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Research Article

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Abstract

The objective is to determine how market concentration affects firms' decisions to innovate. With company-level data l from the 2010 Ecuadorian economic census , a probabilistic/linear model was calculated with correction for selection bias. Ecuadorian companies have a limited innovation capability and there is a persistence in market concentration. The estimates confirm the theory of market power in the propensity to innovate for both models. Consequently, increased market share leads to an increase in the likelihood of innovation, thanks to the ability to exploit the gains from these processes.

Resumen

El objetivo es determinar cómo la concentración del mercado afecta a la decisión de las empresas de innovar. Con datos a nivel de empresa del censo económico 2010 del Ecuador, se calcula un modelo probabilístico y lineal con corrección del sesgo de selección. Existe una baja capacidad de innovación de las empresas ecuatorianas y una persistencia en la concentración del mercado. Las estimaciones confirman la teoría del poder de mercado en la propensión a innovar para ambos modelos. Por consiguiente, el aumento de la cuota de mercado conduce a un aumento de la probabilidad de innovación, gracias a la capacidad de explotar los beneficios de estos procesos.

1. Introduction

Due to global competition, firms have been forced to focus on new lines of business by introducing product or process innovations in their production chains (Ahmad *et al.*, 2018). They do this in order to gain a competitive advantage through increased efficiency and profitability, seeking to increase their market shares through the creation of a better reputation. The Organisation for Economic Co-operation and Development (OECD) reports show that firms that innovate continuously have the most skilled workers, receive the highest wages and have the most efficient production systems (Gao *et al.* 2017).

In this sense, to evaluate the causes by which companies undertake innovation processes of goods or services has been a recurrent theme in the literature in developed countries. , In general, positive relations have been found between internal characteristics of the company like size, age, economic sector, and location among others (Mohr, 1969; Tavassoli, 2015; Hermosilla & Wu, 2018). The analysis of these determinants in developing countries, especially in Latin America, has been abundant in recent years. Morales, Ortíz Riaga, & Arias Cante (2012) reviewed a set of papers on the determinants of innovation in Latin America. They found that factors related to innovation systems have a considerable impact within organizations. These national systems provide guarantees and facilities that can influence organizations in the acquisition and development of their capabilities. For many companies, innovation is an internal process explained by the complexity of the national conditions within which they emerge.

The role of market concentration in innovative activities is found in the debate from the Schumpeterian and Arrow point of view. The first promulgates that lack of competition is beneficial for innovation activities, given that monopolistic companies can more easily perform R&D activities as they face less market uncertainty and have larger and more stable funds. On the other hand, Arrow (1962) asserts that competitive environments stimulate innovation; the monopolistic company does not need to innovate as it has secured the market based on its size and dynamism.

For Schumpeter, imperfect competition provides the best environment for internalizing the benefits of R&D, the so-called market power hypothesis (Galbraith, 1952). For example, Scherer (1967a), and Levin *et al.* (1985) find for the US that maximum intensity occurs at 50-60% of the market concentration level. However, the concentration-innovation relationship is sensitive to the characteristics of the branch of activity studied. Scott finds market concentration can only explain a 1.5 percent variation in R&D intensity. From another point of view, there are studies that relate market size with innovative activity, such as Hermosilla & Wu (2018), which relate market size with firms' propensity to innovate. They show that in sectors with larger market sizes, innovation increases thanks to support between suppliers and vertical integration.

In this order of ideas, many prominent scholars in the literature are interested in understanding the empirical relationship of this Arrow vs Shumpeter debate. For example, the seminal paper of Aghion *et al.* (2005) found an inverted U-shaped relationship between concentration and innovation, whereas Beneito, Rochina-Barrachina & Sanchis (2017) found a linear positive relationship. However, these relations have not been studied in the context of a developing country such as in Latin America. For this reason, the objective of this research is to fill this gap in the literature by determining how market concentration affects companies' decision to innovate in Ecuador. The data are used at the enterprise level using a probabilistic and linear model with selection bias correction. The 2010 Ecuadorian economic census is the data source used for the estimation.

These results are relevant in terms of public policy and organizational theory. In the first aspect, policy actors must consider the effectiveness of public policy in relation to market volume and concentration. Managers must take into account the capacity to exploit their competitive advantages, although in Ecuador only the companies with the greatest resources seem to consider this characteristic.

Among the results are the low innovation capacity of Ecuadorian companies and the persistence of the concentration of economic sectors in the market. Of these, 76% present characteristics of a high degree of competition. However, the estimates confirm the market power theory of both models. Consequently, a higher market share leads to an increased likelihood of innovation, thanks to the ability to exploit the benefits of these processes.

The paper is organized as follows. Section two emphasizes the relationships drawn between innovation, firms' characteristics and market competition. Section three presents the matching and censorship models implemented to calculate the net effect of innovation on financial performance. Finally, the results of the estimates are presented together with conclusions.

2. Innovation and market competition

This paper is part of the Shumpeterian debate on the relationship between market concentration and firms' incentive to innovate. There are different measure of competition: the number of companies (e.g. Darai, Sacco and Schmutzle 2010), types of competition, entry costs, differentiation rates, market size and spillover effects (Vives, 2008). This configuration has led to mixed results. Scherer (1967a, 1967b) was the first to observe a non-linear relationship between market structure and R&D. Kamien and Schwartz (1976) gave the theoretical interpretation of this result. In this model, efforts to innovate increase to the point where the intensity of competition adapts to the innovation and then decreases. Aghion *et al* (2005) perfected this model by introducing a leading and following company. Followers innovate to reach the level of the leader, but in sectors where there are several strong firms, it can be difficult for lagging companies to catch up.

There is a risk for the leading company ; the loss of its dominant position against those that arise. In the case of finding a market where companies have a similar technological level, the rivalry will induce investment in innovation to achieve leadership. Therefore, this model adds an incentive and a deterrent effect. The first of these should predominate in contexts with high levels of competition and the second in the opposite case. According to these authors, the inverted U relationship should be more pronounced for companies close to the technological frontier of the industry. Several subsequent complementary or alternative theoretical models (e.g. Hashmi, 2013; Bento, 2014) have validated this view, with i ts success based on its effectiveness in confirming empirical research.

However, there are also recognized dual effects. Boone (2001) shows that changes in competition change the identity of the innovator: in an industry where competition is low, the laggard is more innovative because innovation brings the greatest cost reduction, while when competition is high; the cost leader innovates because he does not want to lose his dominant position. An important advance has been the use of randomized experiments to test hypotheses. Aghion, Bechtold, Cassar & Herz (2018) analyzed the intertemporal causal effects of competition on innovation gradually through laboratory experiments. Innovations wer measured in terms of R&D investments. They found that increased competition leads to a significant increase in R&D investment by companies that innovate continuously and consequently, while the same phenomenon reduces R&D investment by lagging companies. Blundell, Griffith and Van Reenen (1999) found that increased competition in the product market in an industry tends to stimulate innovative activity. Beneito, Rochina-Barrachina & Sanchis (2017) used external patent information from the European Patent Office and the United States Patent Office, alongside data from Spanish manufacturing companies from the Business Strategy Survey (ESEE) from 1990 to 2006. Their objective was to corroborate the hypothesis validated by Aghion. They did not find an inverted U- relationship between innovation and competition, rather a positive relationship between competition and patents. Finally, increased competition affects the composition of an industry by reducing the proportion of firms in a precarious financial position. The results of Kyläheiko, Puumalainen, Pätäri & Jantunen (2017) indicate that companies' specific internal factors (including size, age, and access to financing) explain the propensity to innovate and also company growth, while external factors related to market power have low explanatory power.

In the case of Latin America, there has been research about general innovation determinants. For example, Jiménez *et al.* (2009) concluded that the two capacities that have the greatest influence on innovative performance are production capacity and organizational learning capacity, as opposed to the others identified in the Technological Innovation Capabilities (TIC) model (R&D capacity, resource management capacity and strategic planning capacity). In the same study, the most innovative firms were found to have focused on the acquisition of organizational skills through production processes, many of them through quality management systems and the purchase of machinery and equipment to increase productivity.

Several research papers focusing on Ecuadorian territory (Durán & Briozzo, 2015; Astudillo & Briozzo, 2016; Sánchez & Alejandro, 2017) have shown that the determining factors in a company's decision to innovate are: a) size, mainly when they are large b) formal protection mechanisms, c) belonging to sectors of high technological and knowledge intensity, d) receipt of public funds. They also conclude that the determinants of R&D intensity (R&D expenditure on sales) of Ecuadorian companies are: a) capital investment, b) being a small company, and c) having an R&D department in the organization. The studies highlight the lack of specific information to characterize innovation activities. Likewise, all of them use sample type information (Astudillo & Briozzo, 2016) or for a respective economic sector (Sánchez & Alejandro, 2017).

Based on the previous review, the main contribution of this paper is to validate the inverted U model proposed by the literature in Ecuador. In specific terms, it also seeks to incorporate the market concentration variable, supported by an economic census of a developing country. This contributes to the soundness of the estimates. On the other hand, it performs two exercises on measures related to innovative activity (1) Determinants of a company's propensity to innovate, i.e., the probability of being innovative, and (2) Determinants of its innovation intensity, i.e. the amount of resources dedicated to innovation and development (R&D) activities. Finally, this study uses population microdata together with a wide set of control variables that combine companies' internal characteristics with variables related to the industry context.

The following methodology was implemented to test the hypotheses on market power, propensity to innovate and innovative intensity.

3. Methodology

3.1 Data

The Ecuadorian economic census conducted in 2010 by the National Institute of Statistics and Censuses (INEC) is used. This was based on the methodology proposed by the OECD and its aim was to collect representative data on innovative activities undertaken by companies. It provides information on the characteristics of the firm, including its age, size, industry, international orientation and participation in business groups. It also contains information on funding sources, R&D expenditures, staff training, and more. Within the census data, 330,823 firms were found to possess complete information on the variables of interest.

3.1 Measuring Innovation

Most of the aforementioned research uses research and development (R&D) expenditure as the main measure of innovation. For example, Griliches (1986) uses cross-sectional data from U.S. firms between 1972 and 1977, finding that greater investment in R&D results in higher rates of productivity growth. Similarly, it was indicated that privately funded research appears to be more effective than state-funded research. Lichtenberg and Siegel (1991), who used panel data on U.S. firms between 1972 and 1985, later confirmed these findings. In Japan, Goto and Suzuki (1989) carried out research based on a sample of Japanese manufacturing firms in 1982; they found that productivity growth within firms is positively related to the growth of R&D investment in a firm's core business. Similarly, for a sample of UK firms between 1988 and 1992, Wakelin (1998) found that R&D intensity has a positive and significant effect on productivity growth.

However, it has been suggested in several studies that R&D expenditure suffers from a number of shortcomings. The Oslo Manual (2005) points out that R&D expenditure does not cover all firms' innovation efforts, such as expertise or knowledge incorporated into the human capital of the organization, in the words of Kemp *et al.* (2003) "studies based on R&D expenditure do not correctly inform the actual innovation process". From this point of view, spending of this type could bias the value of the innovation effort, since while a company may show low R&D expenditures, it is possible that innovation activities are being carried out in collaboration with universities or another external agency, which covers most of the cost of development. Another associated problem is that smaller firms may underestimate the amounts invested. While large expenditures on innovation can be developed, only a small percentage of innovation efforts translate into new processes or goods, so many firms can spend on R&D for many years without reaping the potential benefits (Bessler and Bittelmeyer, 2008). Despite the problems of this indicator, there is a lack of better complete information for companies in developing countries. Therefore, research and development expenditures are the proxy used here.

For this study, innovation is a dichotomous variable, becoming one if the company had R&D expenses and zero if not. The indicator for measuring innovation intensity is the amount of R&D divided by total sales. The logarithm of the absolute dollar amount used in R&D is also used.

3.3 Measuring market concentration

According to Van Rixtel (2008), market power is the ability of certain firms to control the market for certain products. Analyses have calculated the degree of competition across several indicators.

However, it is necessary to find a way to make comparable measurements. This has been done using the Boone indicator, the Learner index and the Hirschman-Herfindahl index (HHI), which measures the degree of market concentration.

The latter indicator is often implemented in competition studies by antitrust authorities. According to the U.S. Department of Justice if the HHI of the market exceeds 2000 points it is considered a concentrated market and should be put under surveillance. Accordingly, the European Central Bank (2015) considers that an HHI value above 1,800 implies a high concentration, while values between 1,000 and 1,800 imply a moderate concentration. Market power can also be measured by profit margin; a high value can be indicative of a lack of competition.

This research calculates the Hirschman-Herfindahl index based on company sales at the level of the International Standard Industrial Classification (ISIC) in its fourth revision for its core business.

3.4 Model

3.4.1 Probabilistic model on the probability of innovating

Probabilistic or discrete choice models can model the phenomenon of innovation as a dichotomous variable that can be estimated. Depending on the function used to estimate probability, there is the truncated linear model, the logit model and the probit model. In general, it is considered that behind the dependent variable in these models (Y) there is a non-observable variable (I) which depends on a set of explanatory variables $(X)_i$ that takes certain values if it has exceeded a certain threshold, as expressed below.

$$\begin{gathered} Y_i = 1 \textit{ if } I_i^* > 0 \textit{ when } \beta_i X_i + \varepsilon > 0 \\ o \\ Y_i = 0 \textit{ if } I_i^* < 0 \textit{ when } \beta_i X_i + \varepsilon < 0 \end{gathered} \quad (2)$$

The assumption on the distribution of ε, establishes the class of model to be estimated: if a uniform distribution function is assumed, the truncated probability linear model is used. If it is distributed as a normal with mean zero and variance one, the model generated will be a probit; while if it were assumed to be distributed as a logistic curve, it would be a logit model. The hypothesis that the threshold to be exceeded by the latent variable is zero can be modified by any other value, for example, that the critical value is the one defined by the constant term (Pérez, 2004). Under the first approach, the probabilistic model would be defined (Medina, 2003).

$$P_i = Prob\ (Y_1 = 1) = Prob\ (\beta_i X_i + \varepsilon > 0) = F\ (X_i \beta_i) \quad (3)$$

Where (Y) is the variable to be explained or dependent, categorized dichotomically, where (1) is whether the company carries out innovation activities in 2010 and zero otherwise. On the other hand, the coefficient, β, captures the marginal contribution of each factor to the probability of innovative activity. The latter is grouped into a vector that summarizes characteristic factors of the firm (X) which were selected based on the previously revised literature. In this case, the variables taken for control and a hypothesis to test are specified:

C1: Size of the company: the number of employees or sales volume of the company.

C2: Age, years of operation of the company.

C3: Technological capacity: possession of email, website, training of workers in quality courses.

C4: Characteristics of the organization: formalization, access to financing, form of business organization.

C5: Sectoral indicators: activity sector, country and province where the firm is located.

H1: Concentration and size of the respective national market. The market power hypothesis would be confirmed if the beta coefficient associated were positive and significant.

It is also necessary to consider how to measure the effectiveness of these models. This is assessed by four equally important criteria. The first of them measures the percentage of the variance of the dependent variable captured by the independents, an indicator called McFadden's R2. In the second instance, it is checked if the model satisfies the conditions of the indicator is significant as a whole when trying to explain the dependent variable; measured by means of the chi-square statistic of global adjustment, which will seek to reject the hypothesis of no joint significance of the model through higher values of this indicator. Third, the individual significance of the variables within the model is tested by observing a probability value of less than 5% to reject the nullity hypothesis. A fourth consideration is the ability of the model to correctly classify the observations into the corresponding groups. The number of cases that, not being successful credit claimants, were classified as such by the model is tabulated, and vice-versa these are known as errors of hypothesis I and II respectively (Reynoso, 2011). There are different situations regarding the nature of the data that must also be corrected for optimal model calibration such as the presence of heteroscedasticity, multicollinearity and serial autocorrelation. These four criteria were evaluated when choosing the best model in order to present conclusions that are more accurate. It is necessary to emphasize that between the first and second criteria the difference lies in that the first one evaluates global significance and the second one does it individually for each explanatory variable.

3.4.2 Model Innovation Intensity

The first model used is a linear regression model calculated on a logarithmic model by means of ordinary least squares (MCO), having as independent variables the socioeconomic characteristics of the worker (equation 3.1).[1].

$$Monto = B_o + \sum_{i=1}^{n} = B_i X_i + e_i \qquad (3.1)$$

1 The linear relationship between the dependent variable and the independent variables is tested in Annex 1 for continuous variables.

Where *Monto* corresponds to the amounts allocated to R&D. The coefficients (β) are interpreted as the percentage increase or decrease in the amount dedicated to innovation activities that will be exerted by the presence of each of the firms' internal and external characteristics (X_i).

The e_i error is distributed as normal with zero mean and constant variance. Once the linear regression model has been established, the tests of the assumptions of normality, homocedasticity and non-collinearity are carried out; if any of the previous assumptions are not met, their correction and re-estimation will be carried out. The effectiveness of this model is measured through the variance of the dependent variable captured by the independent variables; this indicator is called R^2; the higher this is, the more effective it is in determining the behavior of the dependent variable.

There is an additional implicit problem in the database of selection bias. This consists mainly of the absence of randomness within the surveys (Esquivel, 2007; Rivera, 2013). It is defined as bias because a sample concentrated in a certain population group "biases" the result obtained from a variable of interest towards the group that has greater representation. This problem in this research is manifested in some companies due to individuals not reporting their R&D expenditures. This could bias the results; therefore, this model requires a way of compensating for this imbalance.

The rectification of this problem is carried out with Heckman's correction and is carried out by estimating two regressions. According to Heckman (1979), the first estimation is made based on an equation on the probability of non-zero response of its expenditure on innovation compared to the factors that may influence the choice (See equation 3.2).

$$\pi = Z_o + \sum_{i=2}^{n} = \phi_i Z_i + u_i \tag{3.2}$$

Where π refers to the probability of non-zero response, (Z) corresponds to a vector with explanatory variables that influence the decision to innovate. The component fi (ϕ) represents the vector of coefficients, and *u* are the errors of the estimation. After that, the second calculation is the equation incorporating the selection correction made by pi (π) (See equation 3.3).

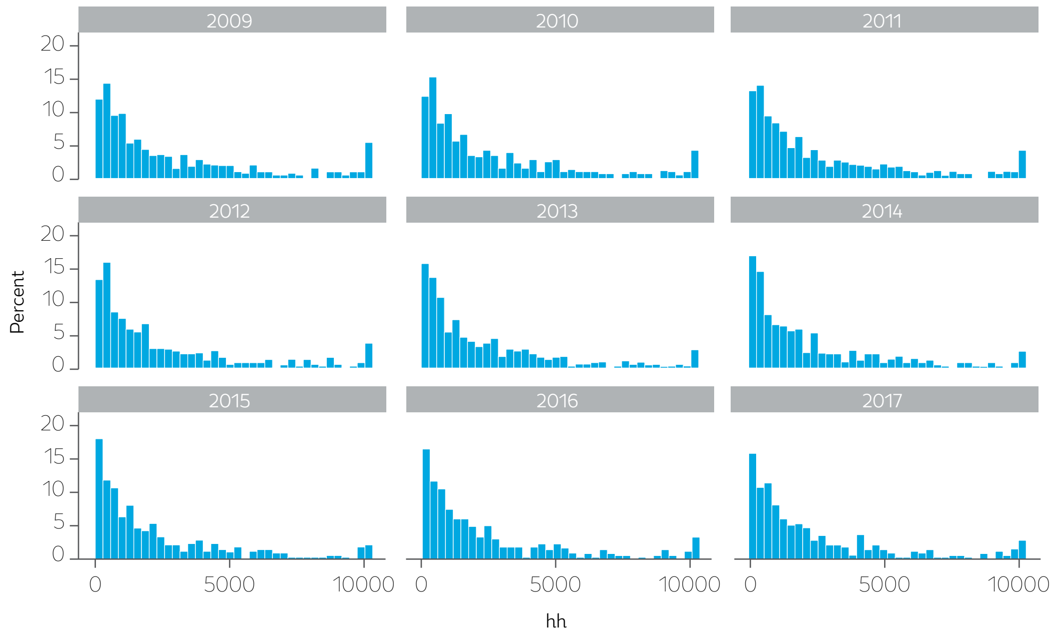
$$Monto = B_o + \sum_{i=1}^{n} B_i X_i + \theta\pi + e_i \tag{3.3}$$

According to Torres and Celton (2009), the importance of the use of (λ) is determined by estimating the regression, as long as its coefficient (θ) is significant. If this were not the case, it would be possible to work directly without the need for correction.

4. Results

The market concentration by sectors in Ecuador as measured by the HHI is shown in Graph 1 for the years 2009 to 2017. A majority of sectors (76%) show perfect competition behavior (have an HHI of less than 1,000), 8% show moderate concentration, 5% expose a monopolistic competition market, 11% are oligopolies, while 12 sectors are natural monopolies.

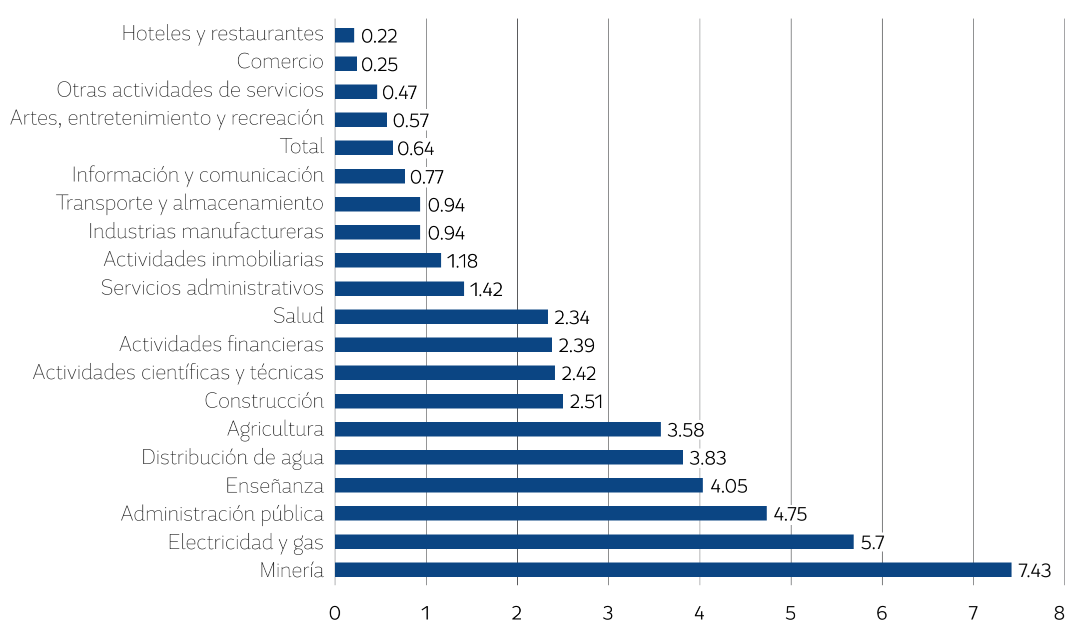
Graph 1. IHH Distribution by sector. By years



Source: Directory of companies. Statistics Institute of Ecuador.

The economic census data show that only 0.64% of companies invest in innovation and development (graph 2). The distribution is characterized by the concentration of companies which innovate in specific branches of activity such as mining, public administration and the public services sector (electricity and water).

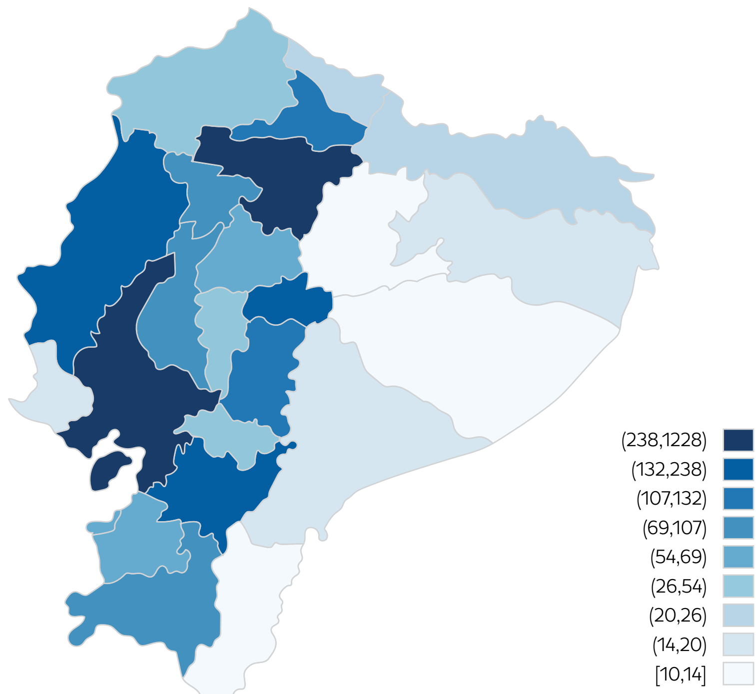
Graph 2. Percentage of companies that innovate by economic sector



Source: Directory of companies. Statistics Institute of Ecuador.

There is also a geographical concentration of innovation and development activities, especially in urban development centers such as the capital Quito and Guayaquil. Map 1 shows the distribution of innovative companies by province.

Map 1. Distribution of innovative companies in Ecuador



Source: Directory of companies. Statistics Institute of Ecuador.

With this description of the data, the results of the estimates of the models presented in section 3.4 are presented.

4.1 Results of the estimates innovation propensity and intensity

Table 1 shows the results of estimates of 330,000 firms with complete information from Ecuador's 2010 economic census for all three estimates. Accordingly, the results of the estimates of the probit models are included with the marginal effects and standard errors of each one of the control variables on the probability of Ecuadorian companies to innovate.

In terms of global adjustment, the model is acceptable considering that the introduced variables presented levels of statistical significance of 5%, and according to R2 the model manages to explain 29% of the variance of the dependent variable, while the percentage of cases correctly classified within the proposed model reached close to 96%. For the interpretation of the results, the marginal effect (elasticity) in the continuous variables is equivalent to the percentage by which the probability of access to credit is increased given a 1% change in the independent analysis variable. For the categorical ones, the marginal effect measures the probability relatively as a comparison of a base characteristic. On the hypotheses raised by this work it was found that:

H1: Concentration and size of the country's respective market. A 1% increase in the IHH indicator of the impact on the propensity to innovate was 0.01%. The theory of a quadratic influence between both variables was tested, but it was not significant. This contradicts the results of Scherer (1970), Kelly (1970), Scott (1984) and Levin et al. (1987). The theory of a quadratic influence between the two variables was tested, but it was not significant. The market size was also significant in explaining the probability of innovating; smaller markets allow companies to better exploit their innovations, and an increase in total sales volume by 1% decreases the probability of innovating by 0.006%. For the absolute intensity, the increase was 0.58% and the relative increase was 0.8%.

The results of the control variables were:

C1: Size of the company: A positive relationship was found between the income strata shown by the firm and the propensity and intensity of the firm to innovate. For example, a company with more than USD$400,000 has an additional probability to innovate of 0.6% than a company with an income of less than USD$10,000. This corresponds to the Schumpeterian thesis that companies with greater resources manage to form an organizational structure that encourages innovation.

C2: Age: The years of operation of the company in its main activity were positively associated with a greater propensity to innovate. A 1% increase in age translated into 0.0182%. For intensity, the increase was 0.67%.

The theory of a quadratic influence between both variables was tested, but it was not significant.

C3: Technological Capacity: the possession of email and the use of internet increases the firm's capacity to innovate by 0.005% and 0.5% respectively.

C4: Characteristics of organizations: Being formal (having the Registro Único de Contribuyentes, RUC) is associated with a 0.006% increase in the probability of innovating. Enjoying external access to funding increases the propensity to innovate by 0.01%.

C5: Sectoral Indicators: The degree of formality of the sector, its size and sectoral/geographic distribution had significant impacts on the study of this topic. The sectors with the greatest positive influences are public services and public administration. From the point of view of the provinces, Guayaquil and Pichincha were the regions with the greatest propensity to innovate.

Table 1. Result of the estimates for the proposed models

Variables	Propensity to innovate		Absolute intensity R & D		Relative intensity R & D	
	Marginal effect	Error	Marginal effect	Error	Marginal effect	Error
Log (IHH)	0.000150***	(3.70e-05)	0.582***	(0.139)	0.00893***	(0.00207)
Observations	330,615		330,823		330,823	
R2	0.299		0.206		0.363	

Source: Author calculations

*** Statistical significance at the 1% level

5. Conclusions and remarks

The objective of this research was to determine how market concentration affects the decision of firms to innovate. Data were used at the level of the Ecuadorian firm using a probabilistic and linear cross-sectional model with selection bias correction. The 2010 Ecuadorian economic census was the data source used for the estimation. Among the results, it was found that Ecuadorian companies have limited capability to innovate; only 0.64% of them presented expenses in amounts of R&D. Likewise, firms located in the provinces with the largest populations and economic agglomeration concentrated the largest number of this type of firms.

The economic sectors of Ecuador expose persistence in market concentration. According to the HHI index 76% of these exhibit characteristics of a high degree of competition, however, the estimates confirm the theory of market power in the propensity to innovate for both models. Consequently, greater market share leads to an increase in the likelihood of innovation, thanks to the ability to exploit the gains from these processes. A 1% increase in the HHI indicator of the impact on the propensity to innovate was 0.01%. The theory of a quadratic influence between both variables was tested, but it was not significant. This contradicted the results of Scherer (1970), Kelly (1970), Scott (1984) and Levin *et al.* (1987). Market size was also significant in explaining the probability of innovating, as smaller markets allow companies to exploit their innovations, and an increase in total sales volume by 1% decreases the probability of innovating by 0.006%. For the absolute intensity, the increase was 0.58% and the relative increase was 0.8%.

The results are compatible with the model of Agnon *et al.* (2005), as this model can explain both a linear and non-linear positive relationship between competition and innovation. The estimated results also support the conjecture that a highly concentrated market may induce firms to exit, which explains the empirical conclusion that there is a negative relationship between competition and technological development within the industry.

These results are relevant in terms of public policy and organizational theory. In the first aspect, policy actors must consider the effectiveness of public policy in relation to market volume and concentration. Managers must take into account the capacity to exploit their competitive advantages, although in Ecuador only the companies with the greatest resources seem to consider this characteristic.

The extensions of this work seek to use the survey of innovation activities to estimate these relationships in a dynamic panel, which will allow us to find a direct causal link between the two variables. This model will be based on the INEC Innovation Activities Survey between 2009 and 2015. This base provides information on the characteristics of the firm, including its age, size, industry, international orientation and participation in business groups. The surveys also provide information on different types of innovation: product, process, organizational and marketing. They contain information on funding sources, R&D expenditures, licenses, and innovation limitations. Finally, there is information by level of education of the contracted workers. The two rounds include a panel of 1,065 companies, excluding companies that had already started innovation and development work before 2009 and companies that have undergone a merger or acquisition at any time during the whole period (2009-2014).

Consequently, the information will be in the form of a dynamic panel where the processes of market concentration affect with some delay the propensity to innovate and the intensity of innovation. The innovation variable can be separated into the innovation of goods, processes or services.

$$\Delta I_{i,t} = \sum_{j=1}^{i} \beta_j ihh_{i,t-j} + \sum_{j=0}^{i} \beta_j X_{i,t-j} + \sum_{j=0}^{i} \beta_j \gamma_{i,t-j} + \Delta\varepsilon_{i,t}$$

This auto-regressive model is estimated by generalized least squares (GMM) and was proposed by Blundell and Bond (1998). The authors have shown that this estimator performs better than the level values estimator, especially in two cases: first, in short sampling periods, and secondly if the variables are persistent over time. Given the way employment and innovation are measured at the enterprise level, it is very likely that innovation variables are correlated with the specific effect of the enterprise. For this reason, potentially endogenous variables are instrumentalized.

The main hypothesis to be validated through the estimates is whether the coefficients derived from the variables associated with market concentration are positive.

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7. Anex

Table 2. Result of the estimates for the proposed models

Variables	Characteristic evaluated	Propensity to innovate		Absolute intensity R & D		Relative intensity R & D		Base Characteristic
		Marginal effect	Error	Marginal effect	Error	Marginal effect	Error	
Export	Yes	0.00162***	(0.000483)	4.215***	(0.816)	0.0875***	(0.0196)	No
Log (Percentage of formal enterprises)		0.00123***	(0.000345)	4.925***	(1.319)	0.111***	(0.0315)	Continuous
Log (IHH)		0.000150***	(3.70e-05)	0.582***	(0.139)	0.00893***	(0.00207)	Continuous
Log (Age)		0.000182***	(4.02e-05)	0.679***	(0.149)	0.0151***	(0.00397)	Continuous
Use email	Yes	0.000594***	(0.000126)	1.942***	(0.343)	0.0408***	(0.00897)	No
Log (Sales)		-6.32e-05**	(2.92e-05)	-0.233**	(0.109)	-0.00453**	(0.00209)	Continuous
Size	From $10000 to $29999	0.000661***	(0.000164)	2.295***	(0.503)	0.0366***	(0.0116)	From $1 to $9999
	From $30000 to $49999	0.00143***	(0.000316)	3.969***	(0.629)	0.0668***	(0.0170)	
	From $50000 to $69999	0.00260***	(0.000541)	5.719***	(0.738)	0.0995***	(0.0220)	
	From $70000 to $89999	0.00204***	(0.000573)	4.892***	(0.890)	0.0882***	(0.0237)	
	From $90000 to $199999	0.00336***	(0.000619)	6.762***	(0.716)	0.249***	(0.0685)	
	From $200000 to $399999	0.00364***	(0.000769)	6.979***	(0.825)	0.266***	(0.0748)	
	More than $400000	0.00632***	(0.00117)	9.719***	(0.857)	0.270***	(0.0652)	
State	Bolívar	0.000326***	(0.00121)	6.336***	(1.388)	0.115***	(0.0301)	Azuay
	Cañar	0.000912*	(0.000508)	2.378**	(1.169)	0.0480**	(0.0238)	
	Cotopaxi	0.000834*	(0.000437)	2.442**	(1.027)	0.0393**	(0.0196)	
	Chimborazo	0.00186***	(0.000454)	4.476***	(0.743)	0.0796***	(0.0172)	
	Imbabura	0.00273***	(0.000552)	5.712***	(0.725)	0.103***	(0.0195)	
	Guayaquil	0.00251***	(0.000541)	5.442***	(0.753)	0.0946***	(0.0193)	
	Manabí	0.000746***	(0.000244)	2.256***	(0.617)	0.0517***	(0.0185)	
	Pichincha	0.00107***	(0.000134)	3.334***	(0.325)	0.0623***	(0.0102)	
	Tungurahua	0.000682***	(0.000261)	2.069***	(0.672)	0.0360***	(0.0135)	
	Santo Domingo	0.000871**	(0.000359)	2.497***	(0.835)	0.0395**	(0.0163)	
You have RUC	No	-0.000674***	(0.000127)	-2.809***	(0.585)	-0.0559***	(0.0146)	Yes
Internet use	No	-0.00544***	(0.000464)	-9.404***	(0.390)	-0.177***	(0.0261)	Yes
Guild affiliation	No	-0.00147***	(0.000169)	-4.038***	(0.321)	-0.0700***	(0.0106)	Yes
Organization	Public	0.000539***	(0.000162)	1.830***	(0.435)	0.0448***	(0.0102)	Private
You have RUC	No	-0.000583***	(0.000181)	-2.919**	(1.227)			Yes
Access to credit	No	-0.00129***	(0.000130)	-3.832***	(0.292)	-0.0655***	(0.0105)	Yes

Variables	Characteristic evaluated	Propensity to innovate		Absolute intensity R & D		Relative intensity R & D		Base Characteristic
		Marginal effect	Error	Marginal effect	Error	Marginal effect	Error	
Economic Sector	Electricity and gas					0.193**	(0.0861)	Agriculture
	Water distribution	0.00249	(0.00195)	5.132**	(2.558)			
	Construction	-0.000642***	(0.000176)	-3.393**	(1.332)	-0.0672***	(0.0253)	
	Trade	-0.00120***	(0.000151)	-4.312***	(0.459)	-0.0700***	(0.0124)	
	Transport	-0.000894***	(9.67e-05)	-5.976***	(1.143)	-0.113***	(0.0270)	
	Hotels and restaurants	-0.000596***	(0.000116)	-2.823***	(0.647)	-0.0452***	(0.0141)	
	Information and communication	-0.000445***	(0.000126)	-2.072***	(0.675)	-0.0421***	(0.0148)	
	Real estate activities	-0.000683***	(0.000200)	-3.849**	(1.624)	-0.0723**	(0.0313)	
	Administrative and support service activities	-0.000749***	(0.000112)	-4.288***	(0.960)	-0.0847***	(0.0224)	
	Health	0.00142***	(0.000301)	3.588***	(0.549)	0.0620***	(0.0119)	
Observations		330,615		330,823		330,823		
R2		0.299		0.206		0.363		

Source: Author calculations

*** Statistical significance at the 1% level