

# Effects of product and process innovations on the employment growth rate: Evidence for the Colombian manufacturing industry.

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## Research Article

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# Abstract

This paper estimates the effect of product and process innovation on the employment growth rate in Colombian manufacturing industry between 2007 and 2012. Based on the model forward put by Harrison et al. (2008), employment growth rate is explained by both the introduction of process innovations that have an effect on old products and the product innovations that have a positive effect on the growth of sales. This research uses the firm-level data panel from the Technological Development and Innovation Survey (EDIT) and the Annual Manufacturing Survey (EAM) in Colombia between 2007 and 2012. Given the firm's production, results show a positive effect of product innovations on the employment growth rate and a negative effect of process innovations on the employment growth rate in manufacturing firms in Colombia.

**JEL classification:** O25, E24, O33

## Introduction

Innovation can improve competitiveness of firms and increases their total factor productivity. However, innovation also affects the intensity in which these factors are used in the production process. Specifically, product innovations[1] tend to have a positive effect on product demand and therefore on labour demand. In contrast, process innovations can have a negative effect on employment through greater efficiency in the production process, which would lead to a saving inputs. There is no consensus in the literature about the impact of innovations on the employment, therefore this research provides empirical evidence of the effect of product or process innovations on employment growth rate in Colombian manufacturing firms between 2007 and 2012.

The effects of innovation on employment at the firm-level are evaluated in a sample of 17.980 Colombian manufacturing firms using the structural model developed by Harrison et al. (2008). The econometric methodology used for the estimation is pooled ordinary least squares. In this model, products innovations affect employment through their effect on sales of new products while process innovations affect employment through their effect on production efficiency of old products for the firm. Given the firm's production, the results of this research show a positive impact of product innovations and a negative and statistically significant impact of process innovations on the employment growth rate in Colombian manufacturing firms between 2007 and 2012.

According to the neoclassical theory, the effects of product innovation on employment are mostly positive since it increases the demand for new or improved products[2]. The impact of process innovation on employment depends of the displacement and compensation effects that it may have in the demand for labor. Displacement effect is a reduction of production factors per product unit often associated with an increase in productivity. However, the increase in productivity reduces production costs and through different compensation mechanisms the process innovation can generate more employment. These

mechanisms work when firms do not have sufficient market power and the fall in prices is sufficient to stimulate demand for products (Edquist, et al., 2001 and Vivarelli, 1995).

In developed countries, most empirical research found a positive effect of product innovation on employment growth rate in manufacturing while the effect of process innovation is unclear. The process innovation had a negative effect on employment in UK manufacturing firms, although this effect was statistically significant on firms that developed only process innovations (Harrison et al., 2008; Peters, 2008; Van Reenen, 1997). On the other hand, Hall et al (2006) and Smolny (2002) found that process innovation had a positive effect on job creation in Germany and other countries.

In Latin America, most research based on the structural model developed by Harrison et al. (2008) found a positive effect of products innovations and an ambiguous effects of process innovation on employment growth rate in manufacturing [3]. These results generally do not differ between firms of different size or technological intensity. Regarding to the impact of innovation on employment compositions, authors found scant evidence of a skill bias, although product innovation was more complementary to skilled than to unskilled workers.

In Colombia, López and Zárate (2014) following the model developed by Harrison et al. (2008) found that products and process innovations had a positive effect on employment in manufacturing firms between 2011 and 2012. On the other hand, Barrios (2019) found a positive effect of innovative efforts on total factor productivity (PTF) in Colombian manufacturing firms between 2008 and 2012. Given the firm's production, this latter result can have a negative effect on the employment growth rate in Colombian manufacturing firms.

This research has an analytical contribution about the effects of product and process innovations on the employment growth rate in Colombia between 2007-2012. It uses a firm-level data panel on total innovations in firms in the manufacturing sector and activities associated with technological development, which enables to control the unobservable heterogeneity between firms and obtain more efficient estimated effects. The results of this analysis are present in consideration of different sources of endogeneity in the model by the correlation between innovation outputs and the productivity.

This document is divided into three sections. First section has the theoretical framework of the structural model through which the impact of innovation on employment is evaluated. Second section shows the econometric strategy and descriptive statistics of the most relevant variables of the model. Finally, the three section presents results of the econometric estimation and conclusions.

[1] Schumpeter defines product innovation as the introduction of a new good or better quality of goods in the market and process innovation as the introduction of a new production method.

[2] Hall et al (2008), Harrison et al (2008), Piva and Vivarelli ,(2004) , Smolny (2002), Van Reenen (1997).

[3] Benavente and Lauterbach (2007) and Alvarez et.al (2011) evaluated the impact of innovation in manufacturing firms in Chile; Crespi and Tacsir (2012) evaluated this effect in Argentina, Chile, Uruguay and Costa Rica.

## Methodology

The effect of product and process innovations on the employment growth rate is analyzed with the conceptual framework developed by Harrison et.al (2008). This is a multi-product model that considers the displacement and compensation effects of innovation on labor demand. The main assumption in this model is the production of two types of goods in the firm: old and new products for the firm.

In order to produce these goods, firms have a production function with constant returns to scale in labor. We also assume that labor is the only factor of production and this is homogeneous. Additionally, there is a technology parameter,  $\theta_{ijt}$  which increases the efficiency of the production process. Thus, the firm's production function is:

$$y_{ijt} = \theta_{ijt} F(L_{ijt}) e^{\eta_j + \omega_{1jt}} \quad (1) \text{ For } i = 1 \text{ and } 2; j = 1 \dots, n \text{ and } t = 1 \text{ and } 2$$

Where  $\eta$  are unobservable fixed factors,  $\omega$  are idiosyncratic shocks, products are denoted by  $i$  and firms by  $j$ . In the following of the development of the theoretical model the subscript of the firm is omitted.

The firm's labor cost function is defined as [4]:

$$c(w_{1t}, w_{2t}, y_{1t}, y_{2t}, \theta_{1t}, \theta_{2t}) = c(w_{1t}) \frac{y_{1t}}{\theta_{1t} e^{\eta + \omega_{1t}}} + c(w_{2t}) \frac{y_{2t}}{\theta_{2t} e^{\eta + \omega_{2t}}}$$

2

Where  $y_1$  is the production of old products for the firm and  $y_2$  is the production of new products for the firm. In this model if  $t = 1$  all production corresponds to old products, i.e.,  $y_{21} = 0$ , and if  $t = 2$  the firm has no production of new products. Similarly,  $w_{1t}$  and  $w_{2t}$  represent wages at time  $t$  in the production of old and new products for the firm, respectively. Finally, we assume that the firm's productivity levels are affected by fixed unobserved factors  $\eta$ , idiosyncratic shocks  $\omega$  and production efficiency  $\theta$ .

According to Shepard's Lemma and given the firm's production, labor demand in the production process of each type is well expressed as follows:

$$L_{it} = c_L(w_{it}) \frac{Y_{it}}{\theta_{1t} e^{\eta + \omega_{it}}}$$

3

The employment growth rate at the firm level is given by the employment growth rate in the production of  
Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js production of new products. Since in this model the

production of new products at the beginning of the period is zero ( $y_{21} = 0$ ), the employment growth rate may be represented as:

$$\frac{\Delta L}{L} = \frac{L_{12} + L_{22} - L_{11}}{L_{11}} = \ln \left( \frac{L_{12}}{L_{11}} \right) + \frac{L_{22}}{L_{11}}$$

4

In this equation, the employment growth rate for the production of old products is approximated by the logarithm of this variable in order to obtain a linear equation in terms of the relevant variables. To simplify the model, we assumed that the salary of workers for the production of new and old products remains constant and equal during two periods. In other words,  $c(w_{11}) = c(w_{12}) = c(w_{22})$ .

After replacing the values of Eq. (2) in Eq. (3) and assuming that  $\omega_{22} = \omega_{11}$ , the employment growth rate is given by the following equation:

$$l = \frac{\Delta L}{L} = - \left( \frac{\theta_{12} - \theta_{11}}{\theta_{11}} \right) + \left( \frac{Y_{12} - Y_{11}}{Y_{11}} \right) + \frac{\theta_{11}}{\theta_{22}} \frac{Y_{22}}{Y_{11}} - (\omega_{12} - \omega_{11}) \quad (5)$$

According to this equation, the employment growth rate is the result of: (i) the variation in efficiency in the production of old products; (ii) the growth rate in the production of old products and (iii) the share of new products in total production, i.e., the expansion in production attributable to new products. This latter effect depends on the efficiency ratio between the production of old and new products ( $\theta_{11} / \theta_{22}$ ), which is less than one if new products are produced more efficiently than old products. In this case, there could be labor savings per unit of new products and employment would not grow as much as sales for new products.

Due to the background of the model, greater efficiency in the production of new or old products reduces labor demand. Thus, an increase in the employment growth rate is only through lower production efficiency because in this model the change in labor demand is not derived from an increase in production. However, productivity gains can increase the scale of production and, therefore, the end result of this is an increase in labor demand. On the other hand, improvements in profitability from the production of new or improved products can increase a firm's market share and scale of production and thus employment.

The expected results of the share of production by new products in the rate of employment growth are two. First, a lower relative efficiency estimate ( $\theta_{11} / \theta_{22}$ ). In this case, the firm indicates that gets more productivity from the production of new products and this lead to a displacement effect on labor. However, this is not the net effect because the model takes production as given and does not take into account that improvements in productivity increase production. The second result is a higher relative

efficiency estimate ( $\theta_{11} / \theta_{22}$ ). In this case the firm has more production share for older products, perhaps because obtains greater productivity in the production of old goods than in the production of new ones.

The growth rate of efficiency in the production of old products in Eq. (5) can be interpreted as an average productivity growth between firms. This efficiency may be different between innovative firms and non-innovative in productive process. So, the model has a dummy variable equal to one if the firm developed process innovation and zero otherwise. As in the theoretical model, process innovations in the empirical model only affects the production technology of old products. Thus, the equation to estimate the effects of innovation on the rate of employment growth is:

$$l_i = \alpha_0 + \alpha_1 d + y_{1i} + \beta_1 y_{2i} + \beta_2 X_i + u_i$$

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In this equation,  $l$  is the growth employment rate in the Colombian manufacturing industry between 2007 and 2012;  $d$  is a dummy equal to one if the firm implemented process innovation not associated with a product innovation (only innovation process)  $y_1$  and  $y_2$  are the rate of production growth by old and new products, respectively. However, these latter variables are not observed in the database used, so they are replaced by the sales growth rate for old and new products. On the other hand,  $X_i$  are control variables,  $\alpha_0$  represents the growth in efficiency in the production of old products that do not come from of innovations in process and  $u_i$  is the error term that contains fixed unobservable fixed effects at the firm level and productivity shocks,  $u_i = -(\omega_{12} - \omega_{11}) + \epsilon$ . Additionally, the model includes a set of industry dummies to control the unobserved heterogeneity at the industry level and the common shocks to all firms.

The  $\beta_1$  coefficient measures the relative efficiency between the production of old and new products. If  $\beta_1$  is less than one, new products are produced more efficiently and thus the growth of production due to these increase the productivity per worker. In this case, the firm demands less amount of labor for the production of a good. However, the production of new product may increase the firm's market share, would probably lead to an increase in production and labor demand.

Through the efficiency parameter  $\alpha_1$ , the dummy variable of process innovation captures the effect of process innovations related to old products. These innovations are new or significantly improved methods of production, distribution, delivery, or logistics systems, implemented in the firm. This variable does not contain variations in productivity due to production of new or significantly improved products. Thus, the process innovation only has efficiency gains due to changes in the production of old products.

Finally, sales growth from old products may be affected by several factors. One of these is the demand substitution of old products by new ones. Another factor may be the fall in prices as a result of production efficiencies that could lead to an increase in the demand for old products. And one more, the

Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js it is difficult to disentangle these factors in the

model, the sales growth from old products is subtracted from both sides of Eq. (6). In this way, the estimated impact of sales growth from old products is equal to one and the model is:

$$l_i - y_{1i} = \alpha_0 + \alpha_1 d + \beta_1 y_{2i} + \beta_2 X_i + u_i$$

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According to Crepon et. At (1998), the share of total sales from new products can be a proxy for the intensity of innovation. Then, this model also allows to evaluate the impact of innovation on employment taking into account the innovative effort in each firm.

### Identification Issues

To obtain an unbiased estimator of  $\alpha_0$ ,  $\alpha_1 y \beta_1$ , it is necessary that the error term,  $u_i$  of Eq. (7) is not correlated with the variables of process and product innovation,  $d$  and  $y_2$ , respectively. Since investments in innovation depend on the productivity of the firm, the results of innovation are correlated with productivity. The error term in Eq. (7) has a component of productivity and thereby the regression has an endogeneity bias on estimates of process innovation and sales from new products in the employment growth rate.

The literature has been the lags of the innovation as instruments to reduce potential bias by the correlation between results of innovation and productivity. However, sales from new products and process innovations are result of the productivity from technological investment thereby the lagged values of innovation are correlated with the productivity. It is difficult to find a variable affecting the sales growth and uncorrelated with the productivity of the firm, since the production includes all the improvements from the innovation. Nevertheless, identifying components in the error term leading to endogeneity helps analyze potential biases in the model.

The error term in Eq. (7) has shocks productivity,  $\omega_{ijt}$  which are external changes to firms that affect the firm productivity such as an increase in foreign investment. If these shocks are random, i.e. on average they are identical for all firms in an economy, the shocks productivity would not lead to bias on estimators. Nevertheless, if firms affect their decision to innovate in the period affected by productivity shocks, even if they are random, the results of the innovation in that period could be correlated with  $\omega_{ijt}$  and the innovation estimates would be biased.

Rouvinen (2002) states that there at least a lag between technological investment and its effects on productivity. Therefore, it is possible that the technology investment has lags on the results of the innovation. This implies that although productivity shocks affect a firm's decision to participate in innovation activities its impact lagged on the results in innovation would have not a correlation with the productivity, sales and employment in the firm. Thus, the firm does not simultaneously determine investment in innovation and employment, which depends on productivity. In this case, the innovation variables in Eq. (7) are not correlated with the productivity shocks of the error term.

Another cause of endogeneity is measurement errors in sales. In the database there are no prices at the firm level, so the growth of nominal sales is observed instead of the growth of real sales. Then, the producer price index is used as a deflator to obtain real sales growth. Additionally, it is difficult to have sales from old and new products. For that reason, sales from new products are constructed from their share of

total sales,  $s$ , at the end of the period and the growth rate of total sales,  $y_t$ . Thus,  $y_{22} = s * \left( \frac{Y_t}{Y_{t-1}} - 1 \right)$

it is the share of new products in total sales. Meanwhile,  $y_{11} = \left( \frac{Y_{12}}{Y_{11}} - 1 \right)$  it is the growth rate for old

products.

The absence of prices at the firm level in this database and the difficulty to have directly sales from old products and new products leads to endogeneity in Eq. (7) due to measurement errors. This is because there is no way to identify whether price differences between firms are related to individual differences in efficiency growth or other productivity improvements from innovation, as the ability to sell more at better prices. Then, it is difficult to separate the effects on productivity generated by new and old products.

Additionally, in this model wages are assumed to be equal in the two periods in the production of old and new products. If this assumption fails and the wages in the production of new products is greater than the wages in the production of old products  $c(w_{12}) >$ , there is an upward bias in the estimate of relative efficiency  $(\theta_{11} / \theta_{22})$ . This is because in the absence of information regarding wages would be estimated an effect of productivity on the production of new products greater than the real value and therefore the impact of the production of these goods on the employment growth rate may be overestimated.

In the absence of a variable that helps mitigate the correlation between innovation and productivity in the equation that determines the rate of employment growth, in this research the model is estimated using the method of ordinary least squares under the consideration that the estimates may be biased.

## Data

This research uses the firm-level data panel from the Technological Development and Innovation Survey (EDIT) and the Annual Manufacturing Survey (EAM) in Colombia between 2007 and 2012. The former is a survey that DANE applies to firms registered in the EAM to know the development of innovation in manufacturing firms as well as the activities associated with technological development. The EAM includes information about performance in the productive process of companies with 10 or more employees or their production value is greater than a fixed amount for each year. Additionally, information about employment, output and fixed assets of firms is obtained from the EAM.

Information about the development of innovations in firms is obtained from EDIT V and VI. In these surveys there are categorical variables which allows identify whether a firm developed product or process innovation. A firm has innovation in product when answered affirmatively to the question as to whether have developed new or significantly improved products whose are significantly different from the products old produced by the firm. Likewise, a firm develops an innovation in process when answered affirmatively to the question as to whether have developed new or significantly improved methods of production, distribution or delivery during the survey's reference period.

In the Eq. (7), the dummy variable that indicates whether or not the firm developed process innovations is equal to one if this innovation is not associated with any developed of new products. To ensure that process innovation is associated only to the production of old products, firms are divided into two groups: firms with only process innovation and firms with product or process innovations. Thus, the process innovation would be associated only has productivity associated from production of old products. On the other hand, sales from new or old products are not observed but are constructed following EDIT question: how much was the percentage of sales from new or significantly improved goods or services introduced to the market during the survey's reference period. This allows to have nominal growth sales from new products.

## **Descriptive Statistics**

Table 1 presents the descriptive statistics of the most relevant variables used in the analysis of the effects of product and process innovation on growth employment. Moreover, this table shows the distribution of firms by type of innovation based on information from the EDIT and EAM between 2007 and 2012.

### **Table 1. Descriptive statistics. Total firms, 2007 -2012**

Variable	Mean	Median	Dev. Standard	Minimum	Maximum
<b>Number of observations</b>	17980				
<b>Firm distribution (%)</b>					
Not innovative	59,3				
Innovative only in process	10,5				
Product Innovators	20,7				
Innovative in product and in process	9,5				
Innovative in process and organization only	4,1				
<b>Number of employees</b>	83	3 1	161	10	2513
<b>Employment growth (annual%)</b>					
Total Firms	1,8	0,4	16,5	-57,9	94,6
Not innovative	1,5	0,0	15,4	-53,4	92,0
Innovative only in process	3,0	2,2	16,2	-50,0	70,8
Product Innovators	3,9	3,2	15,8	-54,3	94,2
Innovative in product and in process	3,9	4,3	16,3	-50,0	65,9
Innovative in process and organization only	3,4	2,8	12,3	-45,9	34,5
<b>Growth in wages (annual%)</b>	7,4	5,26	14,5	-50,88	71,27
<b>Sales growth (annual%)</b>					
Total Firms	5,5	5,3	22,9	-79,4	98,0
Not innovative	5,3	4,9	21,3	-77,0	98,9
Innovative only in process	7,6	7,2	22,2	-68,5	97,8
Product Innovators	8,3	7,4	20,1	-65,0	95,8
Innovative in product and in process	8,2	7,7	18,5	- 65,0	80,4
Innovative in process and organization only	8,4	8,5	20,9	- 68,5	89,6

Source: DANE - EDIT IV, V and VI and EAM 2007-2012

According to the descriptive statistics obtained from table 1, approximately the 41 % of the Colombian manufacturing firms developed product or process innovations between 2007 and 2012. Meanwhile, the 21 % of the firms developed product innovation and the 11 % developed only process innovation. Additionally, innovative firms had higher employment and sales growth. Specifically, companies with product or process innovation in the 2007-2012 period increase the sales in 8% while the non-innovative companies increase the sales in 5,3%. Also, companies with product innovation increased their employment in 3.9 % and this result is 3 % for companies with process innovation compared to the 1,5% for non-innovative companies.

The relationship between innovation and employment is complex and according to statistics it is affected by the characteristics of the production process. The results of the econometric model given a greater

Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js innovations on employment. However, this model

does not take into account the characteristics of the labor market, which contributes to explain the creation of new jobs.

[4] See Harrison et al (2008) where the employment growth rate is explained by the introduction of process innovations that affect old products and sales growth derived from the introduction of product innovations.

## Results

The Table 2 presents the results of the estimation of the effects of innovation on employment by Ordinary Minimum Squares where the dependent variable is net employment, employment growth rate minus the real growth rate of sales for old products for the firm. Control variables include a dummy for organizational innovation, the growth rate of fixed assets per capita and a dummy of firm size. This last variable is introduced to control the heterogeneity of the impact of innovation on employment in large and small firms. According to DANE, large firms are those that have more than 50 employees and small firms that have 50 or fewer employees.

Table 2  
Model estimation by Pooled OLS

Variables	Net employment growth rate		
	Innovation only in process	-0,017 **	- 0,020 **
Innovation only in process and organizational	(0,008)	(0,008)	-0,001 (0,014)
Sales for new products	0,859 ***	0,852 ***	0,856 ***
	(0,018)	(0,018)	(0,011)
Size		0,024 ***	0,024 ***
Asset Growth per capita		(0,006)	(0,005)
		-0,001 **	-0,001 **
		(0,001)	(0,001)
Constant	0,229 *	0,229 *	0,226 **
R-square	(0,135)	(0,135)	(0,135)
	0,35	0,35	0,35
Observations	12.555	12.505	12.505
Standard errors in parentheses			
*** p < 0.01, ** p < 0.05, * p < 0.1			

Estimation by ordinary least square (OLS) from Table 2 shows that estimated effect of growth in sales of new products is positive and less than one. Given the firm's production, this estimated shows the relative profitability of production between old and new products. Then, a coefficient less than one implies that the firm obtained more profits from new products than that of the production of old products. Additionally, the product innovation, measured by sales growth from new products, had a positive impact on the employment growth rate in Colombian manufacturing firms between 2007 and 2012. Finally, as employment equation is estimated in growth rates the effects observable and unobservable specific to firm that not vary over time are eliminated.

On the other hand, given the firm's production, only innovation process had a negative and significant impact on employment growth Colombian manufacturing firms, although this impact is small. The previous result shows that process innovation can lead to improvements on the productive process in a

firm, along with a labor savings per product unit. This result is obtained based on background of theoretical model as improvements in production efficiency reduce the demand for labor. Nevertheless, is possible that firms with greater productivity increase their sales and thereby the production and employment.

The innovation activities may differ depending on the size of the firm, since in some cases smaller firms can be more innovative than large firms or vice versa. So, in the model, the firm's size dummy is expected to capture this heterogeneity. This estimated effect shows that larger firms have higher employment growth rates than small firms. Additionally, the constant coefficient in the econometric model is negative. This indicates that the contribution of productivity in the production of old products resulting by factors different from the innovation is positive. Then, firms on average have an increase in productivity that is expected to lead to lower employment growth rates. Similarly, the assets growth rate per capita generates a significant displacement effect at 5% in employment.

## Discussion

According to results, product innovations have a positive impact on employment growth in Colombian manufacturing firms while process innovations had a negative impact. The effect of process innovation differs from López and Zárate (2014) who found that process innovation had a positive effect on the employment growth in Colombian manufacturing firms between 2011 and 2012, although the researchers used the same theoretical framework. Nevertheless, the positive effect of product innovation on employment growth is similar to those obtained by some research for Latin America (Alvarez et.al, 2011; Benavente & Lauterbach, 2007; Crespi & Tacsir, 2012).

The estimated effects could be biased by endogeneity on the econometric model mainly two issues. First, there could be measurement errors mainly because innovation can be a subjective and ambiguous concept for each people that answered the surveys. We acknowledged that this the principal restriction to analyzed issues relating to innovation. Second, since investments in innovation depend on the productivity of the firm, the results of innovation are correlated with productivity. Moreover, it is difficult to find a variable affecting the sales growth and uncorrelated with the productivity of the firm, since the production includes all the improvements from the innovation.

## Conclusions

This research finds that product innovations had a positive impact on employment growth in the manufacturing industry while process innovations had a negative impact on this. The results must be analyzed taking into account two issues. First, these estimates could be biased by the endogeneity that results of the correlation between innovation and productivity. Second, in the model greater efficiency in the production of new or old products reduces labor demand because in this model the change in labor demand is not derived from an increase in production. On the other hand, the results show that innovative and large-sized enterprises had far more employment growth than their small counterparts.

The findings in this research are preliminary article but helps to public policy-makers to design strategies that could improve the development of innovation activities in firms, given the positive results of these in job creation. Likewise, it is necessary to know the mechanisms by which the innovations developed by students benefit the employment growth. Finally, in this document was evaluated only the impact of innovation on the demand at work in firms in quantity terms, but it would be interesting that subsequent research evaluate the impact of innovation on the composition of employment.

## Declarations

### • Ethics approval and consent to participate

Ethics approval: Not applicable because our manuscript does not report on or involve the use of any animal or human data or tissue

### • Consent for publication

We Fernando Barrios Aguirre and Sandra Yaneth Mora Malagón give consent for information about our research to be published in Journal for Labour Market Research Editorial Office

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## • Availability of data and materials

The datasets analyzed during the current study are available in the National Administrative Department of Statistics in Colombia (DANE) repository. The Technological Development and Innovation Survey (EDIT) between 2007- 2012 is available in the following link

[http://microdatos.dane.gov.co/index.php/catalog/MICRODATOS/about\\_collection/34](http://microdatos.dane.gov.co/index.php/catalog/MICRODATOS/about_collection/34). The Annual Manufacturing Survey (EAM) in Colombia between 2007 and 2012 is available in the following link [http://microdatos.dane.gov.co/index.php/catalog/MICRODATOS/about\\_collection/6](http://microdatos.dane.gov.co/index.php/catalog/MICRODATOS/about_collection/6).

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## • Authors' contributions

Fernando Barrios organized the database and analyzed and interpreted the data regarding the development of innovations in Colombian manufacturing firms. Moreover, he reviewed existing literature about this issue and actively to the drafting of the outcome document. Sandra Mora, review the theoretical framework of the structural model through which the impact of innovation on employment was evaluated and was a major contributor in writing the manuscript. All authors read and approved the final manuscript.

## Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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