281	0.1343	0.0751	0.480	0.707	0.517	0.816
Standard error	33.74	19.97	34.15	19.93	34.45	19.93	32.86	22.66	32.71	22.57	32.94	22.67
Number of observations	616	616	616	616	616	616	421	421	421	421	421	421
F test, g2			32.51	32.51	32.32	31.32			36.42	36.42	32.61	32.61
p-value			0.00	0.00	0.00	0.00			0.00	0.00	0.00	0.00
F test, d					7.644	7.644					6.6	6.6
p-value					0.00	0.00					0.00	0.00
g2 Exogeneity (Davidson-McKinnon)			6.16	0.43	4.30	0.37			0.20	0.35	0.21	0.63
P-Value			0.01	0.51	0.04	0.54			0.65	0.55	0.65	0.43
d Exogeneity (Davidson-McKinnon)					0.68	0.00					0.02	0.29
P-Value					0.41	0.96					0.88	0.59
Sargan (m)			6.214	6.799	5.467	6.784			6.848	1.408	6.354	1.141
Prob. Value			0.286	0.236	0.243	0.148			0.232	0.923	0.174	0.888

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. Dependant variable in **Skilled** columns is $l^{skilled}$-g_1-π and in **Unskilled** columns is $l^{unskilled}$-g_1-π. 4. All regressions include 2-digit industry dummies. 5. Instruments: 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. 6. F test denotes de F of excluded instruments in the first-stages regressions. 7.Exogeneity denotes Davidson-MacKinnon test of Exogeneity. 8. Sargan test denotes overidentifying restrictions test.

Finally, since we do not know whether process innovations refer to the production of old or new products, we considered the case when firms are undertaking product and process innovation at the same time and checked if the slope for g_2 is different. The latter assumes that process and product innovation correspond to the production of new products. In Appendix D, Table D1, we present OLS and IV estimates for skilled and unskilled labor growth. The specification includes a dummy of process and product innovation interacted with g_2. As can be seen, g2 is still significant and positive in all regressions, while the interaction is not significant for any of the specifications. This allows us to conclude that there is no structural change in the slope of product innovations if these innovators are also introducing process innovation.

3.2.4 Impact of Innovation Strategies on Employment

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

In order to analyze how different types of business innovation strategies influence the capacity to generate or destroy employment (quantity and quality), versions of equations (1) and (2) are going to be re-estimated. Innovation outputs (process and product innovation) will be replaced by different types of innovation strategies (make and/or buy).

We define make and/or buy strategies by distinguishing internal and external knowledge acquisition in the innovation strategy. Firms can develop new products or processes in-house through R&D spending: "internal R&D". Conversely, firms 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, or organizational and management design.

In practice, we are going to define make-and-buy strategies according to the types of innovations undertaken by the firm. Firms surveyed were asked directly about the type of innovation that they undertake. Table 16 shows the definitions of each type of innovation and how they were categorized into buy or make strategies.

Figure 2 shows the number of innovating and non-innovating firms, and which type of innovation strategy they have undertaken. Just over 50 percent of the firms in the sample claimed to innovate, i.e., developed or introduced new or improved products or processes or organizational design during the period of the survey. Next, we determined how firms acquire and develop new technology: the make or buy decision. In the sample, most of the innovating firms (55 percent) buy technology, while 2 percent make technology in-house; the remaining 42 percent do both. It is tempting to interpret this joint occurrence as evidence of complementarity between the two modes. However, we cannot draw this conclusion from the descriptive analysis.

The importance of firm size can be appreciated by looking at table 17. Large firms are more likely to innovate. Of the firms with less than 50 employees, only 37 percent innovate compared to 51 percent of firms in the whole sample. 1 percent of the firms only buy technology, while 28 percent of them have undertaken a make only strategy, and the other 22 percent a combined strategy. Small firms that are innovative are more likely to restrict themselves to a simple innovation strategy.

With respect to the high-low tech division, we found that high-tech sectors innovate relatively more than low tech sectors: 57 percent vs. 43 percent. In the high-tech sector, both buy and buy-and-make strategies are employed, while in the low-tech sector, buy-only is the preferred strategy.

Table 16. 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: Same 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.	

Figure 2. Innovation Strategies

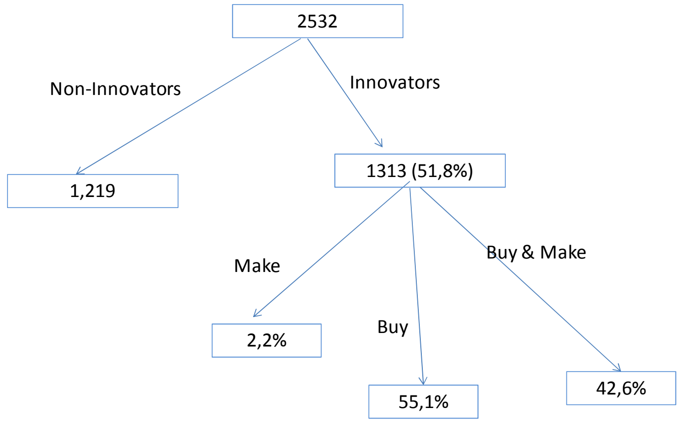

Table 17. Descriptive Statistics for Strategies - Period: 2001-2009
Manufacturing Sector

Share of firms pursuing each type of strategy by type of firm (%)	Buy Only	Make Only	Make and Buy
All Firms	0.28	0.01	0.22
Non-innovators (no process or product innovations)	0.00	0.00	0.00
Process only innovators (non product innovators)	0.81	0.01	0.17
Product innovators	0.38	0.03	0.57
Small Manufacturing			
All Firms	0.22	0.01	0.13
Non-innovators (no process or product innovations)	0.00	0.00	0.00
Process only innovators (non product innovators)	0.84	0.02	0.13
Product innovators	0.45	0.04	0.47
High Technology firm			
All Firms	0.28	0.02	0.28
Non-innovators (no process or product innovations)	0.00	0.00	0.00
Process only innovators (non product innovators)	0.76	0.01	0.22
Product innovators	0.32	0.03	0.64
Low technology firms			
All Firms	0.28	0.01	0.14
Non-innovators (no process or product innovations)	0.00	0.00	0.00
Process only innovators (non product innovators)	0.91	0.00	0.08
Product innovators	0.49	0.02	0.45

Sources: Innovations Survey of manufacturing sector waves 2001-03, 2004-06, and 2007-09.

Notes: Yearly averages for the period 2001-09.

The empirical strategy will be based on equations (1') and (2). A reduced form will be substituting g_2 and d. For the innovation strategy dummies make only, buy only and make-and-buy, the equation to estimate will be the following:

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

Reconciling with the core model we specify two different equations: one that explains product innovation from the input strategies of make only, buy only, and make-and-buy, and the usual labor employment growth equation from the quantity model (1') where g2 is replaced by its predicted value from the first equation. This is a normal instrumental variables approach where the instruments for g_2 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), pp. 623-625. 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.

In the structural approach, we are also going to regress the innovation strategies on product and process innovations and on sales growth of old products. This will allow us to decompose the impact of innovation strategies on employment growth in the three different channels: product innovation, process innovation, and sales of old products.

The econometric model for the first stage of the structural approach is composed by three regressions:

$$d = \delta_0 + \delta_m \; make + \delta_b \; buy + \delta_{bnm} \; make \,\&\, buy + error$$

$$g_2 = \gamma_0 + \gamma_m \; make + \gamma_b \; buy + \gamma_{bnm} \; make \,\&\, buy + error$$

$$g_1 - \pi = \rho_0 + \rho_m \; make + \rho_b \; buy + \rho_{bnm} \; make \,\&\, buy + error$$

These equations measure the impact of different innovation strategies on process and product innovations and on sales of old products. The second stage is simply the usual labor employment growth equation from the quantity model (1'):

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

Hence, to decompose the impact of different innovation strategies on employment growth, we are going to use the estimates of parameters in the first and second stage. As an example, the impact of a make strategy (vs. no innovation strategy) on employment growth can be described as:

$$\begin{aligned} & E(l \mid make = 1, x) - E(l \mid make = 0, x) = \\ & \beta(E(g_2 \mid make = 1, x) - E(g_2 \mid make = 0, x)) + \alpha_1(\Pr(d = 1 \mid make = 1, x) - \Pr(d = 1 \mid make = 0, x)) + \\ & (E(g_1 - \pi \mid make = 1, x) - E(g_1 - \pi \mid make = 0, x)) = \\ & = \beta(\gamma_m + \eta_{g_2 p}(\Phi(\delta_0 + \delta_m) - \Phi(\delta_0))) + \alpha_1(\Phi(\delta_0 + \delta_m) - \Phi(\delta_0)) + \rho_m \end{aligned}$$

Where η_{g2p} is the coefficient of the instrument derived from the predicted value of d in the probit in the first stage. Remember that we are estimating a probit using the innovation strategies as explicative variables, and then using the predicted value as the instrument for d, in the first stage estimation with instrumental variables. In the first stage estimation for d, the coefficient on this predicted value derived from the probit is the only significant variable and with a coefficient equal to one, hence $\eta_{d,p}$==1, and is already restricted in the above equation. Finally, since we are restricting the coefficient on g_1-π to be equal to 1, we estimate the model for l- g_1-π.

The first term in the above equation is the impact of the make innovation on sales of new products. The second term is the effect on employment growth through make innovation of the process innovation. Finally, the last term is the effect of the make strategy on sales of old products.

The working hypothesis is that since innovation strategies are firms' 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 locally generated ones. In other words, make strategies should be more labor generating (and less skill intensive) than buy innovation strategies.

Table 18 shows the results for total employment growth. Columns 4 and 8 show the OLS estimation (or reduced form estimation) on make only, buy only and make-and-buy strategies, and a constant. All of the innovation strategies are significantly different from zero and positive. 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. Testing for any 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 is the total and the small firms sample.

Columns A to C in the first panel show the first-stage regressions for $g_{2,}$ g_1-π and d. Column A shows the results for first-stage estimations when we only instrument g_2. Column B is the result for the OLS, first-stage regression for g_1-π, while column C shows the results of the probit of the innovation process variables (d). As we can see, all of the strategies have a significant and positive effect over g_2 and the probability of process innovation.

In the panel below, we present the estimation of 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 g2 are positive and below unity.[22] The salient difference is that when instrumenting only for g2, d is significant and negative, showing displacement effects from process innovation. The Davidson-McKinnon test of exogeneity does not reject the null hypothesis of exogeneity of the innovation

[22] The p-value for the test g2=1 is 0.010 in the first column and 0.05 for column 2.

process variable, while the opposite is true for g_2. The F and the Sargan test indicate no problems of valid and weak instruments.

In the next exercise, we analyze the effect of innovation strategies on the skills composition of the labor force. Table 19 shows the results for the growth rate of skilled (columns 1 to 3), and unskilled employment (columns 4 to 6).

In the fourth column of each panel we have the reduced form estimation, the OLS estimation of equation 4. In all cases, all strategies are significantly different from zero and positive, indicating a positive effect on the employment growth of skilled and unskilled labor. The coefficient of the make-or-buy strategy variable is similar for both types of labor, but the make-only and buy-only coefficients are lower for unskilled labor. We can interpret this as a differential impact, with the make strategy having more positive effects. While the hypothesis that the combined strategy has larger effects than the sum of the other two for skilled labor growth can be rejected, this not the case for unskilled labor growth.

For the sub-sample of small firms, results are very similar and go in the same direction as above.

The first-stage equations for g_2 and d show significant and positive coefficients in all cases, while the equation for $g1-\pi$ indicates negative effects of innovation strategies. The second-stage estimations show that the coefficient on g_2 is significant, positive, and slightly higher than unity for the skilled labor, although it is below unity for unskilled labor. This means that innovation has more positive effects on productivity using unskilled labor than skilled labor. Meanwhile, d is not significant in the skilled labor growth equation, while it is significant and negative with respect to unskilled labor growth. Hence, process innovation has displacement effects on unskilled labor but not on skilled labor.

Table 18. Innovation Strategies - Manufacturing Sector - 2001-09

Sector	Manufacturing				Small manufacturing			
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-Pi	d	l-(g1-Pi)	g2	g1-Pi	d	l-(g1-Pi)
Constant	0.220	-5.609***	-2.959***	2.134***	0.318	-6.508***	-2.871***	0.573
(se)	(0.472)	(0.682)	(0.222)	(0.648)	(0.569)	(0.911)	(0.236)	(0.868)
Make only (dummy)	27.455***	-25.778***	1.886***	30.075***	34.266***	-25.087***	1.958***	31.655***
(se)	(3.043)	(4.395)	(0.367)	(3.805)	(3.682)	(5.899)	(0.428)	(5.508)
Buy only (dummy)	12.697***	-4.361***	3.118***	9.914***	14.469***	-7.134***	2.984***	12.661***
(se)	(0.765)	(1.105)	(0.227)	(1.192)	(1.016)	(1.627)	(0.247)	(1.775)
Make & Buy (dummy)	24.959***	-17.512***	1.963***	22.814***	23.685***	-18.158***	1.873***	22.456***
(se)	(0.865)	(1.250)	(0.232)	(1.296)	(1.313)	(2.103)	(0.264)	(2.170)
Time dummies	yes	yes	yes	yes	yes	yes	yes	yes
2-digit industry dummies	yes	yes	yes	yes	yes	yes	yes	yes
Standard error	16.06	23.20		23.93	14.84	23.78		24.22
Number of firms	2532	2532	2532	2532	1353	1353	1353	1353
Test: make+buy <= b&m p-value				0.00				0.00
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	1.938***	1.926***			0.291	0.265		
(se)	(0.581)	(0.581)			(0.821)	(0.819)		
g2	0.931***	0.931***			0.971***	0.922***		
(se)	(0.031)	(0.044)			(0.049)	(0.081)		
d (dummy)	-2.995***	-2.940			-2.927*	-0.405		
(se)	(1.059)	(1.829)			(1.734)	(3.381)		
Time dummies	yes	yes			yes	yes		
2-digit industry dummies	yes	yes			yes	yes		
Standard error	19.49	19.49			21.10	21.04		
Number of firms	2532	2532			1351	1353		
F test, g2real	745.3	303.59			412.7	153.83		
p-value	0.00	0.0			0.00	0.0		
F test, d		484.30				289.12		
p-value		0.00				0.00		
Davidson-MacKinnon test of exog	11.34	5.82			17.77	1.03		
p-value	0.00	0.00			0.00	0.00		
Davidson-MacKinnon test of exog d		0.001				0.725		
p-value		0.9765				0.3945		
Sargan	1.964	7.786			0.0769	3.203		
Prob. Value	0.375	0.0204			0.962	0.202		

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.

To conclude, this exercise indicates that producing technology in-house has the biggest positive effect on employment growth. The combined strategy, where firms produce in-house and also buy knowledge externally, is second in the ranking, both for skilled and unskilled employment. We reject a multiplier effect of the combined strategy. 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 a displacement effect on unskilled labor but not on the skilled labor force.

Tables 20 and 21 replicate the above exercise for the low- and high-technology sectors. The results are very similar to those derived from the complete sample of firms. In the reduced form equation, the three strategies are significant and positive in both sectors. Coefficients on all the strategies are bigger for the low-technology sector, meaning that the effects of innovation on this sector were larger.

The first-stage equations also show significant and positive effects on g_2 and d of all three strategies. In the second-stage equations, g2 is significant, positive, and cannot reject the unity, in both sectors.[23] While d, process innovation, is not significant in the low-tech sector, while significant and negative in the high-tech sector, having displacement effects on employment in the latter sector.

When decomposing the labor into skilled and unskilled labor, results are very similar to the obtained with the complete sample of firms.

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[23] In the low-technology sector there are very few firms doing the make-only strategy. This makes the estimations very imprecise, to the point of not showing estimations in the A and B equations for the low-tech sector.

Table 19. Innovation Strategies and Skill Composition of the Labor Force Manufacturing Sector - 2001-09

Sector	Manufacturing Skilled				Manufacturing Unskilled				Small manufacturing skilled				Small manufacturing unskilled			
First Equation	**A**	**B**	**C**	**Red Form**	**A**	**B**	**C**	**Red Form**	**A**	**B**	**C**	**Red Form**	**A**	**B**	**C**	**Red Form**
Regression	OLS	OLS	Probit	OLS	OLS	OLS	Probit	OLS	OLS	OLS	Probit	OLS	OLS	OLS	Probit	OLS
Dependent Variable	g2	g1-Pi	d	l-(g1-Pi)	g2	g1-Pi	d	l-(g1-Pi)	g2	g1-Pi	d	l-(g1-Pi)	g2	g1-Pi	d	l-(g1-Pi)
Constant	-1.254	-0.478	-2.785***	-1.538	-1.254	-0.478	-2.785***	0.371	-1.063	-2.765	-2.690***	-0.319	-1.063	-2.765	-2.690***	-2.476
(se)	(0.979)	(1.456)	(0.325)	(2.430)	(0.979)	(1.456)	(0.325)	(1.602)	(1.795)	(3.030)	(0.402)	(5.225)	(1.795)	(3.030)	(0.402)	(2.928)
Make only (dummy)	29.326***	-29.269***	2.115***	45.275***	29.326***	-29.269***	2.115***	27.857***	26.934***	-26.305***	2.142***	45.663***	26.934***	-26.305***	2.142***	25.477**
(se)	(5.051)	(7.514)	(0.563)	(12.085)	(5.051)	(7.514)	(0.563)	(9.232)	(5.259)	(8.877)	(0.602)	(13.153)	(5.259)	(8.877)	(0.602)	(10.467)
Buy only (dummy)	9.735***	-2.877*	3.247***	12.461***	9.735***	-2.877*	3.247***	5.521***	11.871***	-4.699*	3.077***	14.899***	11.871***	-4.699*	3.077***	6.461**
(se)	(1.076)	(1.601)	(0.323)	(2.711)	(1.076)	(1.601)	(0.323)	(1.839)	(1.646)	(2.779)	(0.359)	(4.736)	(1.646)	(2.779)	(0.359)	(3.171)
Make & Buy (dummy)	24.851***	-19.636***	1.787***	28.941***	29.326***	-29.269***	1.787***	23.529***	25.742***	-20.144***	1.541***	23.825***	25.742***	-20.144***	1.541***	25.391***
(se)	(1.282)	(1.907)	(0.332)	(3.013)	(5.051)	(7.514)	(0.332)	(2.129)	(2.246)	(3.791)	(0.409)	(6.295)	(2.246)	(3.791)	(0.409)	(4.323)
Time dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
2-digit industry dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Standard error	14.59	21.71		34.82	14.59	21.71		24.76	13.07	22.06		35.32	13.07	22.06		25.08
Number of firms	1037	1037	1037	1037	1037	1037	1037	1037	443	443	443	443	443	443	443	443
make+buy <= b&m p-value				0.01				0.15				0.01				0.28
Second Equation	**(1)**	**(2)**			**(1)**	**(2)**			**(1)**	**(2)**			**(1)**	**(2)**		
Regression	IV	IV			IV	IV			IV	IV			IV	IV		
Dependent Variable	**l-(g1-Pi)**	**l-(g1-Pi)**			**l-(g1-Pi)**	**l-(g1-Pi)**			**l-(g1-Pi)**	**l-(g1-Pi)**			**l-(g1-Pi)**	**l-(g1-Pi)**		
Constant	-0.273	-0.301			1.596	1.674			0.300	0.288			-1.224	-1.460		
(se)	(2.204)	(2.219)			(1.392)	(1.402)			(4.704)	(4.716)			(3.075)	(3.130)		
g2	1.119***	1.200***			0.899***	0.981***			0.982***	1.001***			0.860***	1.028***		
(se)	(0.090)	(0.120)			(0.057)	(0.076)			(0.154)	(0.237)			(0.101)	(0.158)		
d (dummy)	3.797	1.294			-3.256*	-6.167**			6.100	5.382			-3.212	-8.940*		
(se)	(2.691)	(3.912)			(1.700)	(2.471)			(4.912)	(7.805)			(3.211)	(5.179)		
Time dummies	yes	yes			yes	yes			yes	yes			yes	yes		
2-digit industry dummies	yes	yes			yes	yes			yes	yes			yes	yes		
Standard error	33.52	33.74			21.17	21.31			34.94	34.97			22.84	23.21		
Number of firms	1037	1037			1037	1037			443	443			443	443		
F test, g2real	327.6	100.9			327.6	100.9			159.0	42.29			159.0	42.29		
p-value	0.00	0.0			0.00	0.0			0.00	0.0			0.00	0.0		
F test, d		230.66				230.66				117.90				117.90		
p-value		0.00				0.00				0.00				0.00		
g2 DK test of exog	15.14	8.59			0.24	1.66			6.55	3.17			0.19	1.66		
p-value	0.00	0.00			0.62	0.19			0.01	0.04			0.66	0.19		
d DK test of exog		0.846				2.676				0.013				2.056		
p-value		0.3575				0.1019				0.9077				0.1516		
Sargan	1.470	4.314			2.676	0.0150			1.811	1.891			2.086	0.433		
Prob. Value	0.479	0.116			0.262	0.993			0.404	0.388			0.352	0.805		

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.

Table 20. Innovation Strategies in the Low/High Tech Sectors Manufacturing Sector. 2001-09

Sector	**Manufacturing High Tech**				**Manufacturing Low Tech**			
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-Pi	d	I-(g1-Pi)	g2	g1-Pi	d	I-(g1-Pi)
Constant	0.025	-4.893***	-2.944***	2.459***	0.879	-6.986***	-3.052***	2.075**
(se)	(0.653)	(0.921)	(0.310)	(0.874)	(0.673)	(1.010)	(0.326)	(0.959)
Make only (dummy)	22.920***	-25.292***	2.073***	28.379***	38.316***	-23.882***	0.000	31.993***
(se)	(3.486)	(4.914)	(0.441)	(4.337)	(6.133)	(9.200)	(0.000)	(8.010)
Buy only (dummy)	12.069***	-2.761*	3.195***	8.262***	13.152***	-6.023***	3.106***	11.775***
(se)	(1.020)	(1.438)	(0.316)	(1.552)	(1.146)	(1.720)	(0.335)	(1.858)
Make & Buy (dummy)	22.118***	-15.572***	2.028***	20.126***	30.737***	-21.417***	1.726***	28.003***
(se)	(1.066)	(1.502)	(0.319)	(1.512)	(1.486)	(2.229)	(0.355)	(2.438)
Time dummies	yes	yes	yes	yes	yes	yes	yes	yes
2-digit industry dummies	yes	yes	yes	yes	yes	yes	yes	yes
Standard error	15.94	22.47		23.36	16.03	24.05		24.60
Number of firms	1464	1464	1464	1464	1068	1068	1061	1068
Second Equation	**(1)**	**(2)**			**(1)**	**(2)**		
Regression	IV	IV			IV	IV		
Dependent Variable	**I-(g1-Pi)**	**I-(g1-Pi)**			**I-(g1-Pi)**	**I-(g1-Pi)**		
Constant	2.499***	2.458***			1.309	1.239		
(se)	(0.777)	(0.782)			(0.874)	(0.877)		
g2	0.912***	0.958***			0.945***	0.895***		
(se)	(0.041)	(0.062)			(0.047)	(0.064)		
d (dummy)	-3.339**	-5.157**			-2.622	0.702		
(se)	(1.312)	(2.252)			(1.787)	(3.029)		
Time dummies	yes	yes			yes	yes		
2-digit industry dummies	yes	yes			yes	yes		
Standard error	18.87	18.96			20.29	20.34		
Number of firms	1464	1464			1068	1061		
F test, g2real	424.2	154			336.1	160.54		
p-value	0.00	0.0			0.00	0.0		
F test, d		294.51				257.00		
p-value		0.00				0.00		
Davidson-MKinnon test of exog	4.86	2.93			5.89	4.10		
p-value	0.03	0.05			0.02	0.02		
Davidson-MKinnon test of exog d		1.00				1.80		
p-value		0.32				0.18		
Sargan	5.184	6.331			1.043	2.010		
Prob. Value	0.0749	0.0422			0.594	0.156		

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.

Table 21. Innovation Strategies and Skill Composition of the Labor Force in the Low/High Tech Sectors - Manufacturing Sector - 2001-09

Sector	Manufacturing High Tech						Manufacturing Low Tech					
	Skilled				Unskilled		Skilled				Unskilled	
First Equation	A	B	C	Red Form		Red Form	A	B	C	Red Form		Red Form
Regression	OLS	OLS	Probit	OLS		OLS	OLS	OLS	Probit	OLS		OLS
Dependent Variable	g2	g1-Pi	d	l-(g1-Pi)		l-(g1-Pi)	g2	g1-Pi	d	l-(g1-Pi)		l-(g1-Pi)
Constant	-1.773	1.052	-2.402***	-4.094		1.159	0.074	5.153***	-6.088	3.281		1.366
(se)	(1.363)	(1.944)	(0.343)	(3.130)		(1.933)	(0.910)	(1.482)	(160.579)	(2.143)		(1.838)
Make only (dummy)	30.247***	-29.377***	2.023***	49.150***		29.629***	18.551	-23.989		17.896***		6.196
(se)	(5.720)	(8.158)	(0.592)	(13.528)		(10.176)	(13.009)	(21.182)		(4.599)		(4.150)
Buy only (dummy)	10.190***	-2.445	3.125***	14.793***		4.161*	8.720***	-2.646	6.185	8.307**		7.178**
(se)	(1.518)	(2.165)	(0.347)	(3.592)		(2.468)	(1.452)	(2.365)	(160.579)	(4.181)		(2.807)
Make & Buy (dummy)	22.120***	-17.553***	1.598***	27.990***		19.912***	31.292***	-24.751***	4.469	33.054***		30.958***
(se)	(1.671)	(2.383)	(0.354)	(3.655)		(2.429)	(1.978)	(3.220)	(160.579)	(5.337)		(4.078)
Time dummies	yes	yes	yes	yes		yes	yes	yes	yes	yes		yes
2-digit industry dummies	yes	yes	yes	yes		yes	yes	yes	yes	yes		yes
Standard error	15.49	22.10		35.23		24.24	12.87	20.96		34.01		25.44
Number of firms	616	616	616	616		616	421	421	420	421		421
Second Equation	(1)	(2)			(1)	(2)	(1)	(2)			(1)	(2)
Regression	IV	IV			IV	IV	IV	IV			IV	IV
Dependent Variable	l-(g1-Pi)	l-(g1-Pi)			l-(g1-Pi)	l-(g1-Pi)	l-(g1-Pi)	l-(g1-Pi)			l-(g1-Pi)	l-(g1-Pi)
Constant	-2.258	-2.245			3.194*	3.242*	2.637	2.702			-0.654	-0.652
(se)	(2.931)	(2.971)			(1.731)	(1.747)	(3.336)	(3.358)			(2.302)	(2.311)
g2	1.202***	1.327***			0.856***	0.956***	0.989***	1.056***			0.963***	0.996***
(se)	(0.118)	(0.166)			(0.070)	(0.097)	(0.137)	(0.166)			(0.094)	(0.115)
d (dummy)	5.457	1.640			-4.910**	-8.117***	1.752	-0.893			-0.902	-2.134
(se)	(3.512)	(5.098)			(2.075)	(2.997)	(4.199)	(5.914)			(2.898)	(4.070)
Time dummies	yes	yes			yes	yes	yes	yes			yes	yes
2-digit industry dummies	yes	yes			yes	yes	yes	yes			yes	yes
Standard error	33.90	34.36			20.03	20.21	32.90	33.07			22.70	22.76
Number of firms	616	616			616	616	420	420			420	420
F test, g2real	179.4	100.9			179.4	100.9	0.141	42.29			0.304	42.29
p-value	0.00	0.0			0.00	0.0	0.00	0.0			0.00	0.0
F test, d		230.66				230.66		117.90				117.90
p-value		0.00				0.00		0.00				0.00
Davidson-MacKinnon test of exog	13.47	7.49			0.06	1.17	6.43	3.17			0.19	1.66
p-value	0.00	0.00			0.80	0.31	0.01	0.04			0.66	0.19
Sargan	1.230	2.809			2.576	0.294	0.608	0.903			0.519	0.333
Prob. Value	0.541	0.245			0.276	0.863	0.738	0.342			0.771	0.564

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.

Finally, we quantify the total effect of different innovation strategies on employment growth. The main result is that a make strategy has a negative effect on employment when using the complete sample of firms, while the buy strategy is the one with larger and positive effects. Instead, in the small firms sub-sample the make strategy is the strategy with larger positive effects. In all cases, the strategies have a positive effects trough product innovation that compensates the negative impact in sales of old products, and the negligible impact of process innovation. The strategy that has the least positive impact on product innovation and hence on employment growth is the buy strategy. Similar results are found for the high- and low-tech sectors.

Table 22. Decomposition of the Impact of Innovation Strategies on Employment Growth

Sector	Manufacturing				Small Manufacturing			
	Effects on employment growth				Effects on employment growth			
Strategy	Product innovations	Process innovations	Sales of old products	Total	Product innovations	Process innovations	Sales of old products	Total
Make	25.4	-0.4	-25.7	-0.7	31.6	-0.1	-25.0	6.5
Buy	11.5	-1.7	-4.36	5.5	13.1	-1.5	-7.13	4.5
Make&Buy	23.1	-0.5	-17.5	5.1	21.7	-0.4	-18.1	3.2
Sector	**Manufacturing High Tech**				**Manufacturing Low Tech**			
Make	21.7	-1.0	-25.2	-4.5	--	0.0	-23.8	-23.8
Buy	11.2	-3.1	-2.76	5.3	22.1	-2.9	-6.02	13.2
Make&Buy	21.0	-0.9	-15.5	4.6	27.6	-0.6	-21.4	5.7

Source: Authors' calculations based on tables 18 and 20.

4 Conclusions and Some Policy Implications

Our research sheds light on the roles of displacement and the compensation effects of product and process innovation on employment, both in terms of its quantity and quality, in Uruguayan manufacturing firms.

In the first step, we considered the effect of product and process innovation on total employment. Results reveal that in manufacturing, product innovation is complementary to labor (as Harrison et al. (2008) found for European countries), but in general, process innovation displaces labor, which is contrasts with the findings of Harrison et al. (2008) for some OECD countries. This displacement effect seems to be weaker in the case of small firms and firms belonging to the low-tech sector. There is some evidence that the positive impact on labor growth of the introduction of new products is weaker when this innovation is introduced together with a process innovation. This effect does not seem to operate in small firms and firms belonging to the low-tech sector.

In a second step, we considered the impact on employment composition in terms of skills or types of workers. Results do not indicate an important differential impact of innovation on the composition of the labor force. In the low-tech sectors, for skilled labor, product innovation has a larger positive effect than in the high-tech sectors.

Finally, we analyzed the impact of different innovation strategies: producing technology itself (make) and/or sourcing technology externally (buy). In general, the results indicate that, in the manufacturing sector, producing technology in-house has the largest positive effects on employment growth, followed by the combined strategy in second place, and the buy-only strategy in third place. 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 a displacement effect on unskilled labor, but not on the skilled labor force.

The design of innovation and employment policies and instruments should take into account that the impact of innovation on employment could be different depending on firm size and sector. Likewise, it must take into account the diverse effects of different innovation strategies on employment.

Interviews carried out with innovation agents support the view that in general innovation does not lead to job losses and that it generates higher demand for a more highly skilled labor force. This is in contrast with the quantitative evidence that points to displacement effects coming from process innovation and that does not find a clear positive bias toward skilled labor.

The degree of coordination between innovation, employment, and training policies in Uruguay is low. Even though there are interaction between employers and employees in terms of employment policies and training, linkages between innovation policies and the needs of innovator firms are insufficient. Therefore, this is an area where public policy can do more.

Another issue needing more attention is the impact of labor market regulation on innovation. In particular, some rigidities introduced by the legislation (e.g., the strict definition and enforcement of occupational categories) affect the dynamics of the innovation processes of firms. These difficulties could probably be resolved by reducing the rigidity in the patterns of interaction and negotiation between employers and employees, in order to take into account the particularities of each company and their innovation processes. In a related issue, public policy could also enhance the compensation effects through measures aimed to reducing the oligopolistic power of both firms and unions.

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Appendix A. Interviewees

Public Sector:

- Edgardo Rubianes, President of ANII.
- Belén Baptista, Manager of ANII's Evaluation and Information Section.
- Juan Manuel Rodríguez, General Director of Instituto Nacional de Empleo y Formación Profesional (INEFOP).

Academics:

- Judith Sutz, Coordinator of the Academic Unit, Comisión Sectorial de Investigación Científica (CSIC), Universidad de la República.
- Alberto Nieto, Head of Biotechnology of the Polo Tecnológico de Pando (Universidad de la República).

Trade Union and Chamber representatives:

- Edgardo Oyenard, Secretary-General Drugs Industry Union (SIMA), PIT-CNT.
- Carola Saavedra, Executive Coordinator of the Centro de Gestión Tecnológica y Dirección de Desarrollo Empresarial, Chamber of Industries of Uruguay.

Innovative firms:

High-technology manufacturing firm:

- Rafael Leaniz, Technical advisor in the research, innovation and development area of Laboratorio Santa Elena.

Traditional manufacturing firm, domestic market oriented:

- Alvaro Molaguero, Manager of Taxton S.A.

Traditional manufacturing firm, export market oriented:

- Francisco Carrau, Director of Bodegas Carrau

Service sector firm:

- Alvaro Santiago, Deputy Manager of C.U.T.C.S.A

Appendix B. Major Programs for Innovation, Higher Education and Employment

1. Major Programs for Innovation

AGENCIA NACIONAL DE INVESTIGACIÓN E INNOVACIÓN (ANII)			
Area - Type	**Program**	**Recipients**	**Description**
Research and Development	**Fondo Clemente Estable**	Researchers belonging to public or private institutions	This program has been in operation since 2007 and supports basic scientific research in any area of knowledge.
Research and Development	**Fondo María Viñas**	Researchers belonging to public or private institutions	This program was created in 2009 with the aim of financing applied research projects from any knowledge area.
Scientific and technological knowledge transfer	**Fondo Sectorial de Energía**	Researchers belonging to public or private institutions	This program was created in 2008 and is dedicated to promoting research, development and innovation activities in the energy field, through R&D and innovation project financing.
Scientific and technological knowledge transfer	**Fondo Sectorial de Salud**	Researchers belonging to public or nonprofit private institutions	This program was created in 2009 and its objective is to support applied R&D projects in areas such as public health and medicine.
Scientific and technological knowledge transfer	**Fondo Innovagro**	Researchers belonging to public or private institutions	The program was created in 2008 and constitutes the first agribusiness sectoral fund created by ANII together with the National Institute of Agricultural Research (INIA).
Scientific and technological knowledge transfer	**Fortalecimiento de Servicios Científico – Tecnológicos**	Public or nonprofit private institutions involved in R&D activities, from Uruguay	The program's objective is to generate or strengthen scientific services in response to the needs of the productive sector. These scientific services may include the needs of the general population and must be aimed at improving the performance of skilled labor.

Scientific and technological knowledge transfer	**Apoyo a la popularización de la CTI**	Public or private institutions involved in R&D activities or those institutions that are involved in spreading or popularize the CTI.	This activity has the long-term goal of educating the population in the areas of science, technology and innovation. The projects must translate scientific knowledge to make it understandable to non-specialists.
Scientific and technological knowledge transfer	**Proyectos de Alto Impacto Social**	Research groups from public or nonprofit private institutions engaged in research activities.	The objective of the program is to support research, development and innovation projects in every field of knowledge having high social impact.
Scientific and technological knowledge transfer	**Programa de Soluciones innovadoras para la Inclusión de Personas con Discapacidad**	Research groups and companies	This program, part of an agreement between ANII and the Inter-American Development Bank's Science and Technology Division, supports research projects or programs resulting in innovative solutions for handicapped people and promoting their social and economic inclusion.
Entrepreneurship	**Apoyo a Jóvenes empresas**	New National companies involved in some incubation process and dedicated to the development of innovative products or processes at a national level	The objective is to support new, innovative companies by providing them a project subsidy.
Entrepreneurship	**Apoyo a Jóvenes Emprendedores**	People between 18 and 35 years old, who prove having the capacities and skills for starting a new business. A project should be presented.	The program's goal is to promote the creation and development of new companies that are considering marketing innovative products or services in the area they intend to enter.
Business innovation	**Proyectos de Innovación de Amplia Cobertura**	Companies	This program is focused on innovation promotion with the objective of improving the competitiveness, productivity, and profitability of the companies, through subsidies.

Business innovation	**Proyectos de Innovación de Alto Impacto para el país**	Companies	The objective is to promote projects that generate high-impact innovation, i.e., innovations capable of generating spillovers throughout the economy, society, or environment.
Business innovation	**Apoyo a Prototipos de potencial innovador**	Companies	The objective is to promote and incubate companies in the process of creating new ideas, converting them into prototypes or creating spinoffs.
Business innovation	**Recursos Humanos Calificados en la Empresa**	Micro, small and medium enterprises (MPYMES) established in Uruguay.	The program's objective is to hire new skilled human resources to contribute to new technology problem solving which may promote R&D activities and improve the firm's competitiveness.
Business innovation	**Programa de Fortalecimiento del Capital Humano Avanzado**	Companies	The program's objective is to sustain the hiring of international experts whose skills and knowledge might not be available in Uruguay.
Business innovation	**Programa de Vinculación con Tecnólogos Uruguayos residentes en el Exterior**	Micro, small and medium companies (MPYMES) established in Uruguay and chambers or business clusters.	The objective of the program is to strengthen skills in the country by financing visits of Uruguayan technicians living abroad.
Innovation National System articulation	**Alianzas para la Innovación**	Research and development companies and institutions	The objective of the program is to promote the implementation of technological development and innovation projects, establishing alliances between the productive sector and other R&D actors.
Innovation National System articulation	**Programas sectoriales y/o territoriales de innovación para grupos de empresas**	Sector and/or territorial business groups established in Uruguay, which can demonstrate an effective degree of collective organization	The program seeks to support groups of firms in finding solutions to technological problems that are preventing them from becoming more competitive.

Human resources strengthening	**Sistema Nacional de Investigadores**	Researchers working in Uruguay or abroad.	The National System of Researchers was created by law in 2007. The System aims to strengthen and expand the scientific community, identifying, evaluating, and categorizing all Uruguayan active researchers and setting up monetary incentives in order to encourage knowledge production.
COMISIÓN SECTORIAL DE INVESTIGACIÓN CIENTÍFICA (CSIC) - UNIVERSIDAD DE LA REPÚBLICA (UdelaR)			
Area - Type	**Program**	**Recipients**	**Description**
Scientific research	**Apoyo a Grupos de Investigación**	Research Groups (GI) from the UdelaR.	The objective is to provide opportunities to research groups from the UdelaR, through the development of their research agenda and incorporation and training of young researchers.
Scientific research	**Apoyo a Proyectos de I+D**	Professors from UdelaR.	The program's objective is to promote high-quality research in every area of knowledge.
Scientific research	**Proyectos de Iniciación a la Investigación**	Professors, advanced students, and recent graduates from UdelaR.	The objective of the program is to create opportunities for university professors, advanced undergraduate students, and recent graduates from the UdelaR who wish to conduct research and who have little experience in research activities.
Scientific research	**Apoyo a la Investigación Estudiantil**	Students from the UdelaR.	The main objective is to provide opportunities to university student teams to develop small research projects originating from their own ideas.
Scientific research	**Programa de Apoyo a situaciones imprevistas y urgentes que afectan actividades de investigación**	Professors from UdelaR who are formally responsible for research projects.	The objective of this program is to provide resources to ensure the continuity of research activities which are in serious danger due to unforeseen events.
Linkages between research and productive sector	**Programa de Vinculación Universidad-Sociedad y Producción**	Professors from UdelaR.	This program seeks to bring together the research and solution capacities of the UdelaR, in every knowledge area in order to respond to the needs of society and the productive sector.

Linkages between research and productive sector	**Programa de Vinculación ANCAP – Universidad**	Professors from UdelaR, with academic experience in the proposed topics.	The objective is to encourage high-quality research in every knowledge field in order to find solutions to national problems in the areas of expertise of ANCAP.
Linkages between research and society	**Programa de Investigación e Innovación orientado a la Inclusión Social**	Professors from UdelaR.	The objective to promote research and innovation agendas in every knowledge field oriented to promoting social inclusion.
Institutional Strengthening	**Programa de Fomento de la investigación de Calidad**	Faculties and institutes from UdelaR.	The objective is to support proposals aimed at improving research capacity in fields where it needs strengthening.
Institutional Strengthening	**Programa de Equipamiento para la Investigación**	Faculties and institutes from UdelaR.	The objective is to support the purchase and installation of software and equipment that will renew and update the technological research infrastructure in the various Faculties and Institutes of the UdelaR.
Human resources strengthening	**Programa de Becas de Retorno y Contratación de Investigadores provenientes del Exterior**	Faculties and institutes from UdelaR.	The objective of the program is to support researchers living abroad who wish to return to Uruguay.
POLO TECNOLÓGICO DE PANDO (PTP) – Facultad de Química (UdelaR)			
Area - Type	**Program**	**Recipients**	**Description**
Innovation and productive sector articulation	**Polo Tecnológico de Pando (PTP) – Firms**	Companies	This program is part of the UdelaR strategy of sharing its research capacity with the productive sector.
UNIVERSIDAD ORT			
Area - Type	**Program**	**Recipients**	**Description**
Scientific research	**Fondo de Apoyo a la Investigación**	Professors and students from	The purpose of this fund is to finance scientific research conducted by teachers or students from ORT University. This is an annual fund

		Universidad ORT	managed by the deans of each faculty.
Scientific research	**Créditos por Investigación (CPI) o Práctica Profesional**	Students from Universidad ORT	This program provides students with the opportunity to earn college credits through voluntary participation in a research project.

2. Higher Education Scholarships and Support Programs

AGENCIA NACIONAL DE INVESTIGACIÓN E INNOVACIÓN (ANII)			
Area-Type	**Program**	**Beneficiary**	**Description**
Human Resources Strengthening	**Sistema Nacional de Becas**	Uruguayan citizens or residents with a university degree obtained in Uruguay or abroad	Scholarships to initiate postgraduate studies (masters or Ph.D.) in Uruguay or abroad in strategic areas of research and innovation
Human Resources Strengthening	**Apoyo a Programas de Educación Técnico Terciarios Prioritarios**	Public or private institutions	The objective is to support the creation or strengthening of technical education programs in areas defined as priority by the Gabinete Ministerial de la Innovación (GMI).
Human Resources Strengthening	**Apoyo a los Programas de Posgrados Nacionales**	Public or private institutions	The objective is to support the creation or strengthening of national post-graduate study programs in areas defined as priority by the GMI.
Human Resources Strengthening	**Vinculación con Científicos y Tecnólogos en el exterior**	Every national nonprofit institution dedicated to research or productive sector development	The objective is to strengthen human resource capacities through interaction with scientific and technical staff with proven experience and living abroad.
COMISIÓN SECTORIAL DE ENSEÑANZA (CSE) – UNIVERSIDAD DE LA REPÚBLICA (UdelaR)			
Area-Type	**Program**	**Beneficiary**	**Description**
Student Service	**Programa de Estímulo al Aprendizaje (PROGRESA)**	Students enrolling in the UdelaR	The objective is to assist students entering the UdelaR.
Student Service	**Proyectos estudiantiles para dinamizar la vida universitaria**	Students from the UdelaR, prioritizing those generations who are signing in.	This program promotes the presentation of student projects, including academic, cultural, sports, extension, health, social communication, and others.

Curriculum Development	**Ampliación, diversificación, articulación y flexibilización de la enseñanza de grado a nivel nacional**	Faculties and Institutes of the UdelaR.	Through this program, the faculties are called to present proposals on new educational offerings for graduate studies in the hinterlands.
Curriculum Development	**Ciclos Iniciales Optativos (CIO)**	Students wishing to enroll at UdelaR, with a generic major but a weak specific vocation.	The CIO constitutes an alternative way of accessing the university. Besides facilitating curricular flexibility and articulation, they provide support to students who are starting out in their university careers.
FONDO DE SOLIDARIDAD			
Area-Type	**Program**	**Beneficiary**	**Description**
Scholarships	**Becas del Fondo de Solidaridad**	Students who are studying at the UdelaR or the Universidad del Trabajo del Uruguay (UTU) and whose socioeconomic conditions don't allow them to further their studies at a higher level.	The objective is to provide economic support to the student. The system is based on the concept of intergenerational solidarity, whereby graduates from the UdelaR or UTU make contributions to finance the program.
MINISTERIO DE EDUCACIÓN Y CULTURA (MEC) y FONDO DE SOLIDARIDAD			
Area-Type	**Program**	**Beneficiary**	**Description**
Scholarships	**Becas de Posgrado "Carlos Quijano"**	Uruguayan citizens. Afro descendents are given priority.	The objective is to finance postgraduate studies abroad in several disciplines such as exact, social, and human sciences.
UNIVERSIDAD CATÓLICA DEL URUGUAY (UC)			
Area-Type	**Program**	**Beneficiary**	**Description**
Scholarship	Concurso Nacional de Becas	Students with scarce resources and high academic potential, and those who have achieved excellence during their high school studies.	Scholarships aimed at facilitating access to undergraduate studies at the UC.

UNIVERSIDAD DE MONTEVIDEO			
Area-Type	**Program**	**Beneficiary**	**Description**
Scholarships	**Programa de Becas**	Students with scarce resources and high academic potential, and those who have achieved excellence during their high school studies.	Scholarship program aimed at facilitating access to undergraduate studies at the Universidad de Montevideo.
UNIVERSIDAD ORT			
Area-Type	**Program**	**Beneficiary**	**Description**
Scholarships	**Fondos de Becas**	Students whose income is not sufficient to cover their studies at ORT and/or students with high academic potential.	This fund is aimed at financing scholarships for technical and professional degrees at the Universidad ORT.

3. Major Programs for Employment and Training

AGENCIA NACIONAL DE INVESTIGACIÓN E INNOVACIÓN (ANII) AND DIRECCIÓN NACIONAL DE ARTESANÍAS, PEQUEÑAS Y MEDIANAS EMPRESAS (DINAPYME)			
Area	**Program**	**Beneficiaries**	**Description**
Business innovation	**Programa CARPE (Creación, Asistencia técnica y Redes para la Profesionalización Empresarial)** **Componente C-EMPRENDEDOR**	Entrepreneurs (over 18 years of age) or entrepreneurial teams who have identified business opportunities capable of being developed into profitable firms.	The aim of this program is to promote the creation and development of sustainable and profitable new firms.
Business innovation	**Programa CARPE (Creación, Asistencia técnica y Redes para la Profesionalización Empresarial)** **Componente de Apoyo a MIPYMES**	Companies	This component of CARPE's program aims to promote entrepreneurship, innovation, professionalism in management, and the use of technical services among micro, small, and medium enterprises (MIPYMES).
Business innovation	**Programa CARPE (Creación, Asistencia técnica y Redes para la Profesionalización Empresarial)** **Componente de Apoyo a REDES EMPRESARIALES**	Team of at least five domestic companies (at least 80 percent MIPYMES), with (proven) common problems.	The objective of this component is the promotion of business networks that contribute to the improvement of the competitive position of a group of MPYMES and the resolution of common problems.
CENTRO EDUCATIVO DE CAPACITACIÓN Y PRODUCCIÓN (CECAP) – MINISTERIO DE EDUCACIÓN Y CULTURA (MEC)			
Area	**Program**	**Beneficiaries**	**Description**

Training	**Programa Nacional de Educación y Trabajo (PNET)**	Young people (between 15 and 20 years of age), who do not study in the formal education system, do not work, and are at socio-economic risk.	The program seeks to link education and work. The program objective is to encourage social inclusion and civic participation. The program aims to integrate teenagers into the formal education system and to prepare them for entering the labor force with greater chances of succeeding.
DIRECCIÓN NACIONAL DE EMPLEO (DINAE) – MINISTERIO DE TRABAJO Y SEGURIDAD SOCIAL (MTSS)			
Area	**Program**	**Beneficiaries**	**Description**
Business support	**Programa de Inversión Productiva (PIP)**	People with scarce resources and difficulties accessing conventional credit.	The program supports profitable local business initiatives that have a positive impact on employment: either creating new or consolidating existing businesses.
Labor mediation	**Objetivo Empleo (POE)**	Businesses without tax debt and which have been in operation for at least eight months.	Through a subsidy to businesses, the program seeks to create opportunities to incorporate people into the formal labor market.
Labor mediation	**Área de Servicios Públicos de Empleo – Red de Centros Públicos de Empleo (CEPE)**	General public. Priority will be given to those people who have difficulty entering the labor market. Public and private enterprises.	This area is dedicated to helping people find jobs and incorporating the jobless into the labor market.
INSTITUTO NACIONAL DE EMPLEO Y FORMACIÓNPROFESIONAL (INEFOP) [FONDO DE RECONVERSIÓN LABORAL (FRL)]			
Area	**Program**	**Beneficiaries**	**Description**
Training and labor mediation	**PROJOVEN – Programa de Capacitación e Inserción Laboral para Jóvenes.**	Young people between the ages of 18 and 24, from low-income households, that have not completed the Upper Secondary Education,	The aim of this program is to support low-income youth who are having difficulty finding work by improving their job prospects and opportunities. The program seeks to improve young

		with limited or no work experience, and facing difficulties finding work. Priority will be given to young heads of households and to children-headed households.	people's skills through technical training especially linked to the needs identified by the productive sectors of the country.
Business support and training	**EMPRENDE URUGUAY**	Micro and small enterprises (MYPES), formal and informal, and people interested in creating a new business project.	The aim of this program is to support the creation and strengthening of micro and small enterprises that add value and create new employment opportunities.
Business support and training	**FOMYPES – Programa de Fortalecimiento de Micro y Pequeñas Empresas**	Micro and small enterprises (MYPES), with less than 19 employees that are located in Canelones, Colonia, Maldonado, Montevideo, Paysandú, San José and Tacuarembó.	The program supports micro and small firms that seek technical assistance or training for their employees.
Business support and training	**PROIMUJER**	Women and men (quota of men between 20 and 50 percent) between 25 and 55 years of age, living in urban or rural areas, and unemployed. Groups with specific issues: women over 40 with long-term unemployment, young women with dependent children in situations of social vulnerability, and domestic workers.	This is the first nationwide job training program with a focus on gender equality.

Training and labor mediation	**PROCLADIS – Programa de Capacitación Laboral para Personas con Discapacidad**	People over 18 with disabilities. Priority is given to those who are in situations of social vulnerability.	The program promotes social inclusion of people with disabilities through training and job placement, retraining courses, job placement intermediation, and support and guidance in the form of training and material resources to productive enterprises.
Training	**Programa de Capacitación Laboral para los Trabajadores Rurales**	Workers living in rural areas or working in agricultural activities, either unemployed or active.	The program aims to improve the employment situation of rural workers, organizing courses to upgrade the skills of the workforce and promote job creation. The program works with actors, organizations, and institutions.
Training	**Programa de Capacitación para Trabajadores en Seguro de Desempleo (TSD)**	Workers receiving unemployment insurance with grounds for dismissal, end of harvest or end of contract	The objective is to improve the job skills of workers receiving unemployment insurance through specific training and by providing new avenues of entry to the educational system.
Training - Entrepreneurship	**Programa de Capacitación a Empresarios**	Directors, managers, and heads of private companies, with over 20 employees, formally established, and in all sectors.	The program's objective is to professionalize the management of private companies through training of their senior staff.
Training	**Convenios Sectoriales**		Through agreements with different economics sectors, the INEFOP has worked in implementing new specific training.
MINISTERIO DE DESARROLLO SOCIAL (MIDES)			
Area	**Program**	**Beneficiaries**	**Description**
Employment insertion and guidance	**Programa de Primera Experiencia Laboral**	Young people between 18 and 24 years of age, living in Uruguay.	The program provides young people with the possibility of formal employment.

Employment insertion and guidance	**Uruguay Trabaja**	People between 18 and 65 years of age, socioeconomically vulnerable, with less than three years of high school education and unemployed for more than two years	The main objective is to find jobs for the long-term unemployed from low-income strata.
	Aulas para Crecer	Graduates from the Programa Trabajo por Uruguay (Program of the Plan Nacional de Emergencia, 2005-07).	This is a temporary employment program which link two objectives: the construction of classrooms for preschool children from low-income families and the development of a social-educational program in the construction trades to improve the employability of socio-economically vulnerable people.
	Uruguay Clasifica (PUC)	People living from the solid waste recycling.	The Program Uruguay Clasifica works for the social, cultural and labor inclusion of the families living from the urban solid waste classification.
Entrepreneurship	**Emprendimientos Locales**	People over 18 years of age, socially vulnerable, who are working in a group of at least three members and who produce or provide goods or services.	The objective of this national program is to support citizens who are working in groups, developing a productive activity or venture.
FACULTAD DE CIENCIAS ECONÓMICAS Y DE ADMINISTRACIÓN (FCEyA), UdelaR			
Area	**Program**	**Beneficiaries**	**Description**
Entrepreneurship	**CCEEmprende**	Entrepreneur	The CCEEmprende program's objective is accompany the dynamic entrepreneur in the process of creating and developing a business venture through training in key areas of business development, coaching in business plan preparation, and technical assistance.
ENDEAVOR URUGUAY			
Area	**Program**	**Beneficiaries**	**Description**

Entrepreneurship	**Programa Internacional/ Programa Promesas**	Entrepreneurs seeking to boost their businesses in international markets /Entrepreneurs who are seeking to scale up their businesses at the regional level.	These programs seek to support entrepreneurs to professionalize the management of their business in order to achieve their goals.
Entrepreneurship	**Programa Mujeres Emprendedoras Derribando Barreras**	Women Entrepreneurs	The program seeks to train women entrepreneurs, by providing them with tools to overcome barriers in the modern business world.
LABORATORIO TECNOLÓGICO DEL URUGUAY (LATU)			
Area	**Program**	**Beneficiaries**	**Description**
Company support	**Incubadora INGENIO**	Dynamic and potentially profitable businesses which aim to create new jobs and avoid self-employment.	Ingenio provides incubation services to innovative and high value-added ventures.
POLO TECNOLÓGICO DE PANDO – FACULTAD DE QUÍMICA UDELAR			
Area	**Program**	**Beneficiaries**	**Description**
Company support	**Polo Tecnológico de Pando (PTP) – Incubación de Emprendimientos Innovadores**	Companies or innovative ventures. Students, graduates, or research groups with innovative business ideas.	The PTP incubator is a program which promotes entrepreneurship and innovative activities in areas related to chemistry and by means of scientific and technological support and managerial support.
FOMIN, IADB; PROSPÉRITAS CAPITAL PARTNERS (PCP), LABORATORIO TECNOLÓGICO DEL URUGUAY (LATU); CORPORACIÓN NACIONAL PARA EL DESARROLLO (CND); AND CORPORACIÓN ANDINA DE FOMENTO (CAF)			
Area	**Program**	**Beneficiaries**	**Description**
Company support	**Programa Emprender**	Young business	At the initiative of these institutions, the Programa Emprender was launched in 2007 with the aim of increasing the number and quality of new ventures and/or young companies in dynamic sectors of the Uruguayan economy.

PARQUE TECNOLÓGICO INDUSTRIAL DEL CERRO			
Area	**Program**	**Beneficiaries**	**Description**
Company support (MYPES)	**Parque Tecnológico Industrial del Cerro (PTIC)**	Micro and small companies	The PTIC is an industrial park for micro and small firms. Its purpose is to provide a physical space for companies to do business.

CORPORACIÓN NACIONAL PARA EL DESARROLLO (CND)			
Area	**Program**	**Beneficiaries**	**Description**
Company support	**Uruguay Fomenta**	Entrepreneurs with innovative ideas, entrepreneurs seeking to boost, train, achieve association, export, and investors.	The Corporación Nacional para el Desarrollo (CND) is a legal entity which ranks as a national and international facilitator for the implementation of public policies for development.
Company support	**Corporación Fomenta**	Business which has all or some of the following requirements • Promotion of association • Product innovation • Generation of export items • Asset recovery • Employment generation • Import substitution	This is a financial assistance program for project or venture formulation.

DIRECCIÓN DE PROYECTOS DE DESARROLLO (DIPRODE) AND CORPORACIÓN NACIONAL PARA EL DESARROLLO (CND)			
Area	**Program**	**Beneficiaries**	**Description**
Company support	**Microfinanzas para el Desarrollo Productivo**	Entrepreneurs below the poverty line. Informal entrepreneurs. Micro, small. and medium-sized companies without access to bank credit.	The program aims to contribute to sustainable development of productive enterprises in order to increase employment and facilitate social inclusion by reducing poverty through advising, training, insurance, and credit.

DIRECCIÓN NACIONAL DE ARTESANÍAS, PEQUEÑAS Y MEDIANAS EMPRESAS (DINAPYME) – MINISTERIO DE INDUSTRIA, ENERGÍA Y MINERÍA (MIEM)			
Area	**Program**	**Beneficiaries**	**Description**

Company support (PYMES)	**Programa de Apoyo a la Competitividad y Promoción de Exportaciones de la Pequeña y Mediana Empresa - PACPYMES**	Exporting companies or companies with exporting potential	PACPYMES aims to improve the competitiveness of the Uruguayan economy through the strengthening of clustering, internationalization, and export capacity of small and medium enterprises (SMEs).
Training	**Programa Nacional de Capacitación para Pequeñas y Medianas empresas**	Small and medium firms	The Program was established by law to fulfill the Ministry of Energy, Mining and Industry (MIEM)'s goals. It targets projects that "aim to develop and consolidate ventures with innovative characteristics and have an export profile and/or impact on job creation".

Appendix C

C.1 Definition of Variables and Information Available for Manufacturing Firms

Innovation surveys	IS	1998-2000, 2001-2003, 2004-2006, 2007-2009 (only 2004-2006, 2007-2009 for SIS)
Economic activity surveys	EAS	1998, 2000, 2001, 2003, 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 dependant relationship, owners and business associates working in the firm, and not paid family workers. For years 2000, 2003 we used EAS.
employ_init	Total employment beginning of period	EAS	All surveys	Total employment including only dependant 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	Producer Price Index of National Products (IPPN)	INE	Years 2000, 2003, 2006, 2009	Index of prices is computed on the basis of the Producer Price Index of National Products (IPPN) for the industry on a 4-digit level (ISIC-Rev. 3). For some activities where no information was available, the IPPN at the 2-digit was used.
pindex_init	Producer Price Index of National Products (IPPN)	INE	Years 1998, 2001, 2004, 2007	
gprices	Prices growth rate			Average annual prices growth rate, calculated by (ln(pindex_fin)−ln(pindex_init))/2*100
wagebill_init	Wage bill	EAS	Years 1998, 2001, 2004, 2007	Total payment to the personal of the firm.
wagebill_fin	Wage bill	EAS	Years 2000, 2003, 2006	
gwagebill	Growth rate of the wage bill			(ln(wagebill_fin)- ln(wagebill_init))/2*100
foreign_own	Foreign ownership	IS		´=1 if percentage of foreign capital is bigger than 10%
capitalreg	Located in capital	IS	Last three surveys	´= 1 if firms has locals in Montevideo
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*		All surveys	Firm does not report innovation in product or process

	product)			
typefirm=2	*Process only innovators*		All surveys	Firm introduced new or significantly improved technology or production methods that substantially changed production
typefirm=3	*Org Change innovators*	IS	All surveys	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 and / or packaging.
typefirm=4	*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	2003, 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	2003, 2006, 2009	lskill_employ=ln(share_fin*employ_fin/100)
lunskill_employ	Log of unskilled employment	IS	2003, 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, organization and management design.
bnm	Make-or-buy dummy	IS	All surveys	=1 if firm reports both activities

Table C.2: Descriptive Statistics – Small Manufacturing Firms

	Mean	Median	Standard deviation	Minimum	Maximum
Number of observations	1353				
Distribution of firms (%)					
Non-innovators (no process or product innovations)	62.23				
Process only or organizational only innovators (non product innovators)	14.04				
Product innovators	23.73				
(of which product and process innovators-of the whole 100%)	85.05				
Number of employees at the beginning of (each) survey	26.16	23.00	16.58	1.00	133.00
Foreign Ownsership (10% or more)	0.06	0.00	0.24	0.00	1.00
Located in the capital of the country	0.77	1.00	0.42	0.00	1.00
Employment growth (%) (yearly rate)					
All firms	-3.7	-1.9	15.9	-71.8	45.8
Non-innovators (no process or product innovations)	-5.3	-3.1	16.2	-71.8	43.2
Process only or organizational only innovators (non product innovators)	-1.5	-1.8	15.8	-56.7	44.1
Product innovators	-1.0	0.0	14.5	-62.0	45.8
Growth wage bill per worker (%) (yearly rate)	4.0	4.1	13.7	-43.8	70.3
Sales growth (%)[1] (nominal growth) (yearly rate)					
All firms	3.6	4.6	22.9	-79.9	69.5
Non-innovators (no process or product innovations)	1.2	2.5	23.9	-79.9	69.1
Process only or organizational only innovators (non product innovators)	9.4	6.8	22.5	-67.7	69.1
Product innovators	6.4	5.6	19.2	-46.9	69.5
of which:					
Old products	-25.1	-24.1	20.1	-50.0	33.8
New products	31.5	24.5	23.5	0.1	105.7
Labor productivity growth (%)[1] (yearly rate)					
All firms	7.3	6.9	22.2	-88.4	93.1
Non-innovators (no process or product innovations)	6.5	6.5	23.0	-88.4	81.9
Process only or organizational only innovators (non product innovators)	10.9	8.0	22.3	-61.0	93.1
Product innovators	7.4	7.3	19.4	-56.1	63.1
Prices growth (%)[2]					
All firms	7.69	2.85	11.62	-14.65	40.68
Non-innovators (no process or product innovations)	7.39	2.66	11.41	-14.65	40.68
Process only or organizational only innovators (non product innovators)	9.01	4.76	12.43	-14.65	40.68
Product innovators	7.68	4.55	11.66	-14.65	34.52

Table C.3: Descriptive Statistics – High and Low-tech Sectors

	High Tech	Low Tech
	Mean	**Mean**
Number of observations	1464	1068
Distribution of firms (%)		
Non-innovators (no process or product innovations)	42.6	55.8
Process only or organizational only innovators (non product innovators)	21.9	16.0
Product innovators	35.6	28.2
(of which product and process innovators-of the whole 100%)	89.6	85.1
Number of employees at the beginning of (each) survey	102.83	75.24
Foreign Ownsership (10% or more)	0.16	0.09
Located in the capital of the country	0.77	0.87
Employment growth (%) (yearly rate)		
All firms	0.3	-2.1
Non-innovators (no process or product innovations)	-2.2	-4.6
Process only or organizational only innovators (non product innovators)	2.2	0.7
Product innovators	2.1	1.4
Sales growth (%)[1] (nominal growth) (yearly rate)		
All firms	6.8	3.7
Non-innovators (no process or product innovations)	2.9	0.5
Process only or organizational only innovators (non product innovators)	10.5	7.9
Product innovators	9.2	7.9
of which:		
Old products	-18.9	-25.3
New products	28.1	33.2
Labor productivity growth (%)[1] (yearly rate)		
All firms	6.5	5.8
Non-innovators (no process or product innovations)	5.1	5.1
Process only or organizational only innovators (non product innovators)	8.2	7.2
Product innovators	7.1	6.6
Prices growth (%) [2]		
All firms	7.31	6.17
Non-innovators (no process or product innovations)	7.38	6.28
Process only or organizational only innovators (non product innovators)	7.38	5.70
Product innovators	7.17	6.23

Appendix D – Other Tables

Table D1. Robustness Checks. Product and Process Innovation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sector	**Manufacturing**				**Small Manufacturing**			
	Skilled		**Unskilled**		**Skilled**		**Unskilled**	
Regression	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**IV**
Constant	5.309***	3.292**	0.918	0.225	5.361***	4.222*	-0.419	-0.955
(se)	(1.415)	(1.651)	(0.966)	(1.044)	(1.917)	(2.168)	(1.378)	(1.433)
Process innovation only *(d)*	-0.178	1.917	-4.100***	-3.430**	3.180	4.386	-4.004	-3.389
(se)	(2.685)	(2.739)	(1.579)	(1.732)	(5.401)	(4.906)	(2.714)	(3.243)
Sales growth d.t new products *(g2)*	0.912***	1.293***	0.817***	1.098***	0.861***	1.113**	0.840***	1.087***
(se)	(0.138)	(0.305)	(0.059)	(0.193)	(0.150)	(0.517)	(0.111)	(0.342)
Sales growth d.t new products	-0.072	-0.292	0.052	-0.204	-0.210	-0.313	-0.034	-0.236
x process and product inn	(0.147)	(0.294)	(0.065)	(0.186)	(0.182)	(0.512)	(0.125)	(0.339)
(se)								
Foreign owned (10% or more)	10.283**	9.335*	8.360***	8.186**	20.920***	19.814	2.122	0.660
(se)	(4.830)	(5.334)	(2.626)	(3.372)	(6.527)	(13.947)	(4.797)	(9.220)
Fully foreign owned	-6.759	-5.821	-2.853	-2.371	-36.612***	-34.266**	6.203	8.215
(se)	(5.532)	(6.132)	(3.191)	(3.877)	(10.219)	(16.413)	(7.605)	(10.850)
2-digit industry dummies	yes	yes	yes	yes	yes	yes	yes	yes
Standard error	33.34	33.46	21.09	21.15	34.65	34.54	22.90	22.83
Number of observations	1037	1037	1037	1037	443	443	443	443
F test, g2		18.48		18.48		9.232		9.232
p-value		0.00		0.00		0.00		0.00
g2 Exogeneity (Davidson-McKinnon)		0.01		0.06		0.01		0.00
P-Value		0.92		0.80		0.92		0.98
Sargan (m)		12.51		8.664		10.88		9.549
Prob. Value		0.327		0.653		0.453		0.571

Appendix E - Replicating Berman, Bound and Griliches (1994)

The proposed equation by Berman, Bound, and Griliches (1994) to analyze the impact of innovation on employment quality at firm level is modeled by:

$$\frac{w^s l^s}{VC} = \alpha_o + \alpha \ln(\frac{w^s}{w^u}) + \alpha_2 \ln(K) + \alpha_3 \ln(Y_1) + \alpha_4 \ln(Y_2) + \alpha_5 d + \upsilon$$

where the wage bill of skilled workers is modeled as a function of relative wages between skilled and unskilled workers, capital stock (K), the sales of technologically old products (Y_1), the sales of technologically new products (Y_2) and a variable *d* that captures the impact of process innovation. The coefficients α_3 and α_4 capture the impact of product and process innovation, respectively. This equation has several assumptions behind it. The minimization of the cost variable function assumes symmetry of the effect of relative input prices on input demands, and prices are homogenous of degree one.[24] It also assumes that the price of quality adjusted production and non-production labor does not vary across industries.[25] In order to replicate this estimation we would need data on wages of skilled and unskilled workers, which is not available either in the innovation or the economic activity surveys.

The dependant variable in the equation above captures the changes in wages and employment; in order to untangle both effects, an alternative version of this equation where the dependent variable is the skilled labor employment share is proposed.

$$\left(\frac{l_i^s}{l_i}\right) = \alpha_0 + \alpha_1 \ln(K_i) + \alpha_2 (Y_{i1}) + \alpha_3 (Y_{i2}) + \alpha_4 (d_i) + \upsilon_i$$

Transforming the equation somewhat gives the following equation that we are going to estimate:

$$\left(\frac{l_i^s}{l_i}\right) = \alpha_0 + \alpha_1 \ln(K_i) + \alpha_2 \ln(Y_i) + \alpha_3 (Innovation_i) + \alpha_4 (d_i) + \upsilon_i$$

In the above equation, the share of skilled workers is a function of capital stock (K), total sales of the firm, the innovation variable indicating the percentage of sales of technologically new products, and a dummy, *d*, that captures the impact of process innovation. If α_3 (α_4) is positive, this means that product (process) innovation is complementary to skilled labor. On the other hand, if α_1 is positive, it implies that capital and skilled labor are complementary. Also, if $\alpha_1 = -\alpha_2$ there are constant returns to scale in the production function.

[24] In the original paper they also assume constant returns to scale.

[25] The original paper also includes a relative wage term (between skilled and unskilled labor). Berman et al. (1994) make the assumption that the price of quality-adjusted production and non-production labor does not vary across industries; hence, this term can be considered constant, and can be ignored.

We estimate the equation controlling for fixed effects at the industry level, but still non-observable characteristics can be correlated with innovation variables. Hence, we are going to use an instrumental variables approach, to control for possible endogeneity of the innovation variable. The instruments we are going to use are the same as those used in Section 3.

Table D.1 shows the results for the Berman, Bound, and Griliches (1994) type of analysis. The dependant variable is the share of skilled workers in each firm. Column 1 of the table estimates the equation of interest by OLS, while column 2 controls for possible endogeneity of the innovation variable, using an instrumental variables approach. All specifications include industry fixed effects (at 2-digit level). Columns 3 and 4 replicate these estimations for the sub-sample of small firms.

The OLS estimation shows that the innovation variable is positive and significantly different from zero, indicating that product innovation is complementary to skilled labor. Total sales and the dummy indicating process-only innovation are not significantly different from zero in all the specifications for the total sample. The coefficient on the innovation variable is bigger for the sub-sample of small firms, indicating bigger complementarities between skilled labor and product innovation. Taking into account the sub-sample of small firms, total sales is also positive and significant. Meanwhile, the variable indicating foreign ownership (more than 10 percent) is always significant and positive, indicating that firms with more than 10 percent of foreign capital exhibit larger demand for skilled labor.

Controlling for the possible presence of endogeneity of the innovation variable, we used as instrument the increased range of goods and services indicator, and the indicator of development of new markets. The Davidson-MacKinnon test of exogeneity rejects the null hypothesis of exogeneity for the innovation variable, i.e. OLS gives consistent estimation. When estimating by instrumental variables, the coefficient on innovation increases with respect to that obtained by OLS. We expected the endogeneity bias to underestimate the effect of innovation, biasing the OLS coefficients downward. On the other side, the F tests for exclusion of the instruments in the first step regression, and the Sargan test, for overidentyfing restrictions, give evidence of strong and valid instruments.

To summarize, this exercise indicates that innovation and skilled labor are complementary. The impact of innovation on the share of skilled labor is larger in the small firms sub-sample, evidenced by a bigger coefficient. Finally, there is evidence of endogeneity of the innovation variable. Taking this into account, the estimated coefficient increases, confirming a downward bias in the OLS estimation.

Table E.1: Effect on Quality following Berman, Bound and Griliches (1994). Manufacturing Sector

	(1)	(2)	(3)	(4)
Sector	**Manufacturing**		**Small Manufacturing**	
Regression	**1-OLS**	**2-IV**	**1-OLS**	**2-IV**
Constant	6.435**	7.004**	-4.894	-3.591
(se)	(3.236)	(2.963)	(6.076)	(5.046)
Ln Total sales	0.091	0.046	0.800**	0.690**
(se)	(0.186)	(0.175)	(0.368)	(0.310)
Innovation	0.043***	0.056***	0.081***	0.125***
(se)	(0.012)	(0.018)	(0.022)	(0.028)
Process innovation only *(d)*	1.832***	2.081***	3.140***	3.734***
(se)	(0.654)	(0.751)	(1.158)	(1.174)
Foreign owned (10% or more)	5.239***	5.185***	5.742*	5.587**
(se)	(1.785)	(1.373)	(2.937)	(2.782)
Fully foreign owned	-2.139	-2.074	0.297	0.796
(se)	(1.998)	(1.561)	(4.269)	(3.343)
2-digit industry dummies	yes	yes	yes	yes
Standard error	11.06	11.05	11.97	11.98
Number of firms	1810	1810	939	938
F test, (g2)		143.5		96.34
p-value (g2)		0.0		0.0
Davidson-MacKinnon test of exogeneity g2		0.779		4.437
P-Value		0.378		0.035
Sargan (m)		1.381		9.452
Prob. Value		0.926		0.0924

Notes: 1. All regressions include 2-digit industry dummies. 2. Innovation is 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. 3. F test denotes de F of excluded instruments in the first-stages regressions. 4**.** Exogeneity denotes Davidson-MacKinnon test of Exogeneity. 5. Sargan test denotes overidentifying restrictions test.