Innovation and employment growth in Ecuadorian firms

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Abstract

We study in this paper the four types of innovation and their effect over employment in Ecuadorian Firms. We have worked with a data set from the National Innovation Activities Survey 2009-2011 (NIAS) with information about 2815 firms from 2009 – 2011 in Ecuador. In our research, we have applied Harrison et al. (2008) methodology, where they introduce an innovative sales growth (product), and other types (process, organizational and marketing) of innovation to measure in the dynamic of employment growth. For the final estimation, we have used an Instrumental Variables to have efficient coefficients. The model, although gives us a productivity proxy´s about between new and old products, and demanded factors. The results drive along the line of compensation effect for product and marketing innovation. Furthermore, our results suggest that the innovation increase the demand of its products (new and old), on the other hand, the organizational innovation which was only based on innovation decision that destroys jobs in the short terms for Ecuadorian firms, where the displacement effect over employment dominates. We found that the old products are not different than new products in terms of productivity. Our results, contribute to literature in developing countries for understand the innovative behavior in the firms and it effects.

Keywords: Innovation, employment, Product innovation, process innovation, organizational innovation, Marketing innovation, technological changes, Instrumental Variables

JEL classification: O3, J23, O31, O33, C26

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1 Introduction

The innovation has different effects over the countries. In the economic theory, the technological change, introduces by the countries, has as a result output growth (Romer, 1986). According this type of literature, the technological changes could interpret as the “first step” in the innovation process. In particular, that is a result of R&D investment and human capital develops. Likewise, Mohnen and Hall (2013) suggests which the innovation, at firm level, has several effects as: reduce firms cost, create products or exploit new markets. More specifically, those results are coming from the innovative performance in the countries.

Latin American Countries (LAC) are not a region with a *“long tradition”* on innovative characteristics. In support of that, Lederman et al. (2013) demonstrate that LAC has less product innovation which European or North American countries[1]. Similarly, the Global Innovation Index (GII)[2] 2011 reports a lag on innovation performance for LAC; where six European countries (Switzerland, Sweden, Finland, Denmark, Netherlands and United Kingdom), two North American (Canada and United States of America) and two Asian countries (Singapore and China/Hong Kong) appear as leaders from 125 countries. Chile was high record between the LAC in the 38 place, while Ecuador was in the place 109[3] for the same index. In the same way, Schwartz and Guaipatin(2014) mention as the large difference in Ecuador innovation are in terms of R&D investment by the private sector, labour regulation, education, among others. Also, they explain that the problem of the returns rates from innovation activities has measurement problems. As shown in Table 1, Ecuador has the higher R&D expenditure as percentage of GDP between Andean Countries (Colombia, Peru, Bolivia and Ecuador) but compared to other LAC´s (Argentina, Brazil, Chile, Costa Rica and Mexico for this research) this ratio is not encouraging to this country. For example, Ecuador had 0.40% of R&D expenditure over GDP in 2010 and it value was

[1] They used information from World Bank Enterprise Survey 2006-2010 for their research.
[2] The GII is a report with information about the innovation performance at aggregate level for the countries. More specifically, the GII incorporates inputs and output innovation variables, where it introduce seven groups of ratios related with Institution, Human Capital, Infrastructure, Market sophistication, Business sophistication, Scientific outputs and Creative Outputs. See WIPO and INSEAD (2011) for methodology details and complete ranking.
[3] In the 2009 and 2010 GII, the Ecuadorian rank was 109 and 126 respectively.

higher value, however for other LAC´s from 2009 to 2011 only Chile has smaller values. Similarly, this happen with others aggregates innovation input variables.

On the other hand, one measure for innovation output is the patent applications at country level, where Ecuador has only 10 patents application (from 2009-2011). This result situated Ecuador, in terms of innovation, at large distance than the top LAC, also this lag appears with developing countries to. Alternatively, the effects of introduce an innovation could measure with others manners. In that case, why the innovation has not some relationship with employment? For example, Basker (2005) has an interesting study about the job destruction/creating around the Walmart[4]. He demonstrate with US sample, Walmart increases local job in 100 employees in the short run (one year), although in long run (five years) the "net effect" is around half. This is a good example about how "innovative firm" could have different performance about employment. In the same way, we expect about the innovative firms contribute, for developing countries, at least some effects as: 1) create jobs, 2) better quality of job, 3) higher salaries, and 4) higher qualification in their employees. In addition, as show in table 1, Ecuador does not have a high level of unemployment rate; however the vulnerable employment[5] was, in average, 48% of total employment. That means a large number of the employees has a "bad quality" jobs. Moreover, we found with data from Ecuadorian Economic Census 2010, the firms which R&D activities (innovative proxy), paid higher salaries than the firms without R&D activities[6]. Finally, the figure 1 shows the distribution of the workers by type of education level. That figure suggests the employees, with higher level of education, have a higher proportion in the Ecuadorian innovative firms.

[4] This firm is one of the biggest firms in retail industry around the world, and it is recognizing in efficiency cost innovation (logistical and inventory treatment). Also, Walmart is recognize by it innovation in supply chain improvement, and is higher employer in the US (see (Fortune, 2015), (USA TODAY, 2013))

[5] Vulnerable employment is an indicator to measure the quality of the job. It indicator was establish by the United Nations in their Millennium Goals for 2015. The formula for the vulnerable employment rate is the sum of own-account and contributing family workers over total employment. For more information, see (International Labour Office, 2009).

[6] We improve a basic mean test of salaries, where the null hypothesis of difference on the salaries between innovative and non-innovative firms is rejected at 1% level. The salaries difference, in log terms, is 1.668 favorable for the firms with R&D activities.

[Instert Table 1 here]

The economic debate about the job creation, in the innovation approach, is not clarified. The aim of this paper is contribute in the several lines. First, the researches about the innovation effects over Ecuadorian firms are not very wide in the economic literature. Accordingly, we use a cross-section data set from Ecuadorian firms to measure the effects over employment growth, which come from the different types of innovation. We do not found another econometric estimation over employment and innovation with this data set. For this aim, we use Harrison et al. (2014) methodology applying in four European countries and replies for others nations. First, that methodology suggests the innovative decision could drive in two line effects: direct or indirect effect over employment growth. This implies, the some innovative decisions create jobs, and others destroy it. Our estimation uses four types of innovation as explanatory variables to measure their effect over employment growth, at difference with the seminal research. Second, our estimation enable compare the results in Ecuadorian firms with developed countries above all, where the literature are more extensive. Third, we use different measures of innovation, which compare their impact over employees. The aim of this part is demonstrate the “innovative firms” has higher qualified employees and besides paid higher salaries.

The paper is divided as follow: section 2 gives a literature review about the type of innovation definition, and the relationship between innovation and employment; section 3 explains the methodology and endogeneity problems for our estimation; section 4 presents the data and mainly descriptive statistics; section 5 we present the results of innovation effects over: employment growth, skilled labor and salaries; section 6 gives a conclusion over this paper.

2 Literature review

2.1 Types of innovation

The Oslo Manual (2005) is guide to measure the innovation, at firm level in the countries, by the OCDE. In that version, the OCDE classify the innovation in four types (Product, Process, Marketing and Organization). Previous of Oslo Manual, we found large literature with description about Product and Process. Traditionally, product and process innovation are define as *"technology innovation"*. As an illustration, Utterback et al. (1975) defined product innovation appears in the firms, when they introduce a technology improvement with commercial or market interest. In the same line, the Oslo Manual (2005) defines: *"is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics*" (OECD and Eurostat, 2005 p. 48). Specificially, we could describe product innovation like an "evolution" of the "traditional" product or service offered by the firms. Process innovation has the same idea than product innovation. In this case, the firms interested in maximize their benefits have another way to do it by technology in production. For example, Barras (1986) difference the product and process innovation terms, where he explains the first innovation is related with offer to the customer, and second is with mode of production respectively. The Oslo Manual (2005) defines about the process innovation: *"is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software"* (OECD and Eurostat, 2005 p. 49). As can be seen, both type of innovation has a ligature with the production. On one hand, product innovation modifies the firms output directly. In this case, the aims of the firms are: 1) sale new products to the same market, 2) sales new products to new market, 3) change its products for sale at same market or, 4) change its products for sale to the new market. On the other hand, the firms introduce a process innovation could have two aims mainly. First, the firms' could cost savings when it changes will execute, and increase their productivity as result.

The other groups of innovation variables are marketing and organizational innovation. In the economic literature, these types of innovation are novelty using. Sometimes, we can find management focus to their definitions. Rust et al. (2004) explain marketing innovation in terms of strategies over product, price and promotion. Additionally, Murphy (2002) describes an organizational innovation in three types: management, production approaches and external relations. OCDE includes both type of innovations in the same level than the product and process in Oslo Manual (2005) and defined as follow: **Marketing innovation** "*is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing*"(OECD and Eurostat, 2005 p.49). In the economic literature, marketing innovation has not large evidence over firms output. However, Junge et al. (2015) using a marketing innovation as explanatory variable in their study for productivity with Danish firms data, they found a positive effect over firms growth. Also, they conclude, which the firms introduce innovation in marketing and product together, their growth is faster than the others takes each decision separately. **Organizational Innovation** *"is the implementation of a new organizational method in the firm's business practices, workplace organization or external relations"* (OECD and Eurostat, 2005 p. 51). The marketing and organizational innovation, in some econometrics estimations, are using together. For example, Flikkeman et al. (2007) and Mothe & Nguyen-Thi (2012) use organizational and marketing innovation and call "non-technological" innovation. Schubert (2010) using both variables together in his estimation to determinate the relation with market structure and firm characteristics.

2.2 Innovation, employment and skilled labor

The literatures about the effect of innovation over employment have different focus and kind of measure. Pianta (2005) make a detailed review to the different types of studies of innovation and its relationship with employment in macroeconomic and microeconomic level. He discusses the different focus of technological changes effects. For example, some classical theories are in the line of the labor savings effect. The main idea behind that is, when the firms introduce new machinery or new process, in some cases, requires less number of employees. This author also makes a review of empirical researches about address of innovation effects over employment. The results have different ways depending of the measure, techniques, or data. Also, Vivarelli (2013) resume a theoretical approach about the "compensation" and "displacement" innovation effect over output (labor). The ***displacement effect*** is clearly compressive; the technological changes in the firms generate a pressure over the other production factors (included the human capital). Also he did a review of compensation mechanism and divided it in five groups as: a) new machines, b) decrease prices, c) new investments, d) decrease wages, and e) increase income. For example, the firms introduce technology changes for reducing their cost (sometimes saving jobs).

As results, the firm which increases its profits could do a new investment and create jobs too (***compensation effect***). Although, the firms whether decide do not realize this new investment, that compensation effect is null.

Correspondingly, García et al. (2004) has one of the seminal researches about innovation and employment, with theoretical and empirical approach, for a single country. Later, that model was extending with different versions, which finished with a methodology like a Harrison et al (2014,2008). The contribution of this literature is relevant because, the function combine different times of decision, effects of innovation, and employment growth with a cross-section data. They suggest that employment (growth) in the firms could have two kinds of pressure. On one hand, the displacement effect as result of elasticity of employment with respect to innovation in the demand for labor. On the other hand, the compensation effect could appear, when the firm increases the number of employees as result of the demand relationship. Thus, both effects depend at innovate decision of the firm. The firms, in their model, could decide innovate in product or process (only). Furthermore, this model includes a productivity term for the innovative or non innovative firms. We give more details of this model in section 3.

The empirical literature gives different results using Harrison et al. (2014) model (see Appendix 3). For the Latin American countries, Ejalde et al. (2011,2015) find positive effects over employment explained by product innovation, but they have not a clear result for process innovation for Argentinean firms. On the other hand, Monge-González et al. (2011) using the same methodology, their found positive effects over employment growth by product and process innovation at firm level for Costa Rica. Zuñiga & Crespi (2013) and later Crespi and Tacsir (2012) estimate also for four Latin American countries (Costa Rica, Uruguay, Chile and Argentina) the employment growth equation. They found closer results (in both studies) of a compensation effect in the product innovative firms (except in Costa Rica), and process innovation present the same effect, but not for the case of Chile and Costa Rica manufacturing firms.

In addition to the Latin American countries, Damijan et al. (2014) found both effects on employment growth from compensation for the product innovation in manufacturing and services, and displacement effects of process innovation. Their result was only for the manufacturing firms with a sample of 23 European countries. Further, this research is interesting because introduces marketing innovation, but jointly with the organizational innovation. As results, the combination of that innovative decision is positive to employment growth. Dachs & Peters (2014) analyze the effect with the difference between foreign and domestically firms in 16 countries in Europe. They found the process innovation saving jobs, but it effect in the foreign firms are higher than the domestically. Hall et al. (2008) not found displacement effect in Italian firms with cross section data from 1995-2003. The product innovation (create product) is so close than fifth percentage of job in their study.

In the literature, the Organizational and Marketing innovation are difficult to find them separately, although individual effects could differ. Evangelista and Vezzani (2012) did a review about the problems for identifying the organizational innovation effects over employment. One part of their research was related with the direct or indirect effect of organizational innovation. They explain the indirect effect of that innovation have two routes; first, to be better in the product performance or increase firms demand; second, is related with efficiency gains, this part could be translated to price reduction. Furthermore, their reviews suggest that in the organizational innovation there could be found an indirect effect (displacement or job savings). Although, Evangelista and Vezzani focus their empirical results on job creation manners for European countries. Peters et al. (2013) for the services firms introduces an innovation dummy for organizational innovation decision in their employment growth model. Their results suggest the effect (positive or negative) over employment differ by industry sector. Falk (2001) using Panel data from Service in a region of Germany found a positive effect over actual and expected employment when the firms introduce organizational changes. Falk (2015) using data from Austria introduces a variable to measure the marketing innovation, but have no significance effect on employment for any type of firms (manufacturing or services).

Finally, the technological change (innovation) has a relationship with the skill labor employees. Some authors as Acemoglu (1998) Bogliacino and Lucchese (2016), Giuri et al., (2008), Marouani and Nilsson (2016), and Acs and Audretsch (1988) develop different measured to understand the direction of this effect in the firms and countries. For example, which the firms introduce a technological changes create "attraction" effect over the most qualify employees. Other case, skill labor could increase the "distance", in terms of wages, between employees. Moreover, Vivarelli (2014) has a survey about the skill labor over the firms innovation. He explains the evidence could be different between the countries. In that way, De Ejalde et al. (2015) introduce a Skilled labor variable to measure it effect over employment growth for Argentinean firms.

3 Methodology

We adopt the theoretical model from Harrison et al. (2014) and adopted by other study as shows in the appendix 3. This model, allows studying the firm innovative behavior effects over employment. Our model, as Harrison et al. version begins with a multiproduct function. In the same line that their assumptions, we need to observe the firms output (sales) in two different periods. The first period (***t=1***), the firms output corresponding to the *"**old products (services)**"*. The second period (***t=2***), the firms could divide it production between only "**new product (services)"**[7], only old products or both of them. As results, the production function is:

$$(1) \qquad Y_{it} = \theta_{it}\, F(C_{it}, L_{it}, M_{it}) e^{\eta + \omega_{it}} \; i = 1,2; t = 1,2$$

where i referred to the type of product the firms could produce in a specific period. The previous equation is production function with Capital (C), Labour (L) and Materials (M) as inputs, with technology constants returns to scale for all of them. The term θ is Hicks neutral efficiency parameters different for each function. That term depend of innovative decision by the firms, and it tries to measure the level of efficiency when the firms introduce an innovation. η and ω are the unobservable factors that come from individual productivity effect or productivity shocks respectively. This model supposes the firms could produce new and old products with the same inputs, because they cannot distinguish inputs used for each product. Another assumption in equation (1) is the firms decided their inputs according cost minimization and prices of inputs are equal for both products[8]. Harrison et al. (2014) model define the employment growth equation as follow:

[7] We include the improvement product/service in the part of introduce a new product.

[8] In our data, we don't have information about the amount of capital and materials. We used the same assumption as Hall et al. (2008). They assuming the capital and material have the same industry growth than labor. In other words, Our estimation are based only in the changes of labor inputs.

$$\frac{\Delta L}{L} \cong -(ln\theta_{12} - ln\theta_{11}) + (lnY_{12} - lnY_{11}) + \frac{\theta_{11}}{\theta_{12}}\frac{Y_{22}}{Y_{11}} - (\omega_{12} - \omega_{11}) \quad (2)$$

The equation (2) explains employment growth by the following components: First, term $(ln\theta_{12} - ln\theta_{11})$ reflects the efficiency change coming from old product[9]; second term $(lnY_{12} - lnY_{11})$ explains the change of demand (or output) coming from old product[10]; third term $\frac{\theta_{11}}{\theta_{12}}\frac{Y_{22}}{Y_{11}}$ explains the impact on of the production coming from new products demand[11]; the final term $-(\omega_{12} - \omega_{11})$ explains the productivity shocks.

For our econometric estimation, and following the base model by Harrison et al. (2014), we can modify the equation (2) and add the process (*proc*), organizational (*org*) and marketing (*mkt*) innovation. The equation redefined is as follows:

$$l = \alpha_0 + \alpha_1 proc + \alpha_2 org + \alpha_3 mkt + y_1 + \beta y_2 + u \quad (3)$$

where l is the employment growth rate between t=1 and t=2 (in our survey 2009 to 2011); α_0 reflects the efficiency that is not coming from the firms innovation decision. We follow Hall et al. (Hall et al., 2008), Peters (2004) and Peters et al. (2013) methodology about the how introduce an innovation strategies. They main assumption is the different types of innovative decisions have effects over old product efficiency. If we base on that hypothesis, our $\alpha_1, \alpha_2, \alpha_3$ terms measure the impact (efficiency) of different types of innovation over employment. We introduce innovation strategies by the firms with a dummy variable for each type of decision (except product innovation).The firms demand are including in the terms y_1(old products) and y_2 (new products). The coefficient β ($\frac{\theta_{11}}{\theta_{12}}$ term of equation 2) reflect the difference in efficiency between old and new product production. Finally, u, is

[9] This term give details of efficiency for firms without any type of innovation decisions (organizational, process or marketing). For our case, that term represent labor productivity.

[10] On one side, a negative sign means a new product are substitutes for old products. On the other side, the positive sign means complementarity relationship between old and new products.

[11] The both parts of this term are related with the efficiency and demand growth for new products. Where coefficient or ratio $\frac{\theta_{11}}{\theta_{12}}$ engage with efficiency (old and new product), that's could be interpreting a less employment when the new product are more efficient than the old $\frac{\theta_{11}}{\theta_{12}} < 1$.

the new error term. That error add-on the productivity shocks from equation (2), and assume is uncorrelated with explanatory variables.

In the econometric estimation of this model, we have the same problems than the other authors with similar literatures and they show the different options to solve it (see, Harrison et al. (2014,2008), Peters (2004), Peteres et al. (2013)). The main problem in this part of the model is with variable (y_1). The aim of this variable is identify three effects: 1) if demand variation are exclusive by old products (autonomous variation) and exogenous by market condition; 2) if price reduction are induce by some types of innovation (process, marketing or organizational); 3) if "incumbent" product demand resulting by own new product (cannibalization) or it competitors. Those effects are not possible distinguish in the innovation surveys. To solve this problem with lack of information, we can transform the equation en growth terms. Our survey has sales information in both periods. The model assumes firms only have "old product" in the first period. For the second period, firms could divide their sales between new or old products. The new product output are composing how a percentage of the firm's sales came from it. After, we transform firm's sales in growth terms for new and old product. When we change our output in terms of growth is necessary introducing a prices control to have a real demand of each product. For our estimation, we used a proxy with a price index at industry level.[12]. Finally, the equation (3) was transform as following:

$$(4) \qquad l - g_1 = \alpha_0 + \alpha_1 proc + \alpha_2 org + \alpha_3 mkt + \beta g_2 + v$$

where g_1 and g_2 are variables reflect the growth in sales by old (in the left side of the equation) and new product respectively. Finally, the new error term (v) included the previous unobservable disturbance and uncorrelated with the explanatory variable reflect the new product innovation (next section explain those problems).

[12] The growth of old products could be defined as: $g_1 = \frac{P_{12}y_{12} - P_{11}Y_{11}}{P_{11}Y_{11}}$, where the price difference is $\pi_1 = \frac{P_{12} - P_{11}}{P_{11}}$. If the π_1 include the price difference between the old products in t=1 and t=2, we can use proxy for reflect it difference. The prices index at industry level from country statistics is our proxy to introduce this effect. In the case of new product growth is different than last one. We define that growth as: $g_2 = \frac{P_{22}y_{22}}{P_{11}Y_{11}}$. That variable required the exactly price for each period, but this is not possible to get it in any innovation survey. The problem with this variable is explain in section 3.1.

Equation (4) is a labor demand; it tries to capture the effect of different innovation strategies by the firms. We estimate our model with a linear regression after the correct the endogeneity problems for absence of prices.

3.1 Endogeneity problem

The main problem in the equation (4) is the absence of prices for old and new product. The new error term included this disturbance problem. The error term is defined as: $v = -\pi_1 - \beta\pi_2 y_2 + u$. That term by definition give us an endogeneity problem. First, when we introduce g_1 and g_2 variables both have a price difference over time. Our aim to introduce the prices of growth in the equation is how amount increase each demand in the time. In other words, if we don't considerate price variation how increase the output of new or old product. For the old product, we can create a proxy for price index at industry level. That price level cannot explain the firm's efficiency direction. Second, for the new product, we have completely absent of price information. The endogeneity problem is generated because it's not clear if the firm's growth from new products is uncorrelated with the error terms. The model presents that correlation by definition when the variable g_2 required the prices to explain the employment growth. Remember, the hypothesis is introduce a new product has a compensation effect over employment in the firms. In this case, we can observe "pure" effect over employment with this variable. That is the reason to introduce the price ratios in the error terms.

In our estimation, we apply four instruments to it. First, we use a variable if the firm aim is to increase the assortment (***Range***) of its products/service with a level of importance; second, is a binary variable were the firm gives high importance of (***customers***) as source of information. Those variables are used in other research as Harrison et al. (2014,2008). Third, is a binary variable that includes an obstacle to innovation the market performance (***market***). The variable takes one, if the importance is high when the markets are dominated by incumbent firms or there is uncertainly in demand of products or services. Finally, we introduce another binary variable, that variable measure the impact of innovation in four levels. In our case, we transform 1 if the firms said is high that impact when tried to replace outdated product or process (***replace*****e**). We explain in the section 4 data of those variables. We assume our four instruments solve the endogeneity problems in our estimation because:

1) are not related with price of new or old products. In other words, those instruments are uncorrelated with the error terms, 2) when we included the impact, sources information, obstacle and results of innovation instruments; we suppose those variables are explanatory for new product growth. In section 5.2 we explain the test validity of our instruments. Finally, we estimate our model with a Generalized Methods Moments (GMM) in two stages with the coefficients robust to heteroscedasticity.

4 Data and Descriptive statistics

The data used in this paper is from the National Innovation Activities Survey 2009-2011 (NIAS) "*Encuesta Nacional de Actividades de Innovación 2009-2011*". This is a survey sponsored by the Ecuadorian National Statistics and Census Office (INEC in Spanish), and Secretary of Superior Education, Science, Technology and Innovation (SENESCYT in Spanish). Is the first time in Ecuador has been made a survey about the innovation performance and decision at the firm level. In particular, the NIAS provides information about firm's characteristics follow the Frascati Manual and Oslo Manual Guide of OECD to innovation information (OECD and Eurostat, 2005,OECD, 2002). The data-set of this survey is similar at structure and variables as Community Innovation Survey (CIS) was using in OECD countries. NIAS include 15 different groups of questions and covers information about firms as: Sales, sector, relevant costs, foreign trade, exports, financial constrain, property rights, aid factors to innovation, skill labor, employment, information sources, and the innovation decision of the firm's level between years 2009-2011. The sample covers 2815 firms' data, where it using an Ecuadorian Economic Census 2010 as population and cover all regions in the country. In the sample, NIAS included all type of sectors except agricultural follow ISIC Rev. 4 from United Nation. The survey also excludes the firms with less than 10 employees.

First, we are interest in variables concerning on innovative decision. In that way, we build dummy variables for each type of innovation (***product***, ***process***, ***marketin*****g** and **or*****ganizationa*****l**). The types of innovation are referring period between 2009-2011. In the original model, they do not use the marketing and organizational innovation. Also, the process innovation is introduces as an exclusion to the firms do it only each type. In our case, we want to catch the individual effect of all type of innovation. First, product innovation take value 1 if the firm´s introduce new product/service or improvement of it, 0 otherwise; process innovation take 1 if the firm´s introduce new process or improvement of it, 0 otherwise. Marketing and organizational only have an option take 1 for change a new method in each one. In the Table 2, the firms with some type of innovation are 63.4% of the total, where product and process innovation are the innovation with higher numbers of firms do it. Also, we classify the firms do only one activity in innovation process; take all of decision and non-innovative firms. In one side, we found in the firms do all of innovation activities are lesser (0.07) than either decisions combination. On other side, the non-innovative firms are more than the other decisions (0.35) except with product and process decision, when those decisions are independently.

Second, we have the variables are concerning an employment growth. In our study, we build the variables as Harrison et al. (2014) theoretical model. In our model, the ***innovative employment growth*** is the dependent variable. That variable was obtained with ***employment growth*** minus ***sales growth from old product real.*** The first part, for ***employment growth*** we use information about firms employees 2011 and 2009 as ratio. The second part, is divided as following: first, we calculate ***sales growth*** with firm's sales 2011 and 2009; second, we used the sales of new product 2011 plus sales product improvement 2011[13] divided by total sales of 2011, this is ***ratio sales from new product***; third, the ***sales growth from new product*** is increase ***sales growth*** times **ratio sales from new product**; fourth, ***sales growth from old prod*uct** is a result of sales growth minus ***sales growth from new product;*** finally, ***sales growth from old product real*** use the result from step fourth but minus **Production Price Index (PPI) variaton**[14] effect.

In the table 2, we show the means of variables related with the employment growth equation. The employment growth, in terms of difference of employees from 2009-2011, is quite similar (around 0.21 and 0.20) between all type of innovation except organizational

[13] In the survey, the question cover percentages of sales are new product or improvement product to period 2009 to 2011. To solve this problem Harrison et al., (2014) suppose total sales, in our case 2009, came from old product, and sales in period 2011 include the effect of sales new and old product. The sales in 2011 multiply by previous percentage of the sales new product give us the sales from old and new product.

[14] Ecuador has a Production Price Index (PPI) for different sectors estimated by INEC. We used the change of PPI from 2009 to 2011. In the survey, we can match the PPI variation for 19 sectors in the manufacturing. Also, we used the PPI aggregate to manufacturing for the other firms do it this activities. Finally, the general PPI was used for the services firms.

innovation. The firms introduce an organizational innovation show 0.27 employment growth. In the same line, the firms introduce all types of innovation has higher employment growth (0.27) than other types of combination of innovative decision. Furthermore, in the same table 2 we can see the sales growth divide in two parts (from new and old products). In general, we observe firms with some type of innovation have higher growth form new products than the old. In the same line, the firms introduce all types of innovation their sales increase from new products and decrease from the older. Finally, we compare the firm's size (in number of employees)[15] from 2009 and 2011. We observe the firms have more employees in 2011 to all type of combination of innovative decision. Table 3 reports a mean test to complement that descriptive of table 2. In this case, we test which the firms in 2011 are larger from 2009. As result of that the firms in 2011 are larger. Then, we test individual decision of innovative decision. In other words, we want to know if the firms decide each type of innovation are larger, in number of employees (2011), than the firms do not innovate. In that case, the test show the innovative firms are large than non innovative.

[Instert Table 2 here]

As shows in the previous section, the ***sales growth from new product*** could present endogeneity problem. In our case, we use four variables as instrument to solve it problem. First, we transform to dummy when the firm has a high obstacle if the market was dominate for the dominant firm or uncertain in it demand. Second, we transform to dummy when the impact in it organization was medium replace product or process outdated. Third, we used the variable when the firm innovates to increase the range of its products or services. This variable has a ***natural order*** from 0 to 4 (0 no innovate and 4 to the high relevance). Four, we used a variable where the firms said the client was important to innovation as source of information. In the next section give more details about this variable.

Finally, we used the two types of control variables. First, we control by sector according technology insensitive. The survey used the *ISIC Rev.4* for the firm's classification. In our case, these types of classification generate multicollinearity[16] problems. We

[15] In the estimation we use a Ecuador classification for firms size.

[16] We found in the survey, at sector level using *ISIC Rev.4* classification, a few firms in the sector and with the same type of decision.

divide the sectors in manufacturing and services; Then, we use the (OECD, 2007) classification based in ISIC Rev. 3 for manufacturing firms but checking a correct correspondence in cases of ISIC Rev.4; Finally, we can´t find aggregate classification for the service[17], for this reason and respecting the same correspondence, we use a *NACE Rev. 2* aggregation by knowledge intensive ("High" called Knowledge or Less knowledge intenstive) for service. After this, we have information for 2,502 firms[18]. In the survey found the ***"knowledge-intensive"*** (service) concentrate a large number of firms (30.22%), this variable group sector as Information, communication, finance activities, education, among others; other important group is ***"low technology"*** (manufacturing) with 26.13% of the firms, this variable group mainly food, beverage and tobacco sectors. Second control is the size of firms. Ecuador divided the size of firms in the mixed classification between number of employees and sales level follow the Production Law (Production Code, 2010) and it particular application law (Regulation Production Code, 2011)[19]. In our case, we divide in the four groups of the firms follow Ecuadorian legacy, and generate a dummy variable for each group. Where, 16.27% are ***micro***, 42.81% are ***small***, 21.74% are ***medium***, and 19.18% are ***large***. Is important to remember, in the sampling of survey, the firms with less than 10 employees were exclude.

[Instert Table 3 here]

5 Results

5.1 Innovation and Employment effects

One of the main hypotheses in this research is about the effect of innovation variables over employment. The model Harrison et al. (2014) proposes a methodology in growth terms. The methodology uses a linear model to measure an employment growth as dependent var-

[17] The (OECD, 2006) have research about knowledge in service, but not include a aggregate description like *NACE Rev.2* to Europe countries.

[18] We not include mining and quarrying, construction, water supply, and electricity, gas, steam an air conditing supply as sector. That type of sector represent nearby 11% of the survey.

[19] Ecuador has a particular policy include a tax benefits for each type of firms. The Law (Production Code, 2010) said when do you have an incongruity between sales or number employees do you need used first one to classify the firms. The four levels are: *Micro* with sales under 100,000 USD, *Small* with sales between 100,001 to 1,000,000 USD; *Medium* 1,000,001 to 5,000,000 USD; *Large* over 5,000,001 USD.

iable. The model use fourth type of innovation and two different directions (see Table 4). First, the product innovation is measure in growth terms of sales that came from new product or services. Second, other three type of innovation (process, organizational and marketing) are measure as dichotomy decision variable. The effects over employment growth could be come from two directions efficiency or compensation effects. In our model, all type of innovation, except organizational, have some effect over employment. The product innovation (***sales growth from new product***) has a positive and stronger coefficient with a 5% of significance level. In the model, the coefficient β represents efficiency in the production between old and new products. The facts that the coefficient in our estimation (IV´s) is greater than one, which means the new products are producing *"less efficient*" than the old products. The evidence is consistence with compensation effects. In other words, when the firms introduce a new product, their need increase the number of employees to ***"satisfy"*** it demand. In this line, if the firm amplifies their market, without affect other(s), in the short-run need higher workforce. For this assumption, the old product and new product are been sold in the market together, and for our case that happened. We suggest, in Ecuador case, the product innovation could be "**undrastic**" type.[20] The innovative firms have a "***bigger market demand***" with the same resources, except employees, and the time to "better efficiency" it is quick to reorder of it **productivity structure**, for this reason our results are rational. The results for Ecuadorian firms are the same as Crespi and Tacsir (2012) for Argentina, Chile and Costa Rica; Monge-González et al. (2011) for Costa Rica independently; De Ejalde et a. (2011) for Argentina independently and Dachs and Peters(2014) in European manufacturing firms.

[Instert Table 4 here]

The other results are related with the other types of innovation. The evidence in the literature for process and organizational innovation are driven in two ways (displacement and compensation). The marketing effect has not large evidence in the employment, but could be in the same line than others. In our case, we use the three variables with the same

[20] The assumption are contradictory of the Schumpeter (1942) theory of "creative destruction", because when we do a mean test of difference between the growth in sales of new and old product the results show us are not different at 99% level of signficance. This could be interpreting when the firms innovate in new products, the old product continues in the market.

measure of estimation. The process of innovation gives a negative and significant effect (displacement effect) over employment. The firms when introduce this type of innovation try to gain in efficiency. When we combine the effect in product and process is interesting to analyze their effects. On one hand, when one firm accomplish product introduction and increases its market demand, its structure need more employees to obtain benefits of this innovation. On the other hand, when the firm decides to innovate in process could be interpreting it structure, in employee's number, need to reduce. The marketing innovation could be having both effects, but in our estimation have a positive and significant effect. This result suggests the marketing innovation is in the line of the demand increase. The marketing innovative firms require employments because it changes could not satisfy with previous structure. For example, if the firm decides change the packing (marketing innovation) could arrived the dynamic in its markets but this activity was not relevant before, the more or less important of this innovation will did the firm need new employees or not. Finally, in our estimation organizational innovation have not effect over employment growth.

The last term α_0 is related with the productivity not related with the innovation. This term capture the real productivity growth form from the old products in two years period (2009-2011). The estimation does not give us significance level of this variable; the firms with old product have not additional productivity. This result could interpret that old product not present "learning by doing" or an additional productivity comparing with the new products.

[Instert Table 5 here]

5.2 Test of instruments

In this section, we explain the process to test validity of our instruments. The variable gives us an endogeneity problem with g_2. In that case, to solve this problem, we need to find some variables which it correlates with g_2 and uncorrelated with the error term. In our case, we use four instruments that economic intuition drive in the same way of our interest. The model is divide in two stage, the first stage use all exogenous variables (***innovation dummies, and statistics controls***) and instruments (***range, customers, market and replace***) over variable we want instrumented (***sales growth from new product)***. In this part, we are interesting in the significance of the instruments. The result of this stage is: one variable (range) is significant at 1%, two variables (customers and replace) are significance at 5%, and one variable (market) is significant at 10%. That means our instruments have correlation with the instrumented variable. The F-test gives value of 31.41 with a 99% level.

On the other part, we test some identification problems as under identification, weak or over identification of instruments. First one, the null Hypothesis of this test assumes the regresses are endogenous. In other words, the variables we used in our model not solve the endogeneity problems. The statistics use a chi^2 with degrees of freedom plus 1 (**Number of excluded instruments – number endogenous regressor + 1**). Our variables reject the null hypothesis with at 99% level, that mean our model is identified with the instrument chosen. Second one, the weak identification test has the same null hypothesis to the 2 type of statistics test. The Kleibergen-Paap or Cragg- Donald gives value 30.26 and 31.41 respectively, where in this case we reject Nulle hypothesis of weakly identification. Finally, when the model presents heteroscedasticity we can use the Hansen-Test[21]. This test uses a chi^2 distribution with three degree of freedom for our case, where the null hypothesis is the exogeneity of all instruments. The result of Hansen-test is 0.84 that means we reject he null hypothesis and our four instruments are exogenous at 99% level. In other words, our instruments solve endogeneity problems in estimation of employment growth.

In both stage of estimation, we control by size of the firms and sector by technology. The first stages result is in the table 5, and in the table 4 on column 2 shows the employment growth with IV´s estimation. In fact, we observe two changes in the IV´s and OLS estimations. The IV´s changes the direction of process innovation. Now, the process innovation drives in the way of “displacement” effect over employment growth. That results are not large different which others in the literature (see appendix 3). The same thing happens with the sales growth form new product. In that case, the OLS estimation shows un-significant variable. When, we introduce instruments in our estimation the coefficient is positive at 5% level. That means, g_2 contribute to the job creation.

[Instert Table 4 here]

5.3 Innovation effects over employment growth

[21] This test also is Sargan Test, for this case the estimation model present homocedasticity.

In this section, we try to generate a weighted average of employment growth. In other words, we use the previous estimation to found average percentage of employment growth coming from innovation. We create a equation similar than Harrison et al. (2014), where use a estimation coefficients and the average from terms of equation. The equation to the average percentage of employment growth can be written as:

$$l = \widehat{\alpha_0} + \widehat{\alpha_1} d_{ind} + \widehat{\alpha_2} d_{size} + \widehat{\alpha_3} proc + + \widehat{\alpha_3} mkt + \widehat{\alpha_3} org + \hat{\beta} g_2 + g_1 + \hat{\varepsilon} \quad (5)$$

where industry and size dummies average are multiply by coefficients from estimation. In the case of sales growth from new and old product, we try to separate the effects of each one for innovative firms. In that way, it firms (product innovation) could increase the sales from old products, proportionately high than the new products. For separate the weighed of innovative firms, we separate the sales from old products in two parts. First part, we use the sales growth from old product average which comes to innovative firms (product innovators). Second, we do the same average but only for the non product innovators. As result, we have a term for innovative firms with average in product innovation, sales growth from old product average to product innovators, and estimation from sales growth from new products multiplied by it average. Following, this instruction the equation 5 can rewrite as:

$$l = \sum \widehat{\alpha_0} + \widehat{\alpha_1} d_{ind} + \widehat{\alpha_2} d_{size} + \widehat{\alpha_3} proc + + \widehat{\alpha_3} mkt + \widehat{\alpha_3} org + (\hat{\beta} g_2 + g_1 * dprod) dprod + g_1 * (1 - dprod) + \hat{\varepsilon} \quad (6)$$

Following equation 6, the table 6 shows the results of the employment growth in Ecuador. The employment growth in average is around of 18%, where the marketing innovation and the firms with product innovation generate a positive effect over job creation. On the hand, the process and organizational innovation has an opposite effects, but in less magnitude. That result could interpret as the net effect of innovation over employment growth is positive. In other words, the net effect of innovation types over employment growth (18%) is around the 29%.

5.4 Innovation, skills labor and salaries

In this section, we try to understand labor performance in the innovative Ecuadorian firms. The data set uses in previous section has information about the education level of employees in the firms, but it does not available the salaries. For this reason, the first part uses the Innovation Activities data set, and second part use the Ecuadorian Economic Census.

For the first part, we use a skilled labor follow the De Ejalde et al. (2015) methodology. They define a skilled labor the percentage of employees has more than basic education (primary and secondary). In our case, this percentage includes employees with PhD, Master, Bachelor degrees, Specialists and Technicians. Furthermore, we use that terms as dependent variable (in logs) with two different specifications. First, we apply instrumental variables and introduce an innovative employment growth (*g1*) as explanatory variable. Second, we apply OLS with for type of innovation as explanatory variables (Sales growth from new products as product innovation). In both estimations introduces a sizes and industry dummy controls. The industry dummy control takes 1 if the firm is High technology in manufacturing or Knowledge intensive in services, 0 on otherwise. We proof with different types of industry classification, but could not capture any effects. Our aim, of both estimations, is the innovation contributes to have higher percentage of skilled employees. In other words, we want demonstrate the innovative firms has higher qualify employees. In both estimations, our results drive on the same line. The column 1 and 2 of table 7 shows the results of both estimations from OLS and IV´s respectively. In both cases, the effect of innovation is positive and significant at 5% and 1% respectively. That results suggest, the innovation in the firms contribute to attract the most qualify employees.

In the same way, we use the Ecuadorian Economic Census from 2010[22] to find which the innovative firms paid higher salaries than non-innovative. This data set does not have information about the innovative decision by types. In that case, we use the information about R&D as approach the innovation at firm level. On the one hand, we use the R&D dummy as explanatory variable, and salaries at dependent variable. On the other hand, we use the same dependent variable but R&D expenditure as explanatory. We utilize OLS for both estimations with controls by size and sector. The results are showing in the column 3 and 4 of table 7. As results of, the innovation generates a positive and significant effect over salaries. That means the firms which introduce R&D activities paid higher sala-

[22] See (Rodríguez-Moreno and Rochina-Barrachina, 2015) to details about the data set structure.

ries than the others. Also, micro and small firms (*dsize_2009_1; dsize_2009_2*) have a negative effect; that could interpret as these types of firms paid less salaries than the medium and large firms.

Finally, is important remark about the industry dummy it positive effect in four estimations. In fact, this variable captures the "*most innovative*" sector in manufacturing and services together, where it positive effect drive in the way of the firms required skilled labor and paid higher salaries.

6 Conclusion

In this study we try to explain the effect over firms output (employment) coming from innovative decision of the firms. The literature in the economics continue works if the effect are direct or indirect at the firm level. We use methodology of Harrison et al. (2014) to find the effect over employment by the firm innovative decision in Ecuadorian firms. This type methodology has several studies in different countries but is the first time using with Data set of National Innovation Activities Survey 2009-2011. At difference of Harrison et al. model, we introduce the four type of innovation (product, process, marketing and organizational) to measure separately it effect over employment. Our estimation suggests the three of four type innovation has effect over employment but in different ways. First, product innovation, measured the sales growth from new product, gives us a compensation effect line. This result suggests the hypothesis that the firms need to increase the number of employees to cover this new "demand". Furthermore, the new and old products can live inside the firms and markets. This part are contrary a Schumpeter theory about the creative destruction. Also, the coefficient value, more than one, could be interpreting that the new product are efficient in it productivity terms than the older. Second, the process innovation is in the line of displacement effect over employment. We could explain when the firms, decide this type of innovation was not efficient with their resources. This efficiency problem could bring competency problems. For example, if one firm has cost higher than it competitor in the "homogenous" product industry, it firm is in disadvantage. The process innovation keeps a "possibility" to survive in homogeneous-product market. Third, the marketing innovation individual effect is novelty explored in the employment researchers. Our results suggest the firm decide this type innovation is in the compensation effect line.

The marketing innovation could improvement to increase their demand or create a demand for product. Both things require, in the some stage of the product cycle, an important push of people to promote it product(s). Finally, the methodology improvement presents correlation problems between the sales growth from new product and productivity shocks (error terms). We use four instrument are not correlate with error term but have correlation with our proxy of product innovation. We use different test to validate our instruments and our estimation was correct endogeneity problems.

In a second section of results, we are interest in introduce another robustness instrument to measure the effect of innovative over employment. In facts, we found the innovation contribute to skilled labor in the firms. As results, the innovative firms require high number of employees than the non-innovative. Finally, the NIAS do not have a information about salaries per employees. In this case, we use the Ecuadorian Economic Census to introduce salaries as dependent variables and R&D (dummy and expenditure) as approach of innovation measure. The results drive in the line of the innovative firms paid higher salaries than the non-innovative.

This type of study has high importance to the developing countries. Ecuadorian firms are not technology intensity in their production. For CEO´s in Ecuador is important could demonstrate with empirical research the innovation decision give result in short and long run. In the countries with less experience with the "innovation culture" need more evidence of it benefits. This research contributes to promote this aims.

7 References

Acemoglu, D., 1998. Why Do New Technologies Complement Skills? Directed Technical Change and Wage Inequality. The Quarterly Journal of Economics 113, 1055-1089.

Acs, Z.J., Audretsch, D.B., 1988. Innovation in large and small firms: an empirical analysis. Am. Econ. Rev. , 678-690.

Barras, R., 1986. Towards a theory of innovation in services. Research Policy 15, 161-173.

Basker, E., 2005. Job Creation or Destruction? Labor Market Effects of Wal-Mart Expansion. Rev. Econ. Stat. 87, 174-183.

Bogliacino, F., Lucchese, M., 2016. Endogenous skill biased technical change: testing for demand pull effect. Industrial and Corporate Change 25, 227-243.

Crespi, G., Tacsir, E., 2012. Effects of Innovation on Employment in Latin American. IDB-TN 496.

Dachs, B., Peters, B., 2014. Innovation, employment growth, and foreign ownership of firms: A European perspective. Research Policy 43, 214-232.

de Elejalde, R., Giuliodori, D., Stucchi, R., 2015. Employment and Innovation: Firm-Level Evidence from Argentina. Emerging Markets Finance and Trade 51, 27-47.

de Elejalde, R., Giuliodori, D., Stucchi, R., 2011. Employment Generation, Firms Size and Innovation: Microeconometric Evidence from Argentina. IDB-TN 313.

Evangelista, R., Vezzani, A., 2012. The impact of technological and organizational innovations on employment in European firms. Industrial and Corporate Change 21, 871-899.

Falk, M., 2015. Employment effects of technological and organizational innovations: Evidence based on linked Firm-Level Data for Austria, Journal of Economics and Statistics 253(3), 268-285.

Falk, M., 2001. Organizational change, new information and communication technologies and the demand for labour in services. ZEW Discussion Papers , 01-25.

Flikkema, M., Jansen, P., Van, D.S., 2007. Identifying Neo-Schumpeterian Innovation in Service Firms: A Conceptual Essay with a Novel Classification. Economics of Innovation and New Technology 16, 541-558.

Fortune, 2015. Fortune 500. 2016.

García, A., Jaumandreu, J., Rodríguez, C., 2004. Innovation and jobs: evidence from manufacturing firms .

Giuri, P., Torrisi, S., Zinovyeva, N., 2008. ICT, skills, and organizational change: evidence from Italian manufacturing firms. Industrial and Corporate Change 17, 29-64.

Hall, B.H., Lotti, F., Mairesse, J., 2008. Employment, innovation, and productivity: evidence from Italian microdata. Industrial and Corporate Change 17, 813-839.

Harrison, R., Jaumandreu, J., Mairesse, J., Peters, B., 2008. Does innovation stimulate employment? A firm-level analysis using comparable micro-data from four European countries. National Bureau of Economic Research Working Paper 14216.

Harrison, R., Jaumandreu, J., Mairesse, J., Peters, B., 2014. Does innovation stimulate employment? A firm-level analysis using comparable micro-data from four European countries. International Journal of Industrial Organization 35, 29-43.

International Labour Office, 2009. Guide to the New Millennium Development Goals Employment Indicators Including the Full Set of Decent Work Indicators . International Labour Office, Geneva.

Junge, M., Severgnini, B., Sørensen, A., 2015. Product-Marketing Innovation, Skills, and Firm Productivity Growth. Rev. Income Wealth , n/a-n/a.

Lederman, D., Messina, J., Pienknagura, S., Rigolini, J., 2013. Latin American Entrepreneurs: Many Firms but Little Innovation. World Bank Publications.

Marouani, M.A., Nilsson, B., 2016. The labor market effects of skill-biased technological change in Malaysia. Econ. Model. 57, 55-75.

Mohnen, P., Hall, B.H., 2013. Innovation and productivity: an update. Eurasian Business Review 3, 47-65.

Monge-González, R., Rodríguez-Alvarez, J., Hewitt, J., Orozo, J., Ruiz, K., 2011. Innovation and Employment growth in Costa Rica a Firm-level Analysis. IDB-TN 318.

Mothe, C., Nguyen-Thi, T., Uyen, 2012. Non-technolocial and technological innovation: do services differ from manufacturing? An emperical analysis of Luxembourg firms. International Journal of Technology Management 57, 227-244.

Murphy, M., 2002. Organisational Change and Firm Performance. OECD Science, Technology and Industry Working Papers .

OECD, 2007. OECD Science, Technology and Industry Scoreboard 2007. Organisation for Economic Co-operation and Development.

OECD, 2006. Innovation and Knowledge-Intensive Service Activities. Organisation for Economic Co-operation and Development.

OECD, 2002. Frascati Manual: Proposed Standard Practice for Surveys on Research and Experimental Development.

OECD, Eurostat, 2005. Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data. Organisation for Economic Co-operation and Development Publishing, Paris.

Peters, B., 2004. Employment effects of different innovation activities: Microeconometric evidence. ZEW-Centre for European Economic Research Discussion Paper .

Peters, B., Riley, R., Siedschlag, I., 2013. The Influence of Technological and Non-Technological Innovation on Employment Growth in European Service Firms. Servicegap Discussion Paper 40.

Pianta, M., 2005. Innovation and Employment, in Fagerberg, J., Mowery, D, C, (Eds.), The Oxford Handbook of Innovation. Oxford Handbooks Online, pp. 568-598.

Presidencia de la República del Ecuador, 2011. Reglamentos al Código de la Producción.

Registro Oficial, 2010. Código Orgánico de la Producción Comercio e Inversiones. 351.

Rodríguez-Moreno, J., Rochina-Barrachina, M., 2015. Innovación y productividad en las empresas manufactureras ecuatorianas. Cuadernos económicos de ICE , 107-136.

Romer, P.M., 1986. Increasing returns and long-run growth. The journal of political economy , 1002-1037.

Rust, R., Ambler, T., Carpenter, G., Kumar, V., Srivastava, R., 2004. Measuring Marketing Productivity: Current Knowledge and Future directions. Journal of Marketing 68, 76-89.

Schubert, T., 2010. Marketing and Organisational Innovations in Entrepreneurial Innovation Processes and their Relation to Market Structure and Firm Characteristics. Review of Industrial Organization 36, 189-212.

Schumpeter, J., 1942. Capitalism, Socialism, and Democracy. New York: Harper & Bros .

Schwartz, L., Guaipatín, C., 2014. Ecuador: Análisis del Sistema Nacional de Innovación: Hacia la consolidación de una cultura innovadora. IDB-MG-223.

USA TODAY, 2013. The 10 largest employers in America. 2016.

Utterback, J., Abernathy, W., 1975. A Dynamic Model of Process and Product Innovation. Omega 3, 639-656.

Vivarelli, M., 2013. Technology, employment and skills: an interpretative framework. Eurasian Business Review 3, 66-89.

Vivarelli, M., 2014. Innovation, Employment and Skills in Advanced and Developing Countries: A Survey of Economic Literature. Journal of Economic Issues 48, 123-154.

WIPO, INSEAD, 2011. Global Innovation Index 2011 Accelerating Growth and Development. INSEAD, France.

Zuniga, P., Crespi, G., 2013. Innovation strategies and employment in Latin American firms. Structural Change and Economic Dynamics 24, 1-17.

Table 1 Innovation and Employment Indicators Part A Andean Countries

Variables	Bolivia			Colombia			Ecuador			Peru		
	2009	2010	2011	2009	2010	2011	2009	2010	2011	2009	2010	2011
R&D expenditure (% of GDP)	0.16	n/a	n/a	0.21	0.21	0.22	0.39	0.40	0.34	0.16*	n/a	n/a
Researchers in R&D (per million people)	145.71	165.95	n/a	165.13	184.88	160.66	118.35	141.30	180.30	n/a	n/a	n/a
Charges for the use of intellectual property, payments (in million US$)	18.00	19.00	20.00	298.00	362.00	424.00	47.00	54.00	65.00	152.00	196.00	215.00
Charges for the use of intellectual property, receipts (in million US$)	2.50	2.80	7.10	39.00	56.00	59.00	n/a	n/a	n/a	2.10	3.00	5.30
Patent applications, nonresidents	n/a	n/a	n/a	1,551	1,739	1,770	668	690	n/a	657	261	1,129
Patent applications, residents	n/a	n/a	n/a	128	133	183	6	4	n/a	37	39	39
Unemployment, total (% of total labor force) (national estimate)	3.40	n/a	2.70	11.80	12.00	11.10	6.50	5.00	4.20	4.40	4.00	3.90
Part time employment, total (% of total employment)	23.30	n/a	n/a	15.10	16.30	16.90	20.40	17.90	17.00	18.80	20.50	19.40
Vulnerable employment, total (% of total employment)	54.90	n/a	54.30	47.30	48.60	48.80	42.50	41.80	43.90	48.00	47.70	47.80

Source: World Bank Indicators

* The last information for Peru R&D over GDP is from 2004.

Table 1 Innovation and Employment Indicators Part B – Other Latin American Countries

Variables	Argentina			Brazil			Chile			Costa Rica			Mexico		
	2009	**2010**	**2011**	**2009**	**2010**	**2011**	**2009**	**2010**	**2011**	**2009**	**2010**	**2011**	**2009**	**2010**	**2011**
R&D expenditure (% of GDP)	0.48	0.49	0.52	1.12	1.16	1.14	0.35	0.33	0.35	0.54	0.48	0.47	0.43	0.45	0.42
Researchers in R&D (per million people)	1,071.53	1,154.21	1,208.48	656.34	698.10	n/a	288.71	319.72	353.37	997.94	1,232.71	1,327.47	367.87	379.75	383.21
Charges for the use of intellectual property, payments (in million US$)	1,461.00	1,618.00	1,958.00	2,512.00	3,225.00	3,747.00	596.00	726.00	773.00	64.00	63.00	214.00	1,823.00	658.00	774.00
Charges for the use of intellectual property, receipts (in million US$)	101.00	147.00	177.00	433.00	189.00	300.00	59.00	64.00	75.00	0.58	7.50	n/a	94.00	88.00	96.00
Patent applications, nonresidents	4,336	4,165	4,133	18,135	20,771	23,954	1,374	748	2,453	n/a	1,212	630	13,459	13,625	12,990
Patent applications, residents	640	552	688	4,271	4,228	4,695	343	328	339	n/a	8	14	822	951	1,065
Unemployment, total (% of total labor force)	8.60	7.70	7.20	8.30	n/a	6.70	9.70	8.10	7.10	7.80	7.30	7.70	5.20	5.20	5.20
Part time employment, total (% of total employment)	24.00	20.50	19.90	17.80	n/a	16.00	10.10	18.00	17.20	14.20	15.30	12.00	17.80	18.70	18.00
Vulnerable employment, total (% of total employment)	19.60	19.00	18.60	25.10	n/a	24.50	n/a	n/a	n/a	20.10	20.40	20.20	n/a	n/a	n/a

Source: World Bank Indicators

Table 2 Descritptive statistics

Variables	% of firms	Employment_ growth	Sales_growth_ old_R (a)	Sales_growth_ NewP (b)	Sales_ Growth (a+b)	Log_ workers2009	Log_ workers2011
d_prod	0.432	0.217	0.031	0.600	0.632	3.692	3.836
d_proc	0.421	0.219	0.208	0.462	0.670	3.765	3.916
d_mark	0.250	0.206	0.138	0.375	0.513	3.603	3.740
d_org	0.239	0.272	0.300	0.437	0.738	3.759	3.937
d_onlyprod	0.073	0.178	-0.019	0.544	0.525	3.263	3.377
d_onlyproc	0.065	0.169	0.813	0	0.813	3.593	3.715
d_onlymark	0.041	0.106	0.234	0	0.234	3.279	3.333
d_onlyorg	0.036	0.189	0.291	0	0.291	3.544	3.671
d_allinnov	0.071	0.270	-0.0815	0.642	0.561	3.87	4.073
d_noninov	0.358	0.148	1.179	0	1.179	3.283	3.335
Number of firms	2437						

Table 3 Mean Test by type of innovation

	Difference	Std. Err.
workers 2011 vs 2009	0.112 ***	0.006
d_prod (1) vs d_prod (0)	0.389 ***	0.051
d_proc (1) vs d_proc (0)	0.520 ***	0.051
d_mark (1) vs d_mark(0)	0.165 ***	0.059
d_org (1) vs d_org (0)	0.422 ***	0.060
d_onlyprod (1) vs d_onlyprod (0)	-0.257 ***	0.009
d_onlyproc (1) vs d_onlyproc (0)	0.106	0.104
d_onlymark (1) vs d_onlymark (0)	-0.295 **	0.130
d_onlyorg (1) vs d_onlyorg (0)	0.057	0.138
d_allinnov (1) vs d_allinnov (0)	0.404 ***	0.100
d_noninov (1) vs d_noninov (0)	-0.343 ***	0.053

H0= difference 1 – difference 0; *, ** and *** significant at 10%, 5% and 1% level.

Table 4 The effect of innovation and employment (Final Stage)

Dependent variable: Innovative employment growth[b]	OLS Estimation	(1) IV estimation[a]
Sales_growth_NewP	-0.249	1.444**
	(0.394)	(0.052)
d_proc	0.381*	-0.246**
	(0.075)	(0.099)
d_org	0.157	-0.107
	(0.438)	(0.468)
d_mark	0.355*	0.324**
	(0.072)	(0.057)
Constant	-1.229	-1.076
	(0.350)	(0.322)
Observations	2,437	2,437
Hansen test Chi^2 (3)	n/a	0.806
P-value Hansen test[a]	n/a	0.841

*, ** and *** significant at 10%, 5% and 1% level.
Coefficients and standar errors robust to heteroscedasticity.
a: Ho: $E(Z, u) = 0$
b: The estimation include the Size and Sector controls

Table 5 Test of instruments – First stage

Depend variable: Sales_growth_NewP	OLS (First)
d_proc	0.0503
	(0.272)
d_org	0.095*
	(0.071)
d_mark	-0.044
	(0.0422)
dsize_2009_1	0.239***
	(0.000)
dsize_2009_2	0.107***
	(0.003)
dsize_2009_3	0.058**
	(0.037)
OECD_HIGH	-0.043
	(0.531)
OECD_MED_HIGH	0.0456
	(0.592)
OECD_MED_LOW	-0.053
	(0.383)
OECD_LOW	-0.041
	(0.467)
OECD_KNOWLEDGE	-0.0263
	(0.659)
Instruments	
Range	0.084***
	(0.000)
Customers	0.120**
	(0.020)
Market	0.078*
	(0.107)
Replace	0.118**
	(0.025)
Constant	-0.080**
	(0.018)
Observations	2,437
R-squared	0.111
Endogeneity test	
F-test signif. Of IVs	31.41
p-value	0.000

*, ** and *** significant at 10%, 5% and 1% level
Coefficients and standard errors robust to heteroscedasticity

Table 6 Decomposition employment growth

Variables		Percentage
Employment_growth	l	0.185
α_0		-1.112
no product innov	$g_1 \ (d\_prod_i = 0)$	0.475
product innov	$(\widehat{g_2} + \ g_1) \ (d\_prod_i = 1)$	0.336
<u>Type of innovation</u>		
d_proc		-0.103
d_org		-0.025
d_mark		0.080
<u>Industry</u>		
OCDE_HIGH		0.010
OCDE_MED_HIGH		0.055
OCDE_MED_LOW		0.197
OCDE_LOW		0.310
OCDE_KNOWLEDGE		0.396
<u>Size</u>		
dsize_2009_1		-0.089
dsize_2009_2		-0.349
dsize_2009_3		0.000

Table 7 the effect of innovation in the skill labor and salaries

Dependent variables	(1)[a] skilled_labor OLS	(2)[b] skilled_labor IV	(3)[c] log_salaries	(4)[d] log_salaries
Innovative employment growth	0.002***			
	(0.002)			
Sales_growth_NewP		0.415**		
		(0.039)		
d_R&D			0.855***	
			(0.000)	
Log_R&D expenditure				0.133***
				(0.000)
d_proc		-0.224**		
		(0.023)		
d_org		0.131		
		(0.131)		
d_mark		-0.014		
		(0.852)		
dsize_2009_1	0.347***	0.270**	-2.126***	-2.107***
	(0.002)	(0.032)	(0.000)	(0.000)
dsize_2009_2	0.093	0.053	-0.656***	-0.643***
	(0.287)	(0.557)	(0.000)	(0.000)
dsize_2009_3	-0.106	-0.120	0.925***	0.921***
	(0.281)	(0.228)	(0.000)	(0.000)
OCDE_GROUP_HIGH	1.779***	1.750***	0.599***	0.597***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-1.329***	-1.330***	10.506***	10.487***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	2,437	2,437	126,737	126,737
R-squared	0.222	0.202	0.406	0.409
Hansen test Chi2(3)	n/a	3,35	n/a	n/a
P-Value Hansen test a	n/a	0,34	n/a	n/a

*, ** and *** significant at 10%, 5% and 1% level

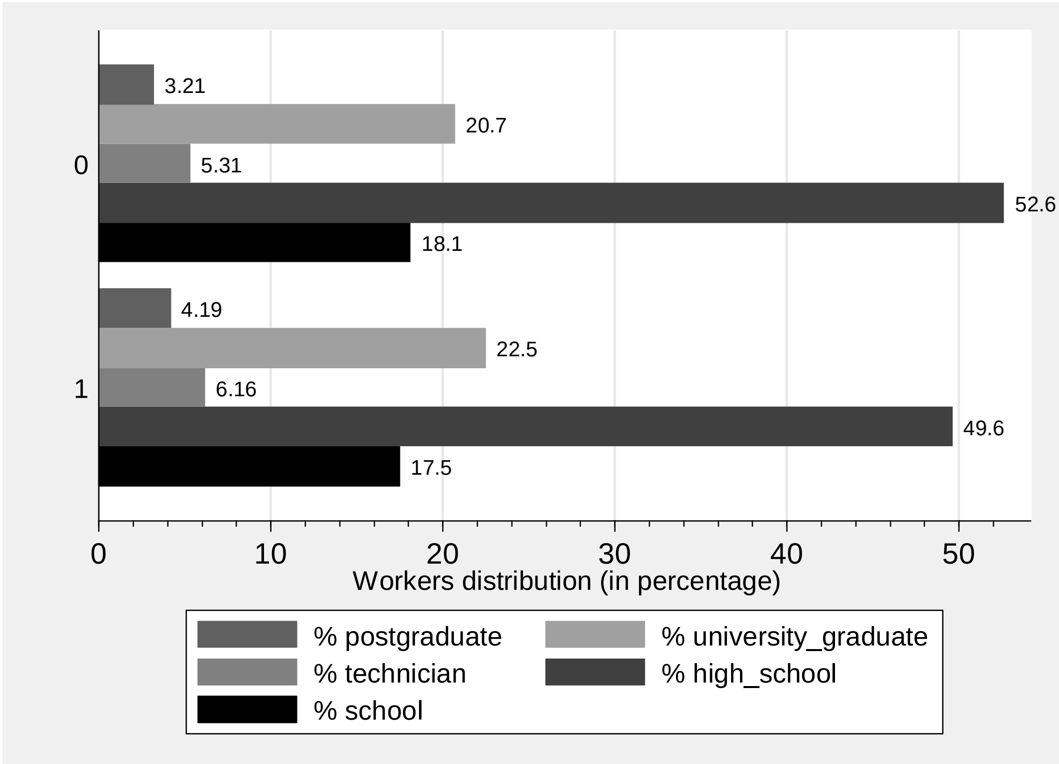
Coefficients and standard errors robust to heteroscedasticity

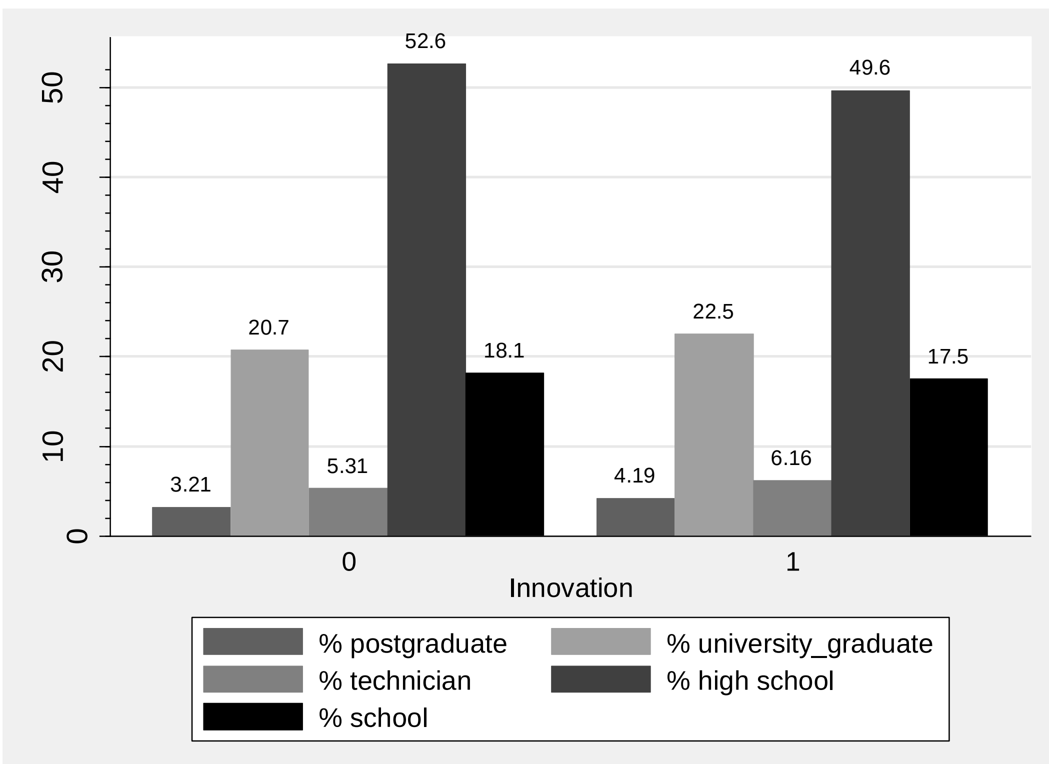
a, b: That dependent variables are the log transformation of percentage of the Skilled workers. Skilled workers are employees with Phd, master, university, specialist, and technician as education.

c,d: The salaries logarithms are information from ***Ecuadorian Economist Census 2010***.

e: Follow the OCDE classification, this variable joint the higher innovative sectors in manufacturing and services. In this case, we use OCDE_HIGH and OCDE_KNOWLEDGE.

Figure 1 Workers distribution by firm innovative performance





Appendix 1 Variables description

Name of variable	Description
d_prod	Dummy product take 1 if the firm innovate in product, 0 otherwise
d_proc	Dummy process take 1 if the firm innovate in producess, 0 otherwise
d_mark	Dummy marketing take 1 if the firm innovate in marketing, 0 otherwise
d_org	Dummy organizational take 1 if the firm innovate in organizational, 0 otherwise
d_onlyprod	Dummy only product take 1 if the firm innovate only in product, 0 otherwise
d_onlyproc	Dummy only process take 1 if the firm innovate only in process, 0 otherwise
d_onlymark	Dummy only marketing take 1 if the firm innovate only in marketing, 0 otherwise
d_onlyorg	Dummy only organizational take 1 if the firm innovate only in organizational, 0 otherwise
d_someinnov	Dummy some type of innovation take 1 if the firm innovate, 0 otherwise
d_allinnov	Dummy all innovation take 1 if the firm innovate in fourth types, 0 otherwise
d_noninov	Dummy non innovative firms take 1 if the firm no innovate, 0 otherwise
Employment_growth	Rate between employees 2009 to 2011
Sales_growth_old_R	Sales growth from old product real
Sales_growth	Rate between sales 2009-2011
Sales_growth_NewP	Sales growth from new product, where the firms give information if have some percentage of their sales brought from new product
Innovative_empl_growth	Employment growth – sales growth old produc in real terms. The real terms use a PPI index by sector.
Log_workers2009	Number or employees in 2009 in log terms
Log_workers2011	Number or employees in 2011 in log terms
Controls	
dsize_2009_1	Micro Firms, when the Sales in the year are less or equal 100,000 US dollar
dsize_2009_2	Small Firms, when the Sales in the year are more 100,000 US dollar and less or equal 1 million US dollar
dsize_2009_3	Medium Firms, when the Sales in the year are more 1 millon US dollar and less or equal 5 million US dollar
dsize_2009_4	Large Firms, when the Sales in the year are less or equal 5 million US dollar
OECD_HIGH OECD_MED_HIGH OECD_MED_LOW OECD_LOW	Sector classification by technology intensity following NACE Rev 2. for Manufacturing firms
OECD_KNOWLEDGE OECD_LESS KNOWLEDGE	Sector classification by knowledge intensity following NACE Rev 2. for services firms
Instruments	
Range	Variable have a natural order from 1 to 4. The firm take value 4 if increase their product/service portofolio are high importance, 3 medium, 2 low, 1 not relevant.
Customers	Dummy take 1 when the customers have high importance as sources information to innovate for the firm, 0 otherwise.
Market	Dummy take 1 when the firm have obstacule at high level in two cases: 1) the incumbents firms dominate a market; 2) uncertain with demand for innovative good and services; 0 otherwise.
Replace	Dummy take 1 if the firm has impact at high level when it replaces the product or process outdated, 0 otherwise.

Appendix 2 Descriptive Variables statistics

Variable	Mean (SD)
Innovative_empl_growth	-0.251
	(15.00)
Sales_growth_NewP	0.260
	(0.765)
dproc	0.422
	(0.494)
dorg	0.239
	(0.427)
dmark	0.250
	(0.433)
dsize_2009_1	0.144
	(0.351)
dsize_2009_2	0.447
	(0.497)
dsize_2009_3	0.220
	(0.414)
OECD_HIGH	0.00903
	(0.0946)
OECD_MED_HIGH	0.0484
	(0.215)
OECD_MED_LOW	0.158
	(0.365)
OCDE_LOW	0.264
	(0.441)
OCDE_KNOWLEDGE	0.301
	(0.459)
Observations	2,437

Appendix 3 Innovation estimation with the Harrison et al. (2014) Model in different countries

Country	α_0	New Product (g2)	Proc	Org	Mark	Observation
Italy	-2.80***	0.95***	-1.22*	n/a	n/a	Hall et al (2008); Process dummy are restricted to do Only process.
European Countries Manufacturing	-14.878*** -14.062*** -14.020*** -14.015***	0.998*** 1.011*** 1.011*** 1.011***	-2.171** -1.970** -1.970** -1.973**	n/a	n/a	Dachs & Peters (2014) – Process dummy are restricted to do Only process innovation. The model do differents estimation dependent of it owners. DnGF: Domestically owned non-group firms DGF: Domestically owned group firms FOF: Foreign-owned firms FOFEU: Foreign-owned European firms FOFNON-EU: Foreign-owned non-European firms from: Bulgaria, Czech Republic, Denmark, Estonia, Spain, France, Greece, Hungary, Italy, Luxembourg, Latvia, Norway, Portugal, Romania, Slovenia, Slovaquia
European Countries Service	-11.144*** -10.338*** 10.348*** -10.375***	0.893*** 0.903*** 0.903*** 0.903***	-1.573 -1.598 1.599 -1.603	n/a	n/a	
European Countries (28)	11.486***	0.676***	-0.001	0.307***		Damijan et al. (2014). Organizational y Marketing are including together
France	-3.52***; -5.25**	0.98; 1.16	-1.31***; -1.45***	n/a	n/a	Harrison et al (2014) - International Journal of Industrial Organization. Process dummy are restricted to do Only process innovation. The results are separate to Manufacturing and Services
Germany	-6.95***; -3.36	1.01**; 0.92	-6.19***; 1.54***	n/a	n/a	
Spain	-6.11***; -4.04*	1.02; 0.99	2.46***; -0.38***	n/a	n/a	
UK	-6.30***; -5.51***	0.99*; 1.05	-3.51***; 3.21***	n/a	n/a	
Bulgaria	-5.820***	0.994***	-0.771	3.820	n/a	Peters et al (2013). Process dummy are restricted to do Only process. The estimation is restricted by services firms.
Cyprus	-7.263**	1.028***	-0.246	-1.507	n/a	
Czech Republic	-35.034***	1.054***	1.870	-1.906	n/a	
Germany	-5.444**	1.050***	0.346	0.098	n/a	
Estonia	-12.931***	0.624***	-5.092	-1.251	n/a	
Spain	7.560***	0.918***	1.652	-2.026	n/a	
France	-9.075***	0.899***	0.256	-2.314**	n/a	
Hungary	-10.099***	1.042***	2.917	-0.011	n/a	
Italy	6.878***	1.026***	2.564	-0.265	n/a	
Lithuania	10.654	0.978***	-16.689**	-8.698	n/a	
Luxemburg	0.511	1.299***	25.596***	-9.611*	n/a	
Latvia	14.455***	1.310***	-9.976	-2.100	n/a	
Malta	-16.162***	1.008***	-7.759	-1.833	n/a	
Netherlands	3.871***	1.085***	-1.738	-1.104	n/a	
Portugal	1.195	0.973***	2.431	-1.871	n/a	
Romania	6.912***	0.885***	-7.811	2.419	n/a	
Slovenia	-1.348	0.773***	-7.315	5.837	n/a	
Slovakia	-28.010***	0.925***	-9.193	8.134	n/a	
UK	-7.209***	1.107***	4.383*	-0.292	n/a	
Ireland	-5.785	1.123***	-1.205	-4.813	n/a	

Continue Appendix 3

Argentina	-0.994	1.170***	1,398	n/a	n/a	Crespi & Tacsir (2012) Process dummy are restricted to do Only process. The estimation is restricted by manufacturing firms.
Chile	-2,016	1.751***	0.333	n/a	n/a	
Costa Rica	-12.160**	1.015***	18.413*	n/a	n/a	
Uruguay	1.402**	0.961***	-2.716**	n/a	n/a	
Chile	-0.790**	0.545***	n/a	n/a	n/a	Benavente & Lauterbach (2008); Process dummy are restricted to do Only process
Costa Rica	-12.160**	1.015***	18.413*	n/a	n/a	Monge-González et al (2011); Process dummy are restricted to do Only process
Argentina	0.082	1.294***	0.717	n/a	n/a	De Elejalde et al (2011); Process dummy are restricted to do Only process. The estimation is restricted by manufacturing firms.
Argentina	n/a	1.151***	1.252	n/a	n/a	De Elejalde et al (2015); IV