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Inter-American Development Bank

28 September 2011

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***Abstract*—This study examines the impact of process and product innovation on employment growth across four Latin American countries (Argentina, Chile, Costa Rica, and Uruguay) using micro data from innovation surveys. Specifically, we relate employment growth to process innovations and to the growth of sales separately due to innovative and unchanged products. Results show that that compensation effects are prevalent, and the introduction of new products is associated with employment growth at the firm level. Specifically, we find that for the manufacturing firms as a whole, the introduction of process innovations only affects the employment growth in the countries case of Chile. At the same time, we observe no evidence of displacement effects due to the introduction of product innovations. In fact, the observed compensation effects resulting from the introduction of new products imply, in turn, employment growth even when the replacement of old products is taken into account.**

***Index Terms*— Innovation, Employment, Developing countries, Latin America, Innovation surveys.**

I. Introduction

Innovation is widely considered to be a primary source of economic growth, and policies to encourage firm-level innovation are high in the agenda in most Latin American countries. But innovation as such might not be sufficient to generate employment. And for countries that are facing labor market problems, persistent poverty and inequality, employment generation is probably the main route out of poverty and the most efficient way to reduce inequality, so the consequences of innovation for employment are of particular interest.

The relationship between innovation and employment is a complex one. Innovation could trigger direct (mainly firm level), partial and general equilibrium effects on employment, and across all these levels the relationship between these variables depends on many different transmission mechanisms, feedbacks and institutional factors [1]. Recent evidence on the firm level relationship between innovation and employment in develop economies indicates that whether and how innovation creates new jobs depends first and foremost on the type of innovation [2]. In addition to this, the effects of innovation on innovators' employment depend on the state of the technology that determines how much innovation improves productivity and demand conditions that induce different dynamic effects.[1] At sector level, innovation can also trigger indirect effects that include the competitive redistribution of outputs and jobs from low to high innovation-intensive firms, job losses due to the exit of non-innovative firms and job creation from innovative spin-offs. Finally, general equilibrium effects clearly emerge when the interactions between different markets are considered. Indeed, how fast innovators can meet increased demand depends in part on how fast intermediate inputs can be supplied. Innovation can also affect employment through complementarities in consumption goods and increased variety or better quality of intermediate inputs. Finally, new products could lead to completely new economic activities ([2], [3], [4], [5], [1] among others provide empirical basis for some of these hypotheses).

The evidence on the relationship between innovation and employment is lacking for Latin America where the very idiosyncratic nature of innovation means that the above-mentioned findings cannot be simply extrapolated to this region.[2] Indeed, for Latin American firms the acquisition of technological knowledge from abroad through contacts, trade, collaborations and joint ventures with industrialized countries is very relevant [8]. Technological change in developed countries might respond to different objectives, incentives and factor endowments as well as go in different directions from technological change in developing countries. Innovations borrowed from developed countries may not be adapted to developing countries contexts and

Manuscript received September 28th, 2011. This work takes is part of the research project entitled "Employment Generation, Firm Size and Innovation in Latin America: the Microeconometric Evidence" coordinated by the Science and Technology Division of the Inter-American Development Bank.

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[1] This applies to both process and product innovation. Although process innovations might displace labor in the short term, in the extent that productivity gains are pass-through to prices and consumers react to price reductions, it might increase labor in the long term. The opposite applies to product innovations, in the extent that short term demand shifts might be compensated by imitators later on.

[2] There are so far only two recent papers on innovation and employment in LAC. One is Benavente and Lauterbach [6] on Chile, while the other one is Fanzylber and Fernandes [7], that covers only Brazil. However, while the first paper only deals with employment quantity issues in a cross-section setting, the second one uses trade proxies as controls for technology and as such does not properly control for innovation.

may produce different effects on employment than locally-developed innovations. So, it is not only that Latin American firms produce different types of innovations (based on the imitation of the best practice frontier rather than being the first to introduce world class innovations) but also that the very nature of the innovation process is different. As a consequence the effects of innovation on employment generation in this region might be quite different.

Furthermore, in Latin America the production structure is strongly dominated by small and medium enterprises (SMEs). The innovation process in SMEs shows very different characteristics from that of large firms. Indeed, SMEs' innovation is strongly dominated by informal search routines and learning from already available knowledge and technologies, while in large firms innovation processes are more systematic and tend to be formalized in R&D labs [9]. So the typical business innovation strategy observed in Latin America is quite different from the one which is dominant in frontier economies. Finally, an additional reason to expect a differential impact of innovation on employment in LAC relates to differences in the production structure. These impacts depend on the strength of the demand reaction to both product and process innovations, so if the mix of goods produced in LAC is remarkably different from the mix produced in developed ones, the final impacts of innovation might be different.

This paper aims at closing the evidence gap on the effects of innovation on employment growth at the firm level in Latin America by using innovation surveys for four Latin American countries: Argentina, Chile, Costa Rica and Uruguay.

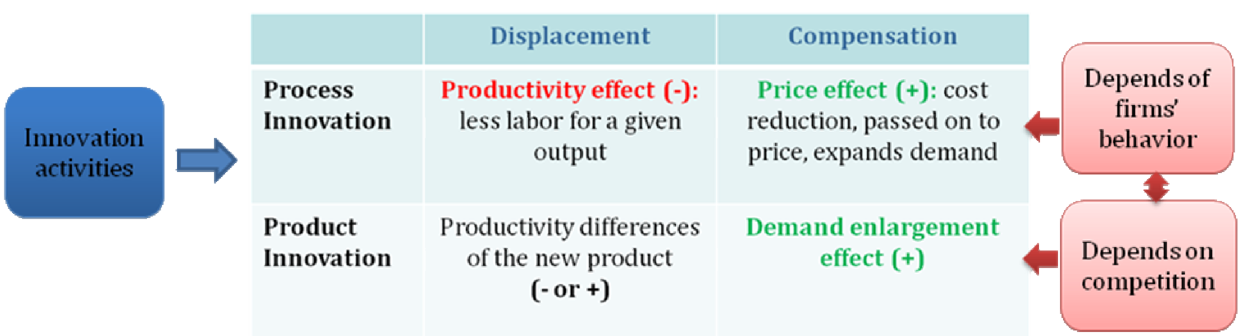
The rest of this paper is organized as follows. Section 2 presents the relation between innovation and employment. Special emphasis is put on explaining potential identification problems and the need to implement IV estimation to obtain consistent estimates. Section 3 describes the sources of the data used and presents the main characteristics of the firms' behavior in the four countries under study. Section 4 presents the results and Section 5 uses these results to decompose the different effects of innovation on employment growth. Section 6 presents conclusions.

II. Relationship between innovation and employment generation

Recent evidence on the firm level relationship between innovation and employment in develop economies indicates that whether and how innovation creates new jobs depends first and foremost on the type of innovation [2].

Specifically, the effects of innovation on employment (quantity) depend on the relative intensity of the displacement and compensation effects that it might induce. The introduction of new processes is generally driven by labor cost considerations and tends to reduce labor. The introduction of new products or services may replace or add to the list of existing products or services with different effects on the generation of employment (see Figure 1). Organizational innovation is frequently an indispensable complement to the adoption of new technologies critically affecting the productivity and employment consequences of technological innovation, especially ICTs [10].

Figure 1: Employment effects of innovation



Source: Adapted from [2].

Harrison, et. al. [2] show that in order to untangle the employment creating versus displacing effect of innovation, a distinction between product and process innovation is useful. This research will take the same starting point. In the basic model two types of products are distinguished: the production of existing products and the production of new products. The change in employment is then decomposed into the part due to the increased efficiency in production of old products (which could be related to process and organizational innovations) and the part due to the introduction of new products (product innovations). Hence, it is possible to capture the relative extent of expansion and displacement effect of innovation on employment as follows.

We assume that a firm can produce two types of products: "old products" and "new products" Outputs of old and new products at time t are denoted Y_{1t} and Y_{2t} respectively. We observe firms at two points in time, at the beginning (t=1) and at the end of the period (t=2). We also assume that each type of product is produced with an identical separable technology production function, with constant returns to scale in capital and labor. Each production technology has an associated efficiency parameter - θ_{it} – that change over time. New products can be produced with higher or lower efficiency than old products and the firm can influence the efficiency of production of either product through investments in process innovation. The firm's cost function at time t can then be written as follows:

$$C(w_{1t}, w_{2t}, Y_{1t}, Y_{2t,} \theta_{1t}, \theta_{2t}) = c(w_{1t})\frac{Y_{it}}{\theta_{1t}} + c(w_{2t})\frac{Y_{2t}}{\theta_{2t}} \quad (1)$$

Where $c(w)$ is a function of input prices. According to the Shephard's Lemma, the conditional demand for labor in the production of each product is:

$$L_{it} = c_L(w_{it})\frac{Y_{it}}{\theta_{1t}} \quad (2)$$

Where $c_L(w)$ is the derivative of $c(w)$ with respect to the wage. Under the assumption that $c_L(w)$ remains constant over the period and that it is the same for old and new products[3], the growth rate of employment at the firm level is given by the growth rate of employment allocated to the production of old products plus the growth rate of the employment allocated to the production of new products. Given that the production of new products at the beginning of the period is nil ($Y_{21} = 0$), so we can approximate the employment growth decomposition as follows:

$$l = \frac{\Delta L}{L} = -\left(\frac{\theta_{12} - \theta_{11}}{\theta_{11}}\right) + \left(\frac{Y_{12} - Y_{11}}{Y_{11}}\right) + \frac{\theta_{11}}{\theta_{22}}\frac{Y_{22}}{Y_{11}} \quad (3)$$

This expression says that employment growth is the result of the change in efficiency in the production process for the old products, the rate of change in the production of these products and the expansion attributable to the new products. The increase in the efficiency of the old products production process is expected to be larger for firms introducing process innovations related to the old products (firms that introduce process innovations only, according to the surveys). On the other hand the effect of product innovation on employment growth depends on the difference in efficiency between the production processes for the old and the new products. If the new products are produced more efficiently than the old products then this ratio is less than one and employment does not growth at the same pace as the growth of output accounted for by new products (the growth in innovative sales, according to the innovation surveys). Equation (3) suggests the following regression to estimate the effects of innovation on employment:

$$l = \alpha_0 + \alpha_1 d + g_1 + \beta g_2 + \upsilon \quad (4)$$

Where l is total employment growth, g_1 is the nominal growth in sales of old products, g_2 is the nominal growth in sales of new products (product innovations) and d captures the introduction of process innovations in the production of old products. In general terms one should expect that while innovations with regards to the production processes of old products tend to displace employment, product innovations will tend to create employment (unless new products substitute for old products and the production efficiency of new products is higher than that of the old products).[4]

A. *Identification Issues, causality and measurement errors*

Identification and consistent estimation of the parameters of interest of equation (4) depends on the lack of correlation between the variables representing process and product innovations and the error terms of each equation. Innovations are the result of investment decisions (such as R&D) which have to be decided by the firms in advance. These decisions depend on firm's productivity, which can be thought as an unobservable of two components: firm's attributes that are mainly constant over time (such as managerial skills or organizational capital) and productivity shocks (that might lead to the firm to reduce labor costs). So, if innovation investments are correlated with firm's productivity, so innovation outputs will be also correlated with firm's

[3] This will be the case if relative prices do not change very much over time or across new and old products

[4] The nominal growth in sales of old products, g_1 is the result of three different effects: the autonomous increase in firm demand for the old products, the compensation effect induced by any price variation following a process innovation and demand substitution effect resulting from the introduction of new products. As these components cannot be disentangled without additional data, in practice g_1 will be simply subtracted from l, so an alternative specification for (4) is to use the inverse labor productivity growth as dependent variable.

productivity. Given that firm's productivity also shows up in the error term of the labor demand equation, innovation outputs will be endogenous leading to a serious problem of identification.

Given than equation (4) is specified as a growth rate, it is expected that the influence of productivity fixed effects is already removed from the error term. With regards to the correlation between innovation outputs and productivity shocks (they remain in the error term of equation 4), this depends on the exact timing of investment decisions. If investment decisions are taken in advance to productivity shocks (because for example there is a "time to build" period between when investments decisions are made and actual innovations materialize), innovation variables in (4) won't be correlated with the error term and equation (4) could be estimated by OLS methods.[5] If, on the other hand, investment decisions are taken at the same time as the productivity shocks are observed, innovation outputs might become endogenous in equation (4). In this case identification will depend on the availability of instruments correlated with these variables and uncorrelated with the error term. In this particular, innovation surveys typically include interesting information to be used as instruments.

III. Data sources

The model is run for four countries. The analysis focuses on the manufacturing industry. Innovation surveys used were: Argentina (1998-2001), Chile (1995, 1998, 2001, 2005 and 2007), Costa Rica (2006/2007) and Uruguay (1998-2000, 2001-2003, 2004-2006 and 2007-2009). Table 1 displays the definition of variables and their means. We have established a team of researchers from these countries with access to micro data who implemented the empirical common model. A series of national studies have been conducted in parallel to fully exploit the richness of each individual survey by local researchers

Specifically, in the case of Argentina we use data from Second National Innovation Survey (1998-2001) conducted in 2003 by the National Institute of Statistics and Censuses (INDEC) and collected retrospective information for each year between 1998 and 2001. The firms that were surveyed are the same firms surveyed in the Annual Industrial Survey –manufacturing firms with 10 or more employees. The response rate was 76 percent; questionnaires were distributed to 2,229 firms and 1,688 answered the questionnaire. The sampling frame includes 23 industries –22 of them correspond to industries classified according with two digits of ISIC-Rev3 and the rest include firms with special characteristics –they have linkages with the Ministry of Defense or the National Commission of Atomic Energy. In the Chilean case, there are additional available innovation surveys for studying this relevant issue. In this project, we use the innovations surveys carried out during the years 1995, 1998, 2001, 2005 and 2007. This information is complemented with firm-specific information obtained from the Annual Survey of Manufactures (ENIA). This link between both sources of information is relevant given that, usually, innovation surveys are very limited in terms on information about firm characteristics, such as employment, sales, exports, and investment. Unfortunately, there are not available information sources for firm characteristics in other productive sectors, such as services. The main source of data used in the study is the Costa Rican Innovation Survey for the years 2006/2007. This survey is based on a statistically representative sample of the manufacturing, energy and telecommunications sectors. According to the official data of the National Institute of Statistics and Census (INEC), these sectors comprised a total of 2,285 firms. In the case of the 2006-2007 survey the INEC provided a sample of 566 firms distributed over all sectors. Using this sample, it was possible to obtain responses from 376 firms. After eliminating firms from energy and telecommunications, and also any manufacturing firms with less than 10 employees, we ended with a sample of 211 firms. The survey was conducted by CINPE for the Ministry of Science and Technology (MICIT). The data from the innovation survey were combined with official data from the Costa Rican Social Security System (CCSS) and the Central Bank of Costa Rica related to total amount of workers and total production value for each industry sector (2 digit-codes from the SIC), respectively. In the case of Uruguay we are using the four waves of Manufacturing firms Innovation Surveys (IS) available at the moment: 1998-2000, 2001-2003, 2004-2006 and 2007-2009, and also the annual Economic Activity Surveys (EAS) for the period 1998-2007. The IS data is collected by the National Bureau of Statistics (INE) in parallel with the EAS (same sample and statistical framework). For the IS 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 the ISIC 2-digit level up to 2005. Since then, random strata are defined as those units with fewer than 50 workers within each economic sector at the ISIC 4-digit level. The main reason to match the IS with the EAS is the need to collect sales and employment data at the beginning of each year for the period of reference for each survey of the IS10.

When comparing results across countries, we need to bear in mind that business, economic, and policy environments in Latin America differ between countries and generally diverge from OECD countries. Innovation policy work has made greater strides in the last decade in Argentina, Chile, and Uruguay than in other countries of the region. Finally, the reader should keep in mind that this is an analysis of the manufacturing industry, which represents a small share of the total economy in some countries [11]. The results apply only to this industry. We acknowledge, however, that innovation is relatively more important in manufacturing and services industries where value added originates and knowledge skills are more valued [12].

A. *Descriptive statistics*

Table 1 presents the main characteristics of the firms in the four countries under study. For each variable, the country sample is split in four sub-groups according to whether the firm reports that over the considered period it has not introduced any

[5] This is the sort of timing for investment decisions underlying [13].

innovation, has introduced only process innovation (without product), has implemented organizational changes (without product) or has introduced product innovations.

TABLE 1
MANUFACTURING FIRMS: PROCESS AND PRODUCT INNOVATORS, GROWTH OF EMPLOYMENT AND SALES

	AR	CH	CR	UY
Number of observations	1415	2495	211	2629
Non-innovators (no process or product innovations) (%)	36.2	32.3	2.9	49.3
Process only innovators (non product innovators) (%)	4.8	3.9	4.3	7.0
Organizational change innovator (non product innovators) (%)	10.5	9.7	18.8	11.6
Product innovators (%)	48.5	54.1	74.0	32.2
Employment growth (%) (yearly rate)				
All firms	-4.0	-2.6	2.7	-1.1
Non-innovators (no process or product innovations)	-6.1	-3.5	4.1	-4.4
Process only innovators (non product innovators)	-2.8	2.9	6.7	4.2
Organizational change innovator (non product innovators)	-3.9	-5.6	2.5	1.4
Product innovators	-2.5	-1.9	2.4	1.9
Sales growth (%)[1] (nominal growth) (yearly rate)				
All firms	1.9	4.7	19.3	4.9
Non-innovators (no process or product innovations)	-0.1	1.3	17.1	0.3
Process only innovators (non product innovators)	7.9	1.2	10.1	10.4
Organizational change innovator (non product innovators)	13.5	3.7	23.1	10.7
Product innovators	6.2	7.1	18.9	8.6
of which:				
Old products	-22.2	-6.7	-87.2	-18.9
New products	28.4	13.8	106.1	27.5
Labor productivity growth (%)[1] (yearly rate)				
All firms	5.9	7.2	16.6	5.9
Non-innovators (no process or product innovations)	6.2	4.7	13.0	4.7
Process only innovators (non product innovators)	10.7	-1.7	3.4	6.2
Organizational change innovator (non product innovators)	17.4	9.3	20.6	9.3
Product innovators	8.7	9.0	16.5	6.6
Prices growth (%) [2]				
All firms	6.5	5.6	13.2	6.9
Non-innovators (no process or product innovations)	6.3	4.9	11.2	6.9
Process only	4.8	6.6	11.0	5.2
Product innovators	10.3	6.7	13.2	8.3

Notes: Sales growth for each type of firm is the average of variable g and averages for old and new products are the averages of variables g1 and g2, respectively. Prices computed for a set of industries and assigned to firms according to their activity.

Table 1 shows evidence the high proportion of innovative firms in the region. In fact, the proportion of innovative firms ranges from 50.1% (in Uruguay) to 97.1% (in Costa Rica). Among them, more than half of innovators have introduced product innovations.

Despite the difference in overall performance across countries, it becomes evident (with the exception of Costa Rica) that innovators exhibit better employment performance than non-innovators. Although less clear, a similar situation arises in the case of sales. In particular, we should highlight that product innovators show a composition of sales that shows a cannibalization process of old products. All this, suggests that compensation effects are prevalent. In this respect Harrison et al. (2008) stress that “there is no hope to assess the relative roles played by process and product innovations without estimating a model as the one consider [t]here.” (p.18)

IV. Econometric results of innovation on Employment

Following [2], OLS descriptive or “naive” regressions for the manufacturing –both for total sample and small firms- in each country are presented in Tables 2 and 3, respectively. A SME is defined in the four countries as those firms with less than 50 employees. In each case, employment growth is regressed on deflated total sales growth, dummies for “process innovation only” and product innovation, and a full set of industry dummies.

The results in Table 2 and Table 3 are partial correlations which can be used to describe the dataset, but they cannot identify the effect of innovation on employment. On Table 2 the coefficient on real sales growth is fairly stable across countries and is a long way below unity in all cases. On face value, this suggests that sales growth is associated with less than one-for-one growth in employment. At the same time, being an innovator (widely defined as product or process innovator) is positively related with employment growth except in the case of Costa Rica. When, in the case of all manufacturing firms, we differentiate the effects of the two different types of innovations, we observe that in half of the cases product innovation is positively associated with employment growth. In these cases, also process innovation has the same effects. Only in the case of Chile, the evidence reveals a negative effect of process innovation on employment growth.

Table 3
Naive regression on the effect of innovation on employment quantity

Dependent variable: ***l (Employment growth-yearly)-OLS Estimation with robust errors***

Sector: Small Manufacturing	**Argentina**		**Chile**		**Costa Rica**		**Uruguay**	
Regression	**1-OLS: naïve**	**2-OLS: naïve**	**1-OLS: naïve**	**2-OLS: naïve**	**1-OLS: naïve**	**2-OLS: naïve**	**1-OLS: naïve**	**2-OLS: naïve**
TPP (product or process innovator)	3.910**		2.911**		2.314		3.456***	
(se)	(1.359)		(1.229)		(3.807)		(1.135)	
Product innovator		3.639*		2.691**		0.463		4.028***
(se)		(1.502)		(1.357)		(3.069)		(1.275)
Process innovator		4.939*		-0.51		2.583		3.398*
(se)		(2.186)		(2.117)		(4.397)		(1.861)
Real sales growth *(g-Π)*	0.184***	0.183***	0.353***	0.354***	0.107	0.108	0.375***	0.376***
(se)	(0.052)	(0.052)	(0.031)	(0.031)	(0.067)	(0.070)	-0.041	-0.041
2-digit industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
(se)								
								-
Constant	-3.672***	-3.689***	-0.927	-0.59	0.428	1.840	-4.782***	4.740***
(se)	(1.009)	(1.008)	(0.737)	(0.749)	(3.480)	(2.781)	(0.735)	(0.706)
Standard error	0.154	0.154	0.243	0.242	12.824	12.906	20.769	20.769
Number of firms	417	417	871	871	119	119	1416	1416

Notes: Own elaboration based on country studies.
Significance: *** 1%, ** 5% and *1%. Chile and Uruguay include time dummies.

Nevertheless, the results are quite uninformative about the relative roles of displacement and compensation effects in the relationship between innovation and employment growth. They mainly show what is gained by imposing more structure on the data using our theoretical model and information about the mix of sales between old and new products as done on subsequent tables.

In this sense, Table 4 shows the OLS results for the basic model in [2] for all firms and SMEs. The results of the basic model show that a process innovation does not have a significant effect on employment while a product innovation has a positive and significant effect on employment. The estimated coefficient on is close to one which indicates no important differences in efficiency in the production of old and new products The OLS results of the basic model are similar for SMEs. The main difference is that a process innovation has –in the majority of the cases- negative though not statistically significant effect on employment. In addition, the smaller sample size translates in a loss of precision in the estimations.

TABLE 4
EFFECT OF INNOVATION ON EMPLOYMENT QUANTITY

Dependent variable: ***l -(g1-Π)-OLS Estimation***

	Manufacturing firms				Small manufacturing firms			
Regression	**AR**	**CH**	**CR**	**UY**	**AR**	**CH**	**CR**	**UY**
Constant	3.985***	2.036**	-1.040	2.681***	2.712	2.905**	-0.190	1.28
(se)	(0.831)	(0.935)	(4.008)	(0.684)	(1.686)	(1.272)	(5.324)	(0.977)
Process innovation only *(d)*	0.172	-3.773**	7.952	-3.555**	-2.695	-0.170	5.120	-2.476
(se)	(1.068)	(1.649)	(5.523)	(1.796)	(2.634)	(2.531)	(7.746)	(2.933)
Sales growth due to new products *(g2)*	0.960***	0.765***	0.924***	0.838***	0.963***	0.702***	0.957***	0.805***
(se)	(0.013)	(0.036)	(0.031)	(0.027)	(0.030)	(0.065)	(0.042)	(0.044)
Foreign owned (10% or more)	-4.013***	0.932	2.288	1.615	-3.445	5.028	10.397	-4.036
(se)	(0.904)	(1.674)	(4.045)	(1.69)	(3.677)	(4.102)	(8.432)	(3.509)
Located in the capital (capreg)	1.044	-1.415	5.029	NA	3.963*	-2.132	1.640	NA
(se)	(0.855)	(1.013)	(3.055)	NA	(1.899)	(1.594)	(4.973)	NA
2-digit industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of firms	1415	2494	208	2629	417	871	119	1416

Notes: Own elaboration based on country studies.
Significance: *** 1%, ** 5% and *1%. IV estimations with robust standard errors. Standard errors in parentheses. Small firms refers to firms with up to 50 employees
Argentina (AR)-Innovation Survey 1998-2001; Chile (CH): pooled regressions for the innovation surveys 1995, 1998, 2001, 2007; Costa Rica (CR): Innovation survey 2006-2007 Uruguay: pooled regressions for the surveys 1998-2000, 2001-2003 and 2004-2006.

A. Identification strategy

There are two endogeneity problems that can potentially bias the OLS estimation just presented. Namely, an omitted variable problem because productivity shocks are included in the error term (with a negative sign), and measurement error problem due to unobservability of firm prices. The strategy relies on the choice of instrumental variables that can be considered to be uncorrelated with both the price differences and the productivity shocks. These endogeneity issues tend to generate a downward bias in the OLS estimates of the coefficients on *g2*.

Any valid instrument must be highly correlated to the growth in sales of new products (g2) but not to any change in the price of new products compared to old products and to productivity shocks. The preferred instrument in [2] was the increased range of goods and services indicator, which assesses the impact of innovation on the increase in the range of goods produced by firms. Both in the case of Costa Rica and Uruguay, the indicator of the effects of innovation on the range of products is used as an instrument. In the case of Argentina, the only instrument used is an indicator of the firm knowledge of public support for innovation activities. Firm knowledge of public support for innovation activities is likely to be correlated with time invariant firm's attributes like managerial skills or organizational capital. However, given that the estimating equation is in growth rates, time invariant firm's attributes are not part of the error term. Correlation with productivity shocks or growth in prices of new products seems less likely. For Chile, he instruments used are the importance of 3 obstacles for innovation identified by the firm itself, and the average of these obstacles for firms producing in the 3-digit industry. Table 5 presents the IV results for both the complete manufacturing sample and the group of small firms.

TABLE 5
EFFECT OF INNOVATION ON EMPLOYMENT QUANTITY

Dependent variable: ***l -(g1-Π)***
IV Estimation

	Manufacturing firms				Small manufacturing firms			
Regression	**AR**	**CH**	**CR**	**UY**	**AR**	**CH**	**CR**	**UY**
Constant	-0.920	0.604	-8.197**	1.573**	-0.757	0.005	-4.97	0.171
	(3.124)	(2.063)	(4.108)	(0.757)	(4.450)	(3.332)	(5.108)	(1.043)
Process innovation only *(d)*	2.032	-3.400**	14.902*	-2.87	-2.636	-3.51	12.006	-2.284
	(1.795)	(1.696)	(7.983)	(2.023)	(3.455)	(4.595)	(10.568)	(3.417)
Sales growth due to new products *(g2)*	1.165***	1.107**	1.011***	0.952***	1.141***	1.537*	1.042***	0.959***
	(0.126)	(0.445)	(0.004)	(0.051)	(0.211)	(0.886)	(0.058)	(0.081)
Foreign owned (10% or more)	-5.432***	0.892	2.567	1.435	-5.438	6.015	8.343	-3.941
	(1.437)	(1.452)	(4.356)	(1.516)	(4.715)	(4.138)	(9.244)	(3.117)
Located in the capital (capreg)	1.640	-1.344	5.035*	NA	4.674*	-0.762	-0.089	NA
	(1.027)	(1.02)	(3.042)	NA	(2.291)	(2.282)	(5.035)	NA
2-digit industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Own elaboration based on country studies.
Significance: *** 1%, ** 5% and *1%. IV estimations with robust standard errors. Standard errors in parentheses. Small firms refer to firms with up to 50 employees. Argentina (AR)-Innovation Survey 1998-2001; Chile (CH): pooled regressions for the innovation surveys 1995, 1998, 2001, 2007; Costa Rica (CR): Innovation survey 2006-2007 Uruguay: pooled regressions for the surveys 1998-2000, 2001-2003 and 2004-2006.
Instruments: AR: knowledge of public support for innovation activities; CH: Average per region of economic obstacles (technological risk, very long-term return), workforce related (low qualification, lack of experience) and other (absence of technological or market-related information, imitation risks); CR: Increased range of goods. UY: Increased range of goods and Development of new markets.

When we implement an IV estimation, we observe that the coefficient on g2 moves upwards and this is consistent with a downward bias in the OLS estimate. Although a coefficient greater than one offers evidence that new products are produced less efficiently than old products, we find (with the exception of small firms in Chile) this evidence to be tenuous, given that the estimate is not statistically different than one. To summarize there is no evidence of a displacement effect on employment after a product innovation only a creation effect due to demand enlargement. The results show that process innovation has only negative effects on employment in the case of Chile. There are two plausible interpretations for this result. First, a process innovation may not generate important productivity gains hence there is no displacement effect on employment. Second, a process innovation may generate productivity gains (displacement effect) which induce a demand enlargement through market competition (creation effect). In the end the creation effect on employment compensates the displacement effect on employment. The IV results of the basic model are almost identical for SMEs.

V. DECOMPOSITION

An interesting way to summarize the evidence obtained with our estimates is to use them to decompose the employment growth observed in each country (and type of firm) over four different components. Using our preferred specification, we can write employment growth for each firm in the following way:

$$l = \sum_j (\hat{\alpha}_0 + \hat{\alpha}_{0j}) ind_j + \hat{\alpha}_1 d + [1 - 1(g_2 > 0)](g_1 - \pi_1) + 1(g_2 > 0)(g_1 - \pi_1 + \hat{\beta} g_2) + \hat{u}$$

with the same notations as before and with ind_j denoting the industry dummies and $\hat{\alpha}_{0j}$ their estimated coefficients. For a given firm, the first component $\sum_j (\hat{\alpha}_0 + \hat{\alpha}_{0j}) ind_j$ measures the change in its employment attributable to the (industry specific) productivity trend in production of old products; the second component ($\hat{\alpha}_1 d$) estimates the change in employment associated with the gross productivity effect of process innovation in the production of old products; the third one ($[1 - 1(g_2 > 0)](g_1 - \pi_1)$) corresponds to the employment change associated with output growth of old products for firms that do not introduce new products; and finally, the fourth one $1(g_2 > 0)(g_1 - \pi_1 + \hat{\beta} g_2)$ gives the net contribution of product innovation (i.e., contribution after allowing for any substitution of new products for old products). The last term ($\hat{u}$) is a zero-mean residual component.

Table 6 reports the results of applying this decomposition to the fours samples of manufacturing firms using the proportion of firms and averages presented in Table 1 with the coefficients obtained in Table 5. First, we observe that incremental productivity presents quite a heterogeneous impact in the four countries. While in the case of Costa Rica results in an important source of employment reduction, the case of Uruguay is quite the opposite. However, the growth in output of existing products partially compensates the destruction observed in Costa Rica. Differently, this output evolution is responsible for employment loss in the rest of the countries. Secondly, individual process innovation account for a small share of the changes observed in employment, inducing small displacement effects only in the cases of Chile and Uruguay.[6]

In contrast, product innovations are (with the sole exception of Chile) an important source of firm-level employment growth. This is true even in situations of aggregate employment destruction as in the cases of Argentina and Uruguay.

TABLE 6
DECOMPOSITION OF EMPLOYMENT GROWTH-ALL MANUFACTURING

	AR	CH	CR	UY
Firms employment growth	-4.0	-2.6	2.7	-1.1
Productivity trend in production of old products	-0.1	0.2	-5.5	1.5
Gross effect of process innovation in production of old products	0.1	-0.1	0.7	-0.2
Output growth of old products contribution	-4.6	-1.7	2.0	-2.6
Net contribution of product innovation	0.6	-1.0	5.5	0.2
Contribution of old products by product innovators	-21.1	-6.7	-74.5	-8.3
Contribution of new products by product innovators	21.7	5.7	80.0	8.4

Notes: Own elaboration based on country studies. Based on IV estimations with robust standard errors.
Argentina (AR)-Innovation Survey 1998-2001; Chile (CH): pooled regressions for the innovation surveys 1995, 1998, 2001, 2007;
Costa Rica (CR): Innovation survey 2006-2007; Uruguay: pooled regressions for the surveys 1998-2000, 2001-2003 and 2004-2006.

[6] This can be partially due to the fact that, since the number of firms that introduce only process innovations is small, process innovations are to some extent partially underestimated.

Table 7 presents the results of the decomposition for the case of small firms. Once again, while process innovations (alone) have almost negligible effects on employment, product innovations play an important role in stimulating firm-level employment growth. The negative overall reduction in employment is mostly associated with the reduction of output in the case of existing products.

TABLE 7
DECOMPOSITION OF EMPLOYMENT GROWTH-SMALL MANUFACTURING

	AR	CH	CR	UY
Firms employment growth	-3.4	-1.6	2.7	-4.2
Productivity trend in production of old products	2.1	1.0	-4.3	0.4
Gross effect of process innovation in production of old products	0.1	0.0	0.7	-0.2
Output growth of old products contribution	-6.2	-2.9	1.8	-4.1
Net contribution of product innovation	0.6	0.3	4.4	-0.3
Contribution of old products by product innovators	-15.1	-3.7	-64.9	-6.6
Contribution of new products by product innovators	15.7	4.0	69.4	6.2

Notes: Own elaboration based on country studies.
Based on IV estimations with robust standard errors.
Argentina (AR)-Innovation Survey 1998-2001; Chile (CH): pooled regressions for the innovation surveys 1995, 1998, 2001, 2007; Costa Rica (CR): Innovation survey 2006-2007; Uruguay: pooled regressions for the surveys 1998-2000, 2001-2003 and 2004-2006.

VI. CONCLUSIONS

Despite recent high economic growth, reduction of poverty and inequality are high in the policy agenda in Latin America. Considering the key role played by employment generation in the reduction of poverty and inequality, it is of particular interest to understand the effects of innovation on employment generation.

In this paper, we have estimated a model based on [2] by using a source of comparable and representative data on innovation in manufacturing (by firm size) across four Latin American countries. Our results provide evidence on a relevant and almost unexplored topic in the region. In particular, we are able to shed new light on the relative roles of displacement and compensation effects of product and process innovation on employment growth in manufacturing.

Our results highlight individual process innovation account for a small share of the changes observed in employment, inducing small displacement effects. More importantly, and fundamental for the search for more inclusive growth patterns in the region, we found that product innovations are (with the sole exception of Chile) an important source of firm-level employment growth. This is true even in situations of aggregate employment destruction as in the cases of Argentina and Uruguay.

The evidence gathered in the project requires to be complemented with further understanding of impact of innovation strategies and of the impacts on employment quality.

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