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ARTÍCULO

Does innovation generate or destroy employment? An application for manufacturing and service firms

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Abstract: Firms engage and invest in innovation mainly for profit-making purposes; they create new products or processes and in turn acquire a larger market share. Labor markets play a key role within countries and firms to boost productivity growth and innovation. Hence, it is of paramount importance to assess how technological change might generate both job gains and losses. These effects depend on the dynamics behind innovation and factors such as the speed of adoption, industries and sectors affected, necessary skills, or speed of adjustment in the labor force. In this paper, we estimate how Colombian firms are performing upon the introduction of several types of innovations such as product, process, organizational and commercialization innovations and the subsequent effects on employment growth. In particular, we seek to disentangle the extent to which there is displacement effect or not by the introduction of innovations in the Colombian context. We examine the effects across several employment categories -skilled and unskilled, male and female, full and part time. In addition, we explore heterogeneities by firm size, innovation intensity, and differences across industry and service sectors.

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PALABRAS CLAVE:
Crecimiento del empleo; Innovación en procesos; Innovación en productos; Cambios organizaciones; Cambios en comercialización

Resumen: Las empresas invierten y desarrollan innovaciones buscando principalmente ganancias; además crean nuevos productos o procesos buscando una mayor cuota de mercado. Por otro lado, los mercados laborales desempeñan un papel clave dentro de los países y las empresas para impulsar el crecimiento de la productividad y la innovación. De esta manera, es de suma importancia evaluar cómo el cambio tecnológico puede generar o destruir empleo. Estos efectos dependen de la dinámica detrás de la innovación y de factores como la velocidad de adopción, las industrias y sectores afectados, las habilidades necesarias o la velocidad de ajuste en la fuerza laboral. En este sentido, esta investigación tiene como objetivo estimar como las empresas colombianas se ven afectadas con la introducción de varios tipos de innovaciones (de productos, de procesos, introducción de nuevos modelos organizacionales y de comercialización), y los efectos posteriores sobre el crecimiento del empleo. En particular, buscamos explorar si existe o no un efecto desplazamiento del empleo mediante la introducción de innovaciones en el contexto colombiano. Examinamos los efectos en varias categorías de empleo: calificado y no calificado, femenino y masculino, a tiempo completo y parcial. Asimismo, exploramos las heterogeneidades según el tamaño de la empresa, la intensidad de la innovación y las diferencias entre los sectores de industria y servicios.

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Introduction

The economic literature considers innovation to be a fundamental cause of economic growth. Innovation boosts growth through the diffusion of technology from developed to less-developed countries. In addition, combined with other factors, innovation improves living standards and boosts economic performance (Verspagen, 2006). Presenting the same line of argumentation, several studies elucidate the relation between GDP (Gross Domestic Product) and investment in Research and Development (R & D), suggesting a positive and significant impact from the latter on the former. Firms, regions and countries benefit from R & D through international trade, coalitions, foreign business ownership, worker mobility, etc. (Coe and Helpman, 1995; Keller, 1998; Van Pottelsberghe and Lichtenberg, 2001).

Romer (1990) and Aghion and Howitt (1992) define innovation as the driving force behind growth and thus as affecting the entire economy. Innovations developed by firms affect variables such as productivity, per capita income, distribution, and individual capabilities and opportunities. Thus, technological change can generate both job gains and losses. This effect depends on the dynamics that drive innovation and factors such as the speed of adoption, the industries and sectors affected, the necessary skills, and the speed of employment adjustment, which may lead to frictional or technological unemployment, creating mismatches in the job market (Pianta, 2006; Mariz-Pérez et al., 2012).

Within this context, this paper examines the effects of innovation on employment in Colombian firms in the manufacturing and service sectors using The Annual Manufacturing Survey and The Development and Technological Innovation Surveys. This topic is of particular interest in a country such as Colombia, where the labor market faces structural problems. One indicator of these problems is the striking level of informality: approximately 50% of Colombian workers are employed in the informal economy. Efforts have been made in Colombia to advance investments in science, technology and innovation, which imply the necessity of understanding relations between innovation and employment.

The remainder of this paper is structured as follows. We discuss the literature and relevant empirical findings related to innovation and its effects on employment. This is followed by a description of our empirical strategy, which is based on Harrison et al. (2014) theoretical framework. Our results show that sales growth due to new products positively affects employment growth, and this is robust to different specifications and the inclusion of control variables. Aside from this effect, process innovations have no displacement effect on employment growth in Colombia.

1 Literature Review

From a microeconomic perspective, most research in this field examines the displacement and compensation effects of both types of innovation - product and process innovation - on employment at the firm level (Van Reenen, 1997; Peters, 2005; Harrison et al.,2014). A more comprehensive understanding of micro-structures could prove useful given international differences at this level; these differences are crucial and define ways in which innovation systems in individual countries perform, and they also define appropriate types of innovation and learning processes (Lundvall, 2007). Process innovation improves productivity, as firms require fewer inputs. As a result, firms can produce the same outputs with fewer workers, leading to the destruction of jobs. Given this effect, it can be inferred that process innovation has a negative effect on employment. Nevertheless, with cost reductions and increases in productivity, firms can lower their prices and increase production levels, which ultimately generates jobs by requiring additional workers.

Further, if a firm introduces product innovations on the market, an increase in demand may be possible, leading again to job creation. A firm could also introduce an entirely new product to the market. Until competitors introduce similar or superior products, the company can increase product prices, reduce quantities sold, and thus require fewer workers.

Concerning these effects at the firm level, studies based on Harrison et al. (2014) theoretical model have been conducted for several countries. It takes into account the effect of process innovation and sales growth (from old products and from innovation through new products) on employment. Empirical estimates have been conducted for France, Germany, Spain and the UK for the 1998-2000 period. The main findings for these countries suggest a positive effect from product innovation on employment, although process innovation effects remain unclear, as the results vary across countries and sectors. Using the same theoretical model, Peters (2005) found for German firms that product innovations that are new to the firm but not new to the market (imitation strategies) stimulate employment. In the same study, process innovations are found to have negative effects in the realm of manufacturing, especially innovations that reduce average production costs (rationalization innovations). The result was found to be positive in the services sector, though not significant.

Antonucci and Pianta (2002) highlight the possibility of technological unemployment, situation that happens when process innovation and weak demand dominates. These authors found for some European countries in the late 1990s job losses in the manufacturing industry due to technological change. Because of an active price competitiveness strategy, technological efforts were associated to restructuring and the market expansion effect of new products was modest.

Recent studies have been conducted on the relation between innovation and employment in Latin America. Crespi and Tacsir (2012) conduct estimates for the manufacturing sector in Argentina, Chile, Costa Rica and Uruguay and find a positive effect from product innovation. In the case of process innovation, the effect is not found to be significant except for Costa Rica, which shows a positive impact, and Uruguay, where the displacement effect dominates. Castillo et al. (2011) evaluate this relationship for Argentina, Benavente and Lauterbach (2008) and Alvarez et al. (2011) study this relation for Chile, and Aboal et al. (2015) test this relation for Uruguay. Focusing on Colombia, Lopez and Zarate (2014) attempt to correct endogeneity issues with the theoretical model using Bayesian techniques. The overall result suggests that old products are

produced more efficiently than new products.

The majority of empirical studies find a positive impact from product innovation on employment and an ambiguous effect from process innovation. By contrast, a different estimation strategy is proposed by Lachenmaier and Rottmann (2011). The authors use a dataset drawn from German manufacturing companies to conduct a dynamic panel analysis that includes input and output measures of innovation. The results suggest that process innovation has a stronger positive effect on employment than product innovation. These findings contradict those presented in the studies described above. Van Reenen (1997), Smolny (1998), and Piva and Vivarelli (2005) conduct estimates based on a different theoretical setting. Their main finding is that technological innovation is associated with employment generation at the firm level.

When digging into the factors that shape the innovation practices inside a firm, and among industries, several studies shed light on the importance of firm size and industry (Acs et. al, 1987; Rothwell and Dodgson, 1994; Cohen and Klepper ,1996; Vaona and Pianta, 2008). Small and large-sized firms tend to innovate more, but the incentives to innovate might vary, with large-sized firms more oriented to market expansion, and small and medium-sized firms looking for new products (product innovation), and flexibility leading to new processes (Vaona and Pianta, 2008).

In terms of economic sector, Bryson et. al (2012) highlight the absence of studies where innovation, productivity and competitiveness are explored in the service sector, with the existing studies focusing mainly on Europe and the US, and the lack of evidence in developing countries despite the importance of this sector in the global economy. Some authors have found evidence that service industry firms innovate less than manufacturing firms, mainly because they are adopters and users of technology (Tether, 2005). Nevertheless, as Gallouj and Windrum (2009) argue, there might be problems on the way innovation in services is measured, and new indicators should be studied to have better estimates in this industry, though this goes along with the debate on how innovation in manufacturing and service sectors differ. For this study, we want to look at the heterogeneity by economic sector, thus, we test the effects of innovation on employment in the manufacturing and service sectors by making use of the Technological Innovation Industrial Survey and the Colombian Innovation Services Survey.

Another objective of this study is to analyze the heterogeneity by different types of labor. As Aboal et. al (2015) remarks, there is evidence that innovation is more complementary to skilled than to unskilled labor, this is the case in Uruguay, where product innovation has larger positive effects on skilled labor, and process innovation displaces unskilled labor. In contrast, a more recent empirical study finds that product innovations create more temporary and unskilled jobs than permanent and skilled jobs in the context of 5 countries in Sub-Saharan Africa (Avenyo et. al, 2019).

When it comes to labor flexibility, Altuzarra and Serrano (2010) claim that firms require an institutional framework flexible to modify work force size, workers' hours, wages, and tasks. Breschi and Lissoni (2001) and Braunerhjelm et al. (2014) show how labor mobility of high knowledge workers benefits both firms -sourcing firms and receiving firms-, justifying more flexible labor markets to enhance knowledge flows. In the same line of argumentation, Lorenz (2011) argues that the lack of restrictions on hiring and firing allows managers to rapidly reconfigure the required knowledge and abilities. However, Michie and Sheeham (2003) found empirical evidence suggesting that the use of temporary work is negatively related to innovative activity.

Lastly, we want to tease out how different types of innovation impinge female and male employment growth. There are very few studies trying to answer this question, with the majority coming from case studies for specific firms. Using this approach and data from a Norwegian corporation, Foss et al., (2013) find that women's ideas are not deployed to the same extent as men's ideas, implying that there could be differences in the relation between innovation and employment by gender. Hewlett et. al (2013) use a nationally representative survey for the US, case studies and focus groups to examine the relation between diversity and innovation, finding a positive relation between these two variables -diversity is defined as traits you are born with such as gender, ethnicity and sexual orientation.

Therefore, this study makes an empirical contribution to our sparse knowledge about the impact of innovation on employment growth in developing countries, by adding new evidence in the case of Colombia. There is a large body of the literature focusing on developed countries such as Europe and the US, thus is important to take advantage of the rich data on innovation in the industry and service sectors available for Colombia. Second, it contributes to the literature of the effects of innovation on different types of employment: skilled and unskilled, full-time and part-time, and male and female. In addition, different economic activities, innovation intensities, and firm sizes are evaluated. Finally, this study also contributes to the thin literature on organizational and commercialization innovations and their implications on employment, which have not been widely tested.

2 Methodology

According to Harrison et al. (2014) theoretical framework, employment growth is affected by an increase in the efficiency of existing product production, the rate of change for existing product production, the expansion in production due to the introduction of new products and the impact of unanticipated productivity shocks for existing products. Real output is not observed, and thus nominal sales are used. The first equation to estimate is:

$$l_i = \alpha_0 + \alpha_1 d_i + g_{1i} + \beta g_{2i} + u_i \quad (1)$$

where l_i denotes the employment growth rate, α_0 is the average efficiency growth, α_1 is the average efficiency growth due to process innovation, d_i is a dummy variable indicating process innovation, g_{1i} is the nominal rate of sales growth attributable to existing products, g_{2i} denotes the nominal rate of sales growth due to the introduction of new products, β is the relative efficiency of existing and new product production, and u_i is an unobserved disturbance.

Equation 1 suggests that firms that do not engage in process innovation can also achieve efficiency gains, perhaps due to exogenous technological progress, organizational changes, improvements in human capital, learning or spill-over effects (Peters, 2005). The nominal rate of sales growth attributable to existing products, g_{1i} has a coefficient equal to one and can therefore be subtracted from the employment growth rate. Thus, the new dependent variable is $\left(l_i - g_{1i}\right)$.

However, endogeneity problems may appear, as innovation decisions depend on a firm's productivity; the productivity levels inherent to each firm, which are differentiated in the theoretical model; and unobservable productivity shocks. The latter two depend on the timing of technological investments (lagged values of the explanatory variables or technological investments can be used as instruments). Other complications may occur when real growth sales for the existing products are not observed. One way to resolve this problem involves using firm-level prices, which in our study are available from The Annual Manufacturing Survey. Consequently, the dependent variable is $l_i - \left(g_{1i} - \pi_i\right)$ and the equation to estimate is:

$$l_i - \left(g_{1i} - \pi_i\right) = \alpha_0 + \alpha_1 d_i + \beta g_{2i} + u_i \quad (2)$$

We also study the effects of other variables on employment, such as organizational changes. The latter can boost managerial occupations while reducing the demand for unskilled workers (Caroli and Reenen, 2001). Additionally, according to Dachs and Peters (2014), foreign-owned firms have higher job losses derived from productivity increases and process innovations than domestically owned firms. Moreover, product innovation creates more jobs in foreign-owned firms. Other control variables that have been included in the estimates are a dummy variable, which takes the value 1 if a firm exports, and another dummy variable that takes the value 1 if firms are located in a capital city. Two other dummy variables have been included: one for medium-sized firms and one for large-sized firms, which each take the value 1 when meeting the Colombian legislation definition as a medium- or a large-sized firm, respectively.

We take fixed asset growth as a proxy for capital formation. The assumption of constant input prices is relaxed by including labor cost growth. Equation 2 is estimated using pooled OLS (POLS) and Instrumental Variables. Firms established during the period of analysis and firms with sales or employment values equal to zero or missing for the initial years were excluded. Additionally, the instruments used should be correlated with sales growth due to the introduction of new products but should be uncorrelated with price changes.

3 Data

We explore the relation between innovation and employment for Colombian manufacturing and service firms using data from The Annual Manufacturing Survey for 2007-2010, two waves of The Development and Technological Innovation Industrial Survey for 2007-2008 and 2009-2010, and The Development and Technological Innovation Services Survey for 2010-2011. These three surveys are conducted by the Colombian National Administrative Department of Statistics-DANE. The Annual Manufacturing Survey is a national survey of industrial establishments that includes information for more than 8,000 plants. We selected firms with a balanced panel from 2007 to 2010. The Development and Technological Innovation Industrial Survey was matched to The Annual Manufacturing Survey to obtain detailed information on innovation and technological activities conducted by manufacturing firms in Colombia.

g_1 and g_2 values for manufacturing firms were calculated using the information available in our dataset by comparing products for each firm for the 2006-2010 period. The survey also includes prices for each firm, allowing growth prices to be calculated while avoiding the endogeneity concerns related to this variable.

Regarding economic sector employment participation in Colombia, in 2013, the manufacturing sector participated with 12% of the total employment, service sector participation increased to 64%, and the agricultural sector contributed 18%.[1] These values highlight the relevance of the service sector in terms of employment generation in the country. Taking into account the significant service sector participation rate, we carried out estimates for the service sector using information from The Development and Technological Innovation Services Survey of 2010-2011. Price changes for the service sector could not be obtained at the firm level. For this reason, different components of the Colombian consumer price index were used as a proxy. Detailed information related to the variables and their definitions is presented in table A1 in the Appendix.

Descriptive statistics are presented in table A2. Our database shows that only 4% of all manufacturing firms innovated with respect to both processes and products. By contrast, 10% of service firms engaged in both forms of innovation. It is highly relevant that manufacturing firms engage in more process innovation activities to the exclusion of product innovation. However, service firms innovate more frequently through the introduction of new or improved services. Productive structures also differ among industries. In the manufacturing sector, 51% of all companies employ between 11 and 50 employees, 34% employ between 51 and 200 employees, and 15% employ more than 200 employees. In the service sector, small-sized firms represent 35% of the sample, medium-sized firms represent 37% and large-sized firms represent 28%. In spite of this difference, it is striking to note that in both industries, almost 66% of all firms are non-innovators.

Employment growth in the manufacturing sector averaged 3% from 2007-2010, and skilled labor grew more rapidly than unskilled labor in this sector. The former grew by 12%, and the latter by 4%. Additionally, over the period analyzed, part-time employment followed a significantly positive growth rate, showing an average increase of 47%, while full-time employment had an average increase of only 12%. Furthermore, female employment rose by 10% on average, almost doubling the increase in male employment. In the service industry sample, average employment growth was recorded at 6%, and skilled employment increased to 14% while unskilled labor increased by only 2%.

[1] This information is based on the Colombian great integrated household survey (DANE, 2014)

As depicted in table A2 (See Appendix), g_1 is more significant in the manufacturing than in the service industry. In the former, g_2 only reached 4%, while g_1 reached 9.6%. In the service industry, g_2 was recorded at 6%, and g_1 was recorded at 2.7%. In addition, R & D and innovation intensity levels were considerably higher in the service industry than in the manufacturing industry. Nevertheless, it is important to clarify that the periods of analysis differ.

4 Results

Regarding the empirical strategy, pooled OLS (POLS) estimates were first conducted: the same firms were considered for the two waves of the innovation survey. Here, our objective was to generate benchmark estimates and to determine whether the results vary considerably when other methodologies are used. When the theoretical model with the dependent variable $l_i - (g_{1i} - \pi_i)$ is estimated, g_2 has a positive effect on employment growth. This means that new products are produced more efficiently than existing products and that the compensation effect dominates the displacement effect. These results are shown in table 1, regressions 1 to 4 in which the variable process innovation is not significant, and g_2 has a positive and significant effect. Innovation in commercialization is shown to be positive and significant in estimate 4. The fixed assets growth variable has a negative and significant effect on employment growth, this means that increasing fixed capital leads to a displacement of labor.

As described above in the methodology section, the model presents some endogeneity problems. Hence, it is necessary to conduct estimates using instruments for the variable g_2. As shown in table 1 (regressions 5 to 8), the instruments used were clients, innovation intensity interacting with increased market share, increased ranges and obstacles to innovation. Sargan-Hansen overidentication tests were performed, and the obtained results validate the instruments. The results are similar to those obtained via POLS estimates.

It should be highlighted that when estimating using instrumental variables, process innovation levels were found to be negative and significant in some cases, meaning a displacement effect of process innovation on employment growth. These results are in accordance to the literature, where compensation effects as a result of reduction in output prices lead to an increase in demand and a possibility to rise employment; that is, depending on the demand elasticity firms may demand new employment (Smolny, 1998; Peters, 2005; Lundvall, 2007; Vivarelli, 2011; Harrison et al., 2014). In addition, labor costs have a negative and significant effect on employment, a common result in labor theoretical models such as the one in Van Reenen (1997).

It is also important to elucidate the relation between the innovation variables and the different types of labor. Tables 2 and 3 present the results for skilled and unskilled employment. When estimating via POLS, the effect of g_2 does not vary, perhaps due to a possible downward bias in the coefficients. When instruments are used to correct the endogeneity, the positive effect of g_2 on employment growth is higher for employees with stronger qualifications. In table 3, process innovation has a negative but non-significant effect, and the labor cost growth estimated for each type of labor has a negative and significant impact on skilled employment growth, and negative but not significant on unskilled employment. The commercialization changes and fixed asset growth variables have positive and negative effects, respectively.

Table 1: Manufacturing Firms. OLS and IV Estimates.
Dependent Variable: $l_i - (g_{li} - \pi_i)$

	OLS				IV			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Constant	0.320	0.328	0.772*	0.743*	0.389	0.387	0.387	0.380
	(0.575)	(0.574)	(0.454)	(0.427)	(0.454)	(0.455)	(0.454)	(0.454)
Process Innovation Only	0.028	0.020	0.001	-0.008	-0.041*	-0.039*	-0.037	-0.040*
	(0.060)	(0.051)	(0.039)	(0.038)	(0.023)	(0.023)	(0.023)	(0.023)
Sales growth dt new products	0.307***	0.308***	0.294***	0.293***	0.295***	0.302***	0.306***	0.300***
	(0.094)	(0.095)	(0.089)	(0.088)	(0.101)	(0.100)	(0.100)	(0.100)
Located in the capital		-0.070	0.016	0.013		0.021	0.025	0.022
		(0.088)	(0.038)	(0.037)		(0.022)	(0.022)	(0.022)
Foreign Owned		0.051	-0.137**	-0.101**		0.006	-0.018	0.005
		(0.050)	(0.054)	(0.046)		(0.033)	(0.035)	(0.033)
Medium size			-0.006				0.002	
			(0.032)				(0.024)	
Large size			0.117*				0.060**	
			(0.063)				(0.029)	
Commercialization Change				0.077*				0.019
				(0.042)				(0.024)
Labor cost Growth			-0.049	-0.051			-0.122***	-0.122***
			(0.089)	(0.089)			(0.032)	(0.032)
Fixed Assets Growth			-0.768***	-0.768***			0.009	0.010
			(0.125)	(0.125)			(0.007)	(0.007)
Number of firms	8266	8266	8240	8240	3812	3812	3802	3802
Sargan test					0.473	0.835	0.446	0.643
P-value					0.925	0.841	0.931	0.886
Durbin-Wu-Hausman test					0.778	0.915	0.962	0.878
P-value					0.378	0.339	0.327	0.349

Robust standard errors are reported in parentheses. All regressions include industry dummies.

*Significance at the *** 1%, **5% and * 10% level.*

Instruments used are client, increase market share interacted with innovation intensity, increased range and obstacles to innovate.

Source: Authors' estimates.

The instrumental variable estimates suggest a larger impact from innovation on employment growth in the case of skilled workers. This was also found in the case of full-time employees, as shown in table A3 in the appendix. Regarding female and male employment, table A4 also shows some differences, suggesting a larger impact from g_2 on male employment growth. This suggests that innovation has a stronger effect on male employment despite the fact that average female employment growth was higher for the period analyzed.

Table 2: Manufacturing Firms. OLS estimates by Type of Labor (Skilled and Unskilled).
Dependent Variable: $l_i - (g_{li} - \pi_i)$

	Skilled Employment				Unskilled Employment			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Constant	-0.146	-0.098	1.136	1.290	0.170	0.186	1.472*	1.552*
	(0.168)	(0.187)	(1.060)	(1.070)	(0.168)	(0.167)	(0.873)	(0.879)
Process Innovation Only	0.016	0.005	-0.035	-0.043	0.041	0.033	0.017	0.003
	(0.063)	(0.055)	(0.041)	(0.035)	(0.063)	(0.054)	(0.043)	(0.042)
Sales growth dt new products	0.343***	0.343***	0.328***	0.326***	0.348***	0.349***	0.334***	0.332***
	(0.076)	(0.076)	(0.070)	(0.069)	(0.103)	(0.104)	(0.097)	(0.097)
Located in the capital		-0.105	0.008	0.005		-0.073	0.009	0.007
		(0.091)	(0.044)	(0.044)		(0.090)	(0.039)	(0.038)
Foreign Owned		0.025	-0.185***	-0.129**		0.054	-0.128**	-0.101*
		(0.056)	(0.064)	(0.052)		(0.056)	(0.060)	(0.052)
Medium size			0.012				-0.018	
			(0.040)				(0.034)	
Large size			0.175**				0.083	
			(0.083)				(0.063)	
Commercialization Change				0.097**				0.079*
				(0.045)				(0.044)
Labor cost Growth			-0.138***	-0.140***			-0.000	0.000
			(0.050)	(0.052)			(0.084)	(0.084)
Fixed Assets Growth			-0.781***	-0.781***			-0.769***	-0.769***
			(0.117)	(0.117)			(0.125)	(0.125)
Number of firms	8213	8213	8127	8127	8101	8101	8047	8047

Robust standard errors are reported in parentheses. All regressions include industry dummies.

*Significance at the *** 1%, **5% and * 10% level.*

Source: Authors' estimates.

Table 3: Manufacturing Firms. IV Estimates by Type of Labor (Skilled and Unskilled).
Dependent Variable: $l_i - (g_{li} - \pi_i)$

	Skilled Employment				Unskilled Employment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	0.411	0.411	-0.177	0.392	0.212	0.212	0.175	0.204
	(0.905)	(0.906)	(0.644)	(0.906)	(0.402)	(0.403)	(0.405)	(0.404)
Process Innovation Only	-0.062	-0.062	-0.058	-0.059	-0.015	-0.014	-0.013	-0.017
	(0.045)	(0.046)	(0.046)	(0.046)	(0.029)	(0.029)	(0.029)	(0.029)
Sales growth dt new products	0.441**	0.450**	0.457**	0.454**	0.418***	0.423***	0.418***	0.413***
	(0.194)	(0.194)	(0.194)	(0.194)	(0.126)	(0.126)	(0.126)	(0.126)
Located in the capital		-0.012	-0.005	-0.009		0.002	-0.001	-0.001
		(0.044)	(0.044)	(0.044)		(0.028)	(0.028)	(0.028)
Foreign Owned		-0.036	-0.064	-0.037		-0.003	-0.015	0.001
		(0.066)	(0.069)	(0.066)		(0.043)	(0.045)	(0.043)
Medium size			0.039				-0.035	
			(0.048)				(0.030)	
Large size			0.077				0.034	
			(0.059)				(0.037)	
Commercialization Change				0.010				0.032
				(0.047)				(0.030)
Labor cost Growth			-0.102***	-0.103***			0.025	0.026
			(0.029)	(0.029)			(0.029)	(0.029)
Fixed Assets Growth			0.027	0.027			0.003	0.003
			(0.017)	(0.017)			(0.009)	(0.009)
Number of firms	3795	3795	3776	3776	3747	3747	3728	3728
Sargan test	4.237	5.010	3.993	4.433	1.912	2.289	2.097	1.892
P-value	0.237	0.171	0.262	0.218	0.591	0.515	0.552	0.595
Durbin-Wu-Hausman test	0.783	0.886	0.974	0.947	1.931	2.064	1.921	1.845
P-value	0.376	0.347	0.324	0.331	0.165	0.151	0.166	0.174

Robust standard errors are reported in parentheses.

All regressions include industry dummies.

*Significance at the *** 1%, **5% and * 10% level.*

Instruments used are client, increase market share interacted with innovation intensity, increased range and obstacles to innovate.

Source: Authors' estimates

Table 4 presents the results obtained when the manufacturing sector sample is divided into high and low-tech firms. This classification is obtained by calculating the innovation intensity level of each company and then estimating the median value. Firms exceeding the median level are high-tech firms, and those falling below or meeting the median are low-tech firms. These estimates generated some interesting results: in the high-tech group, organizational and commercialization changes always have a positive and significant effect on employment, and the opposite is true of low-tech firms. In addition, labor cost growth has a significant and negative effect in low-tech firms, and in both cases, large firms generate more employment than their counterparts with fewer employees. Our instrumental variable estimates also suggest a higher impact from g_2 on employment growth.

Another strand of the literature documented that service industry firms innovate less than manufacturing firms, mainly because they are adopters and users of technology. Nevertheless, other approaches suggest that service companies innovate in a different way - focusing on organizational changes and soft capabilities - and that sources of innovation come from relations with suppliers and customers and from external technologies (Tether, 2005). Evangelista and Savona (2003) carried out estimates related to innovation in services. Their findings suggest different impacts depending on the services sector, and at the micro level, depending on the type of strategy implemented by firms.

When the theoretical model is estimated via OLS for service firms, g_2 has a positive and significant effect that is greater than that of manufacturing firms. Labor cost and fixed asset growth rates were not listed in the data provided for the service estimates, which is why they are not included as

control variables. Table 5 also shows instrumental variable estimates wherein the effect of g_2 is slightly larger. The following instruments were used: increased range, increased market share and patents. Table 7 compares the effects between skilled and unskilled workers using instrumental variable estimates. Regarding the last estimates, process innovation has a negative but insignificant effect, and organizational changes affect unskilled employment growth.

Table 4 (part 1): Manufacturing Firms. OLS and IV Estimates by Type of Sector (low-Tech). Dependent Variable: $l_i - (g_{1i} - \pi_i)$

	LOW TECH									
	OLS					IV				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Constant	-0.174	-0.187	-0.178	-0.185	-0.226	-0.000	-0.148	-0.137	-0.151	-0.285
	(0.183)	(0.185)	(0.191)	(0.188)	(0.193)	(0.411)	(0.529)	(0.532)	(0.529)	(0.548)
Process Innovation Only	-0.035	-0.032	-0.024	-0.029	-0.041	0.102	0.236	0.239	0.239	0.248
	(0.033)	(0.034)	(0.029)	(0.031)	(0.034)	(0.143)	(0.199)	(0.197)	(0.199)	(0.207)
Sales growth dt new products	0.623***	0.623***	0.624***	0.623***	0.622***	2.830	4.641*	4.655*	4.645*	4.767*
	(0.065)	(0.065)	(0.065)	(0.065)	(0.063)	(1.912)	(2.670)	(2.656)	(2.673)	(2.752)
Located in the capital		0.026	0.025	0.026	0.031		0.065	0.063	0.066	0.066
		(0.026)	(0.027)	(0.026)	(0.026)		(0.057)	(0.057)	(0.057)	(0.058)
Foreign Owned		0.014	0.015	0.014	-0.034		0.031	0.034	0.031	0.001
		(0.034)	(0.034)	(0.034)	(0.041)		(0.080)	(0.080)	(0.080)	(0.085)
Medium size					0.043					-0.027
					(0.029)					(0.061)
Large size					0.138***					0.092
					(0.053)					(0.073)
Organizational change			-0.023					-0.027		
			(0.033)					(0.051)		
Commercialization Change				-0.012					-0.035	
				(0.040)					(0.054)	
Labor cost Growth					-0.225*					-0.316***
					(0.117)					(0.109)
Fixed Assets Growth					-0.014					0.023
					(0.024)					(0.016)
Number of firms	4217	4217	4217	4217	4203	1789	1789	1789	1789	1785
Sargan test						1.173	0.493	0.460	0.543	0.392
P-value						0.760	0.920	0.928	0.909	0.942
Durbin-Wu-Hausman test						1.776	4.873	4.994	4.882	5.054
P-value						0.183	0.027	0.025	0.027	0.025

Robust standard errors are reported in parentheses. All regressions include industry dummies.

*Significance at the *** 1%, **5% and * 10% level.*

Instruments used are client, innovation intensity interacted with increased market share, increased range and obstacles to innovation.

Source: Authors' estimates.

Table 4 (part 2): Manufacturing Firms. OLS and IV Estimates by Type of Sector (High-Tech).
Dependent Variable: $l_i - (g_{li} - \pi_i)$

	HIGH TECH									
	OLS					IV				
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Constant	0.251	0.272	0.209	0.249	-0.284	-0.503	-0.511	0.307	-0.507	-0.557
	(0.583)	(0.580)	(0.585)	(0.549)	(0.234)	(0.598)	(0.600)	(0.424)	(0.599)	(0.600)
Process Innovation Only	0.097	0.076	0.046	0.054	-0.042	-0.006	-0.005	-0.012	-0.011	-0.004
	(0.110)	(0.089)	(0.075)	(0.081)	(0.039)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)
Sales growth dt new products	0.231***	0.233***	0.232***	0.232***	0.218***	0.260***	0.257***	0.251***	0.254***	0.259***
	(0.084)	(0.086)	(0.085)	(0.086)	(0.075)	(0.090)	(0.090)	(0.090)	(0.090)	(0.090)
Located in the capital		-0.168	-0.167	-0.167	0.052		0.021	0.021	0.020	0.025
		(0.177)	(0.177)	(0.177)	(0.037)		(0.028)	(0.028)	(0.028)	(0.028)
Foreign Owned		0.082	0.080	0.079	-0.190*		-0.014	-0.014	-0.016	-0.047
		(0.090)	(0.089)	(0.089)	(0.104)		(0.041)	(0.041)	(0.041)	(0.043)
Medium size					0.023					-0.005
					(0.036)					(0.031)
Large size					0.223**					0.075**
					(0.111)					(0.038)
Organizational change			0.094*					0.054*		
			(0.051)					(0.028)		
Commercialization Change				0.091**					0.061**	
				(0.043)					(0.030)	
Labor cost Growth					-0.041					-0.084**
					(0.106)					(0.035)
Fixed Assets Growth					-0.864***					-0.004
					(0.041)					(0.010)
Number of firms	4049	4049	4049	4049	4037	2023	2023	2023	2023	2017
Sargan test						1.855	1.314	1.283	1.211	1.644
P-value						0.603	0.726	0.733	0.750	0.649
Durbin-Wu-Hausman test						1.506	1.447	1.270	1.331	1.461
P-value						0.220	0.229	0.260	0.249	0.227

*Robust standard errors are reported in parentheses. All regressions include industry dummies. Significance at the *** 1%, **5% and * 10% level.*

Instruments used are client, innovation intensity interacted with increased market share, increased range and obstacles to innovation.

Source: Authors' estimates.

Table 5: Service Firms. OLS and IV estimates.
Dependent Variable: $l_i - (g_{1i} - \pi_i)$

	OLS						IV					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Constant	0.250***	0.251***	0.227***	0.213***	0.250***	0.190***	0.230	0.231	0.212	0.214	0.225	0.187
	(0.023)	(0.023)	(0.037)	(0.032)	(0.024)	(0.048)	(0.374)	(0.374)	(0.375)	(0.374)	(0.375)	(0.375)
Process Innovation Only	-0.035	-0.032	-0.034	-0.041	-0.032	-0.041	-0.030	-0.028	-0.030	-0.041	-0.026	-0.040
	(0.040)	(0.040)	(0.039)	(0.039)	(0.040)	(0.039)	(0.044)	(0.044)	(0.044)	(0.045)	(0.045)	(0.046)
Sales growth dt new products	0.993***	0.990***	0.985***	0.970***	0.991***	0.971***	1.065***	1.064***	1.050***	0.968***	1.086***	0.989***
	(0.084)	(0.085)	(0.085)	(0.088)	(0.089)	(0.089)	(0.138)	(0.138)	(0.140)	(0.157)	(0.152)	(0.167)
Located in the capital		-0.020	-0.021	-0.019	-0.020	-0.020		-0.018	-0.020	-0.019	-0.018	-0.020
		(0.020)	(0.020)	(0.020)	(0.020)	(0.020)		(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Medium size			0.001			-0.002			0.000			-0.002
			(0.024)			(0.025)			(0.024)			(0.024)
Large size			0.025			0.020			0.022			0.019
			(0.028)			(0.028)			(0.029)			(0.029)
Organizational change				0.043		0.046				0.043		0.044
				(0.027)		(0.030)				(0.032)		(0.032)
Commercialization Change					-0.003	-0.019					-0.013	-0.020
					(0.032)	(0.035)					(0.036)	(0.037)
Number of firms	1371	1371	1371	1371	1371	1371	1371	1371	1371	1371	1371	1371
Sargan test							1.521	1.552	1.775	1.315	1.622	1.585
P-value							0.468	0.460	0.412	0.518	0.445	0.453
Durbin-Wu-Hausman test							0.342	0.362	0.271	0.000	0.476	0.013
P-value							0.342	0.547	0.602	0.991	0.490	0.909

Robust standard errors are reported in parentheses. All regressions include service industry dummies.

*Significance at the *** 1%, **5% and * 10% level. Instruments are Increased range, increase market share and patents.*

Source: Authors' estimates.

Table 6: Service firms. OLS estimates by Type of Labor (Skilled and Unskilled).
Dependent Variable: $l_i - (g_{li} - \pi_i)$

	Skilled Employment						Unskilled Employment					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.046***	0.073**	0.136**	0.255***	0.073**	0.302***	0.079***	0.124***	0.039	0.124***	0.124***	0.045
	(0.000)	(0.033)	(0.059)	(0.045)	(0.033)	(0.058)	(0.000)	(0.035)	(0.055)	(0.035)	(0.035)	(0.054)
Process Innovation Only	-0.039	-0.036	-0.035	-0.044	-0.034	-0.042	-0.049	-0.043	-0.047	-0.060	-0.041	-0.060
	(0.058)	(0.058)	(0.059)	(0.060)	(0.058)	(0.060)	(0.069)	(0.069)	(0.068)	(0.068)	(0.070)	(0.068)
Sales growth dt new products	0.855***	0.851***	0.862***	0.833***	0.856***	0.848***	1.073***	1.064***	1.043***	1.021***	1.069***	1.016***
	(0.061)	(0.062)	(0.062)	(0.065)	(0.063)	(0.065)	(0.144)	(0.145)	(0.143)	(0.155)	(0.149)	(0.154)
Located in the capital		-0.027	-0.027	-0.027	-0.027	-0.026		-0.046	-0.052	-0.045	-0.045	-0.049
		(0.033)	(0.034)	(0.033)	(0.033)	(0.033)		(0.035)	(0.035)	(0.035)	(0.035)	(0.035)
Medium size			-0.054			-0.057			0.002			-0.003
			(0.042)			(0.044)			(0.034)			(0.035)
Large size			-0.062			-0.068			0.091**			0.083**
			(0.040)			(0.042)			(0.040)			(0.039)
Organizational change				0.038		0.055				0.086		0.093
				(0.047)		(0.054)				(0.060)		(0.065)
Commercialization Change					-0.015	-0.032					-0.015	-0.049
					(0.039)	(0.046)					(0.043)	(0.050)
Number of firms	1355	1355	1355	1355	1355	1355	1216	1216	1216	1216	1216	1216

Robust standard errors are reported in parentheses. All regressions include service industry dummies.

*Significance at the *** 1%, **5% and * 10% level.*

Source: Authors' estimates.

Table 7: Service firms. IV estimates by Type of Labor (Skilled and Unskilled).
Dependent Variable: $l_i - (g_{1i} - \pi_i)$

	Skilled Employment						Unskilled Employment					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.275	0.276	0.329	0.259	0.265	0.295	0.166	0.165	0.085	0.125	0.161	0.033
	(0.604)	(0.604)	(0.605)	(0.604)	(0.605)	(0.606)	(0.567)	(0.567)	(0.567)	(0.568)	(0.567)	(0.569)
Process Innovation Only	-0.036	-0.033	-0.030	-0.045	-0.029	-0.038	-0.055	-0.047	-0.054	-0.083	-0.045	-0.084
	(0.072)	(0.072)	(0.072)	(0.073)	(0.072)	(0.074)	(0.070)	(0.070)	(0.071)	(0.072)	(0.071)	(0.073)
Sales growth dt new products	0.901***	0.899***	0.943***	0.809***	0.939***	0.891***	0.984***	0.987***	0.925***	0.712***	1.005***	0.706**
	(0.222)	(0.223)	(0.226)	(0.253)	(0.246)	(0.270)	(0.235)	(0.235)	(0.241)	(0.269)	(0.257)	(0.286)
Located in the capital		-0.026	-0.026	-0.027	-0.025	-0.025		-0.047	-0.054	-0.051	-0.047	-0.056*
		(0.034)	(0.034)	(0.034)	(0.034)	(0.035)		(0.034)	(0.034)	(0.034)	(0.034)	(0.034)
Medium size			-0.055			-0.058			0.005			0.001
			(0.039)			(0.039)			(0.039)			(0.039)
Large size			-0.065			-0.069			0.097**			0.094**
			(0.047)			(0.047)			(0.047)			(0.048)
Organizational change				0.040		0.052				0.115**		0.115**
				(0.051)		(0.052)				(0.052)		(0.052)
Commercialization Change					-0.023	-0.035					-0.009	-0.030
					(0.058)	(0.059)					(0.058)	(0.059)
Number of firms	1355	1355	1355	1355	1355	1355	1216	1216	1216	1216	1216	1216
Sargan test	1.434	1.471	1.229	1.379	1.489	1.124	3.208	3.234	4.666	2.750	3.264	4.126
P-value	0.488	0.479	0.541	0.502	0.475	0.570	0.201	0.199	0.097	0.253	0.196	0.127
Durbin-Wu-Hausman test	0.053	0.059	0.160	0.011	0.141	0.030	0.180	0.133	0.301	1.596	0.077	1.397
P-value	0.820	0.807	0.689	0.918	0.707	0.863	0.671	0.715	0.583	0.207	0.782	0.237

Robust standard errors are reported in parentheses.
All regressions include service industry dummies.
*Significance at the *** 1%, **5% and *10% level.*
Instruments are Increased range, increase market share and patents.
Source: Authors' estimates.

5 Robustness Checks

Table 8 presents additional instrumental variable estimates based on other instruments that differ from those noted above. For results listed on the left side of table 8, estimates were conducted using only innovation intensity as an instrument. For results listed on the right side of table 8, three instruments were used: clients, increased market share interacting with innovation intensity, and increased range. The results were found to be robust when different instruments were used. In all cases, $g2$ is always positive and statistically significant. The only difference is that when innovation intensity is the instrument, the effect of $g2$ is slightly larger: it increases to 0.34, while in the other cases, it reaches 0.30.

Additional estimates were conducted by dividing the different samples by firm size. These results can be observed in table 9, in which $g2$ has a stronger effect in large-sized firms and a lower impact in medium- and small-sized firms; interestingly, the effect of product innovation is higher for small-sized firms than medium-sized firms, as some previous studies have found. In addition to this effect, commercialization changes have a positive effect on employment growth in small firms.

6 Concluding Remarks

The economic literature deems innovation to be a fundamental cause of economic growth. Following the same line of argumentation, several studies elucidate the relationship between GDP growth and R & D investment, suggesting a positive and significant impact on the former. Most innovations are undertaken by firms in developed countries. Firms engage in innovation for profit-making purposes: they create new products and in turn acquire a larger market share. Various empirical studies have attempted to identify the effects of innovation on employment. The direction and magnitude of these effects are related to innovation types and to the ways in which innovations are measured.

The majority of Colombian firms are still non-innovators. When the two waves of the innovation surveys are compared, it is evident that the share of innovative firms has even decreased in this country. This may be attributable to the fact that the Colombian economy lacks sophisticated sectors, high value-added activities, and firms that perform in these areas. Companies must invest more in scientific and technological initiatives, and those that are investing should not just increase their share, but should instead use these resources more efficiently, re-evaluate and change processes, promote commercialization, and execute organizational change.

Table 8: Manufacturing firms. IV estimates with different instruments. Dependent Variable: $l_i - (g_{1i} - \pi_i)$

	IV(A)				IV(B)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	0.398	0.397	0.401	0.396	0.389	0.388	0.387	0.380
	(0.522)	(0.522)	(0.522)	(0.522)	(0.454)	(0.454)	(0.454)	(0.454)
Process Innovation Only	-0.050**	-0.049*	-0.048*	-0.049*	-0.041*	-0.039*	-0.038*	-0.041*
	(0.025)	(0.025)	(0.025)	(0.025)	(0.023)	(0.023)	(0.023)	(0.023)
Sales growth dt new products	0.343***	0.342***	0.344***	0.341***	0.297***	0.295***	0.300***	0.293***
	(0.121)	(0.121)	(0.121)	(0.121)	(0.101)	(0.101)	(0.101)	(0.101)
Located in the capital		0.014	0.019	0.017		0.021	0.025	0.022
		(0.024)	(0.024)	(0.024)		(0.022)	(0.022)	(0.022)
Foreign Owned		0.002	-0.030	0.001		0.006	-0.018	0.004
		(0.036)	(0.038)	(0.036)		(0.033)	(0.035)	(0.033)
Medium size			0.001				0.002	
			(0.026)				(0.024)	
Large size			0.081**				0.060**	
			(0.032)				(0.029)	
Commercialization Change				0.010				0.019
				(0.027)				(0.024)
Labor cost Growth			-0.143***	-0.144***			-0.122***	-0.122***
			(0.036)	(0.036)			(0.032)	(0.032)
Fixed Assets Growth			0.006	0.006			0.009	0.010
			(0.007)	(0.007)			(0.007)	(0.007)
Number of firms	4256	4256	4242	4242	3812	3812	3802	3802
Sargan test					0.448	0.370	0.162	0.210
P-value					0.799	0.831	0.922	0.901
Durbin-Wu-Hausman test	1.115	1.090	1.140	1.104	0.799	0.763	0.835	0.737
P-value	0.291	0.296	0.286	0.293	0.371	0.382	0.361	0.391

Robust standard errors are reported in parentheses. All regressions include industry dummies.

*Significance at the *** 1%, **5% and * 10% level.*

A: Instrument used is innovation intensity.

B: Instruments used are client, increase market share interacted with innovation intensity and increased. Range.

Source: Authors' estimates.

The proportion of new innovations intended for international markets is extremely low in Colombia. In this setting, exporting firms do not necessarily generate more jobs through the effects of innovation, and this may perpetuate a Colombian export structure that is based on primary activities and low value-added products.

Our empirical analysis shows that sales growth due to new products positively affects employment growth, and these effects remain regardless of firm size, labor type, innovation intensity, and economic sector. The study results are robust to different specifications and to the inclusion of different control variables. However, in most cases, process innovation effects are negative, while displacement effects are not significant. These results may vary depending on features inherent to the firms under analysis, e.g., innovation intensity, firm size, sector, and employment type. For instance, the effect of product innovation on employment is larger for large and small-sized firms than medium-sized firms. In the case of Colombia, the effect of product innovation on employment growth is higher for unskilled labor, full time employment and low-tech firms. Though, In the latter two cases, the effect is only significant in the OLS estimates. Finally, male employment growth is higher than female employment growth in the presence of product innovations within a firm, implying a bias of innovation towards male employment in the Colombian case, however additional research would be needed to disentangle the mechanisms of this gender bias.

Table 9: Manufacturing Firms. OLS Estimates by Firm Size.
Dependent Variable: $l_i - (g_{1i} - \pi_i)$

	Small					Medium					Large				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Constant	0.263	0.273	0.239	0.235	0.760*	-0.453	-0.438	-0.441	-0.421	-0.474	-0.170***	-0.170***	-0.164***	-0.170***	-0.159***
	(0.586)	(0.583)	(0.590)	(0.540)	(0.440)	(0.575)	(0.580)	(0.581)	(0.585)	(0.578)	(0.004)	(0.004)	(0.015)	(0.004)	(0.017)
Process Innovation Only	0.086	0.076	0.060	0.046	0.023	-0.043	-0.046	-0.048	-0.034	-0.042	-0.037	-0.040	-0.036	-0.042	-0.037
	(0.122)	(0.109)	(0.096)	(0.098)	(0.075)	(0.034)	(0.035)	(0.031)	(0.031)	(0.035)	(0.033)	(0.034)	(0.031)	(0.031)	(0.033)
Sales growth dt new products	0.374***	0.377***	0.377***	0.377***	0.331***	0.235**	0.235**	0.235**	0.236**	0.238**	0.499***	0.496***	0.498***	0.495***	0.489***
	(0.138)	(0.140)	(0.140)	(0.140)	(0.108)	(0.115)	(0.115)	(0.115)	(0.116)	(0.116)	(0.143)	(0.142)	(0.141)	(0.141)	(0.144)
Located in the capital		-0.109	-0.109	-0.113	0.021		-0.013	-0.012	-0.013	-0.005		-0.038	-0.038	-0.037	-0.033
		(0.160)	(0.160)	(0.161)	(0.061)		(0.029)	(0.030)	(0.029)	(0.029)		(0.033)	(0.033)	(0.033)	(0.032)
Foreign Owned		0.074	0.072	0.070	0.078		-0.031	-0.030	-0.032	-0.023		-0.022	-0.022	-0.022	-0.026
		(0.139)	(0.138)	(0.138)	(0.167)		(0.032)	(0.032)	(0.032)	(0.033)		(0.023)	(0.023)	(0.023)	(0.024)
Organizational change			0.049					0.009					-0.010		
			(0.058)					(0.037)					(0.025)		
Commercialization Change				0.133**					-0.051					0.008	
				(0.067)					(0.047)					(0.027)	
Labor cost Growth					0.082					-0.493***					-0.064
					(0.185)					(0.151)					(0.063)
Fixed Assets Growth					-0.799***					0.026					-0.013**
					(0.106)					(0.031)					(0.006)
Number of firms	4202	4202	4202	4202	4183	2818	2818	2818	2818	2816	1246	1246	1246	1246	1241

Robust standard errors are reported in parentheses. All regressions include industry dummies.

*Significance at the *** 1%, **5% and * 10% level.*

Source: Authors' estimates.

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Table A1: Variable Definitions

Variable	Definition
Employment Growth	Annual growth rate of the firm's number of employees
Sales Growth	Annual growth rate of the firm's sales
Sales Growth dt new products	Ratio of total new sales to past sales old
Sales Growth dt old products	Ratio of current sales old minus past sales old to past sales old
Price Growth	Annual price growth is available for each firm.
Labor Cost Growth	Annual growth rate of the firm's labor costs (measured as total remuneration plus social benefits and fiscal contributions per employee)
Non-innovator	Dummy which takes the value of 1 if the firm did not introduce any process or product innovation during the period
Process Innovation	Dummy which takes the value of 1 if the firm Introduced new or significantly improved methods of service delivery, production, distribution, or logistics.
Product Innovation	Dummy which takes the value of 1 if the firm Introduced at least one new product.
Process Innovation Only	Dummy which takes the value of 1 if Product innovation=0 and Process innovation=1
Process and Product Innovation	Dummy which takes the value of 1 if Product innovation=1 and Process innovation=1
Organizational Change	Dummy which takes the value of 1 if the firm Introduced new organizational methods
Commercialization Change	Dummy which takes the value of 1 if the firm Introduced new marketing techniques
Client	Dummy which takes the value of 1 if Clients has been a source of innovation
Increase market share	Dummy which takes the value of 1 if innovation has allowed to maintain or increase market share
Increased range	Dummy which takes the value of 1 if innovation has allowed increasing quality or range of goods and services
Obstacles to innovate	3 different type of obstacles to innovation averaged across firms located in the same metropolitan area
R&D intensity	Ratio of total R&D expenditure to sales
Innovation intensity	Ratio of total innovation expenditure to sales
Patents	Dummy which takes the value of 1 if the firm applied for a patent during the years of analysis
Located in the Capital	Dummy which takes the value of 1 if the firm is located in Bogotá, the capital of Colombia
Foreign Owned	Dummy which takes the value of 1 if the firm has 10% or more foreign capital participation
Fixed Assets Growth	Annual growth rate of the firm's fixed assets

Source: Colombian National Administrative Department of Statistics -DANE

Table A2: Descriptive Statistics

	Manufacturing Firms 2007-2010		Service Firms 2010-2011	
Small	50.8%		35.3%	
Medium	34.1%		36.7%	
large	15.1%		28.0%	
Non-innovators	65.5%		65.6%	
Process only	23.2%		5.7%	
Product innovators	11.3%		28.7%	
Process and Product Innovators	3.7%		10.7%	
Located in the Capital	42.5%		51.35%	
Foreign Owned	9.3%		-	
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**
Employment Growth	3.0%	0.3751	6.0%	0.258
Sales Growth	14.0%	3.8723	8.6%	0.363
Sales Growth dt new products	4.3%	0.3103	5.9%	0.170
Sales Growth dt old products	9.6%	3.8670	2.7%	0.383
Unskilled Labor Growth	3.8%	0.5117	2.3%	0.505
Skilled Labor Growth	11.7%	1.1219	14.3%	0.530
Full-employment Growth	12.2%	1.8710	-	-
Part-time employment Growth	46.7%	5.9708	-	-
Female employment Growth	9.6%	0.7500	-	-
Male employment Growth	5.6%	0.5324	-	-
Total Labour Cost Growth	8.1%	0.2783		
R&D intensity	0.3%	0.0219	8.5%	1.117
Innovation intensity	6.2%	0.1717	15.5%	1.369
Prices Growth	2.0%	0.4319	3.5%	0.026

Source: Authors' estimates.

Table A3, (part 1): Manufacturing firms. Full-time **Employment.**
Dependent Variable: $l_i - (g_{1i} - \pi_i)$

	Full-time Employment						Part-time Employment					
	OLS											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Constant	-0.225	-0.217	-0.192	0.044	0.144	0.136	0.420	0.428	0.484	0.495	-0.071	0.315
	(0.588)	(0.588)	(0.587)	(0.218)	(0.233)	(0.231)	(0.603)	(0.605)	(0.608)	(0.610)	(0.353)	(0.224)
Process Innovation Only	0.057	0.049	0.023	0.020	0.030	0.037	0.079	0.070	0.014	0.004	0.001	0.019
	(0.072)	(0.065)	(0.059)	(0.056)	(0.056)	(0.053)	(0.151)	(0.158)	(0.168)	(0.175)	(0.176)	(0.140)
Sales growth dt new products	0.323***	0.324***	0.323***	0.331***	0.326***	0.325***	0.259*	0.255	0.253*	0.239	0.238	0.237
	(0.067)	(0.067)	(0.066)	(0.070)	(0.065)	(0.065)	(0.155)	(0.155)	(0.151)	(0.154)	(0.154)	(0.152)
Located in the capital		-0.076	-0.071	-0.091	-0.003	-0.007		-0.118	-0.128	-0.103	-0.103	-0.099
		(0.100)	(0.097)	(0.099)	(0.050)	(0.050)		(0.123)	(0.124)	(0.128)	(0.128)	(0.128)
Foreign Owned		0.019	-0.052	-0.046	-0.165**	-0.118**		-0.163*	-0.212	-0.363**	-0.368**	-0.233**
		(0.059)	(0.063)	(0.059)	(0.074)	(0.051)		(0.089)	(0.131)	(0.183)	(0.185)	(0.093)
Exports dummy			-0.003						-0.423*			
			(0.081)						(0.232)			
Medium size			0.116	0.116	-0.022				0.315**	0.159	0.155	
			(0.084)	(0.096)	(0.046)				(0.126)	(0.105)	(0.104)	
Large size			0.198*	0.223*	0.153				0.717	0.444	0.445	
			(0.114)	(0.136)	(0.131)				(0.495)	(0.409)	(0.410)	
Commercialization Change						0.020						0.130
						(0.055)						(0.200)
Labor cost Growth				-0.317***	-0.110	-0.109				0.001	0.001	0.001
				(0.094)	(0.193)	(0.192)				(0.001)	(0.001)	(0.001)
Fixed Assets Growth					-0.769***	-0.769***					-0.020	-0.021
					(0.125)	(0.125)					(0.016)	(0.015)
Number of firms	7800	7800	7800	7469	7454	7454	6549	6549	6549	6254	6237	6237

Robust standard errors are reported in parentheses. All regressions include industry dummies.

*Significance at the *** 1%, **5% and * 10% level.*

Instruments used are client, innovation interacted with increased market share, increased range and obstacles to innovation

Source: Authors' estimates.

Table A3, (part 2): Manufacturing firms. Part-time **Employment.**
Dependent Variable: $l_i - (g_{1i} - \pi_i)$

	Full-time Employment						Part-time Employment					
	IV											
	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
Constant	-0.168	-0.174	-0.171	0.109	0.074	0.327	0.366	0.216	0.206	-0.075	-0.073	-0.302
	(0.948)	(0.948)	(0.948)	(0.558)	(0.559)	(0.354)	(2.840)	(2.866)	(2.869)	(2.857)	(2.861)	(2.345)
Process Innovation Only	-0.001	0.006	0.003	0.001	-0.000	0.003	0.132	0.283	0.293	0.570	0.570	0.560
	(0.049)	(0.049)	(0.049)	(0.041)	(0.041)	(0.041)	(0.447)	(0.480)	(0.476)	(0.487)	(0.486)	(0.494)
Sales growth dt new products	0.227	0.265	0.254	0.292*	0.291*	0.293*	0.039	1.696	1.918	3.951	3.957	3.944
	(0.211)	(0.210)	(0.210)	(0.173)	(0.173)	(0.173)	(4.753)	(5.100)	(5.052)	(5.071)	(5.057)	(5.155)
Located in the capital		0.058	0.057	0.067*	0.065*	0.065*		0.063	0.071	0.087	0.088	0.078
		(0.047)	(0.047)	(0.039)	(0.039)	(0.039)		(0.162)	(0.161)	(0.164)	(0.164)	(0.165)
Foreign Owned		-0.015	-0.005	-0.023	-0.020	-0.007		-0.189	-0.121	-0.158	-0.159	-0.094
		(0.070)	(0.075)	(0.061)	(0.061)	(0.058)		(0.224)	(0.233)	(0.227)	(0.228)	(0.227)
Exports dummy			-0.084						-0.464***			
			(0.052)						(0.167)			
Medium size			0.024	-0.008	-0.009				0.334*	0.265	0.265	
			(0.053)	(0.043)	(0.043)				(0.180)	(0.183)	(0.184)	
Large size			0.069	0.033	0.031				0.417*	0.270	0.272	
			(0.067)	(0.052)	(0.052)				(0.217)	(0.203)	(0.203)	
Commercialization change						-0.034						0.136
						(0.042)						(0.160)
Labor cost Growth				-0.217***	-0.226***	-0.227***				0.744***	0.744***	0.740***
				(0.033)	(0.034)	(0.034)				(0.037)	(0.037)	(0.037)
Fixed Assets Growth					0.023*	0.023*					-0.004	-0.003
					(0.013)	(0.013)					(0.061)	(0.061)
Number of firms	3643	3643	3643	3538	3531	3531	3299	3299	3299	3176	3171	3171
Sargan test	4.667	9.580	9.269	1.486	1.547	1.448	2.069	3.415	3.144	3.054	2.905	3.335
P-value	0.198	0.023	0.026	0.686	0.672	0.694	0.558	0.332	0.370	0.383	0.407	0.343
Durbin-Wu-Hausman test	0.087	0.011	0.028	0.001	0.000	0.001	0.299	0.388	0.398	0.398	0.374	0.314
P-value	0.768	0.916	0.866	0.981	0.987	0.970	0.585	0.533	0.528	0.528	0.541	0.575

Robust standard errors are reported in parentheses. All regressions include industry dummies.

*Significance at the *** 1%, **5% and * 10% level.*

Instruments used are client, innovation interacted with increased market share, increased range and obstacles to innovation

Source: Authors' estimates.

Table A4 (part 1): Manufacturing firms. Female and Male. OLS
Dependent Variable: $l_i - (g_{1i} - \pi_i)$

	Female Employment						Male Employment					
	OLS											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Constant	0.805	0.815	0.839	-0.005	1.381	1.494	0.028	0.055	-0.063	-0.065	1.326	1.413
	(0.940)	(0.940)	(0.939)	(0.189)	(0.982)	(0.989)	(0.103)	(0.112)	(0.128)	(0.118)	(0.941)	(0.947)
Process Innovation Only	0.026	0.017	-0.007	-0.004	-0.001	-0.018	0.043	0.034	0.011	0.014	0.016	0.009
	(0.062)	(0.054)	(0.043)	(0.044)	(0.044)	(0.042)	(0.061)	(0.052)	(0.041)	(0.042)	(0.040)	(0.039)
Sales growth dt new products	0.296***	0.297***	0.295***	0.295***	0.285***	0.283***	0.309***	0.309***	0.308***	0.307***	0.295***	0.294***
	(0.096)	(0.096)	(0.096)	(0.096)	(0.091)	(0.090)	(0.093)	(0.093)	(0.093)	(0.092)	(0.087)	(0.087)
Located in the capital		-0.087	-0.083	-0.081	-0.002	-0.004		-0.080	-0.076	-0.074	0.006	0.004
		(0.089)	(0.087)	(0.088)	(0.041)	(0.040)		(0.088)	(0.086)	(0.087)	(0.038)	(0.038)
Foreign Owned		0.034	-0.038	-0.031	-0.154**	-0.119**		0.040	-0.025	-0.019	-0.141***	-0.111**
		(0.055)	(0.035)	(0.040)	(0.060)	(0.052)		(0.051)	(0.026)	(0.031)	(0.054)	(0.047)
Exports dummy			0.022						0.018			
			(0.065)						(0.062)			
Medium size			0.099	0.102	-0.021				0.118*	0.119	-0.001	
			(0.073)	(0.083)	(0.036)				(0.071)	(0.082)	(0.034)	
Large size			0.167***	0.176**	0.116*				0.149***	0.155**	0.096	
			(0.064)	(0.077)	(0.069)				(0.051)	(0.070)	(0.060)	
Commercialization Change						0.107**						0.063
						(0.050)						(0.043)
Labor cost Growth				-0.154*	-0.012	-0.015				-0.175**	-0.033	-0.035
				(0.081)	(0.095)	(0.096)				(0.075)	(0.089)	(0.089)
Fixed Assets Growth					-0.766***	-0.766***					-0.768***	-0.768***
					(0.127)	(0.127)					(0.125)	(0.125)
Number of firms	8201	8201	8201	8199	8175	8175	8245	8245	8245	8243	8219	8219

Robust standard errors are reported in parentheses. All regressions include industry dummies.

*Significance at the *** 1%, **5% and * 10% level.*

Instruments used are client, innovation interacted with increased market share, increased range and obstacles to innovation

Source: Authors' estimates.

Table A4 (part 2): Manufacturing firms. Female and Male. IV
Dependent Variable: $l_i - (g_{li} - \pi_i)$

	Female Employment						Male Employment					
	IV											
	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
Constant	0.873	0.871	0.871	0.876	0.857	0.836	0.286	0.287	0.287	0.290	0.289	0.288
	(0.605)	(0.605)	(0.605)	(0.604)	(0.604)	(0.604)	(0.556)	(0.556)	(0.556)	(0.556)	(0.556)	(0.556)
Process Innovation Only	-0.041	-0.040	-0.039	-0.037	-0.039	-0.045	-0.035	-0.036	-0.036	-0.034	-0.035	-0.035
	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.031)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)
Sales growth dt new products	0.265**	0.275**	0.277**	0.277**	0.274**	0.267**	0.313**	0.314**	0.310**	0.315**	0.314**	0.314**
	(0.130)	(0.130)	(0.130)	(0.130)	(0.130)	(0.129)	(0.123)	(0.123)	(0.123)	(0.123)	(0.123)	(0.123)
Located in the capital		0.015	0.015	0.017	0.016	0.015		-0.007	-0.008	-0.006	-0.006	-0.005
		(0.029)	(0.029)	(0.029)	(0.029)	(0.029)		(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
Foreign Owned		-0.004	-0.021	-0.022	-0.016	-0.001		-0.010	-0.012	-0.021	-0.021	-0.012
		(0.044)	(0.047)	(0.046)	(0.046)	(0.044)		(0.041)	(0.043)	(0.043)	(0.043)	(0.041)
Exports dummy			0.004						-0.029			
			(0.032)						(0.030)			
Medium size			-0.029	-0.031	-0.030				-0.014	-0.023	-0.024	
			(0.033)	(0.032)	(0.032)				(0.030)	(0.029)	(0.029)	
Large size			0.035	0.036	0.035				0.033	0.019	0.018	
			(0.042)	(0.039)	(0.039)				(0.039)	(0.036)	(0.036)	
Commercialization Change						0.056*						0.002
						(0.031)						(0.029)
Labor cost Growth				-0.127***	-0.134***	-0.134***				-0.105***	-0.105***	-0.104***
				(0.043)	(0.043)	(0.043)				(0.039)	(0.039)	(0.039)
Fixed Assets Growth					0.037***	0.037***					0.004	0.004
					(0.010)	(0.010)					(0.009)	(0.009)
Number of firms	3786	3786	3786	3784	3776	3776	3806	3806	3806	3804	3796	3796
Sargan test	2.069	3.415	3.144	3.054	2.905	3.335	0.592	0.536	0.556	0.438	0.469	0.521
P-value	0.558	0.332	0.370	0.383	0.407	0.343	0.898	0.911	0.907	0.932	0.926	0.914
Durbin-Wu-Hausman test	0.299	0.388	0.398	0.398	0.374	0.314	0.861	0.875	0.801	0.881	0.877	0.884
P-value	0.585	0.533	0.528	0.528	0.541	0.575	0.353	0.350	0.371	0.348	0.349	0.347

Robust standard errors are reported in parentheses. All regressions include industry dummies.

*Significance at the *** 1%, **5% and * 10% level.*

Instruments used are client, innovation interacted with increased market share, increased range and obstacles to innovation

Source: Authors' estimates.