**Impact of competition from unregistered firms on R&D investment in emerging economies: A sectorial analysis.**

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**Abstract**

This research evaluates the impact of competition from unregistered firms on R&D investment by formal firms in emerging economies considering their industrial sector and institutional factors, such as intellectual property rights. We performed a study using the propensity score matching approach and the World Bank Enterprise Survey of 16 Latin American emerging economies. We observed that the R&D investment response of formal firms varies according to the typology of industrial sectors proposed by Pavitt. Supplier-dominated industries reduce investment in R&D when confronted with the informal sector. However, science-based, specialized suppliers and scale-intensive industries do not alter their investment. In addition, the level of Intellectual Property (e.g. IPRI) modifies the effect of the informal sector on R&D investment. Formal firms reduce the investment in R&D when the IPRI environment is underdeveloped; this reduction does not occur in highly developed IPRI environments. We also discuss the finding’s theoretical and practical implications and suggest avenues for future research.

**Keywords:** unregistered firms; competitive strategy; R&D investment; innovation; emerging economies; manufacturing firms.

1. **Introduction**

Emerging economies are low income, rapid-growth countries using the strategy of economic liberalization principally and contributed about the 34 % to the global economy around the world[[1]](#footnote-1) (Hoskisson et al., 2013). Schneider (2002) suggests that 60% of the gross domestic product in emerging economies corresponds to the informal sector. The informal sector (unregistered firms) refers to economic activities in the production and trade of goods and services that are conducted by unregistered firms that operate outside of government regulation and taxation systems. Therefore, unregistered firms avoid the costs associated with regulatory compliance and tax payment and thus gain an advantage over formal firms (Darbi et al., 2016; Ketchen et al., 2014). According to the World Bank[[2]](#footnote-2) in all countries around the world, 53.2 percent of formal firms compete against unregistered firms, and 27.1 percent identify the practices of their competitors in the informal sector as a major constraint[[3]](#footnote-3). For Latin American and Caribbean countries, 62.0 percent of formal firms compete against unregistered firms, and 30.6 percent identify the practices of their competition from unregistered firms as a major constraint. However, the informal sector is an underexplored variable, which has begun to be important for the field of strategic management in general and such areas as dynamic capabilities, absorptive capacity, property rights, innovation, non-market strategies and international management in particular (Darbi et al., 2016; Iriyama et al., 2016; Mccann and Bahl, 2016; McGahan, 2012; Mendi and Costamagna, 2017). Unregistered firms is a new type of competitor that have not possess only cost advantages but also higher flexibility regarding products, processes, and acceptance in society (Williams and Martinez-Perez, 2014), consequently, unregistered firms will have a substantial effect on the strategic behavior of formal firms (Darbi et al., 2016; Mendi and Costamagna, 2017).

The preliminary research by Mendi & Costamagna (2017) found that competition from unregistered firms has a negative effect on innovation outcomes (i.e., process and product) in formal manufacturing firms from Latin American and Africa. The authors noted that the presence of competition from unregistered firms affects the innovation strategy of formal firms because they observe a weakening of returns from innovation; thus, formal firms are discouraged from introducing new products or processes. However, Mccann & Bahl (2016) concluded that competition from unregistered firms has a positive effect on new product development (NPD) in manufacturing firms from Eastern Europe and Central Asia. Therefore, we argue that much of this contradiction results from two contextual factors (industry sectors and institutional effects) have not been taken into account to analyze the variation of the effect of un-registered firms on the R&D investment of formal firms. First, the previous research did not consider important contextual variables on organizational behavior (Johns, 2006) as the different industrial sectors where formal firms developed (Bogliacino and Pianta, 2010; Pavitt, 1984). Second, the previous research did not consider the institutional factors as the Intellectual Property Right Index (IPRI) (Zhao, 2006). If these two variables are considered, the effect of competition from unregistered firms on formal firms may deliver different results concerning those previously found. Our study extends well beyond the previous research, considering the existing diversity across the manufacturing sectors, we move away from the idea that the competition from unregistered firms has the same impact across industries sectors on innovation performance measurement as NPD or R&D.

Against this background, we want to address the following research questions: Do formal manufacturing firms that confront competition from unregistered firms invest differently in R&D than do formal firms that do not? If the answer is yes, Is formal firms’ R&D investment affected by industry sector (i.e., science-based, supplier-dominated, scale-intensive, or specialized-suppliers) or level of property rights? How do formal firms adapt to this environment of competition from unregistered firms?.

We examined the variability of the effect of competition from unregistered firms on the R&D investment decision by formal firms according to the industrial sectors and property rights in a sample of emerging Latin America economies (Hoskisson et al., 2013).We analyzed R&D investment because it is a highly significant input to the innovation process and has a positive effect on innovation performance and on the propensity to innovate (Geldes et al., 2017; Helfat, 1997). Also, R&D explains a substantial part of productivity growth in emerging economies, as well as increasing social returns as employment, consumer confidence, and reducing poverty (Bravo-Ortega and García Marín, 2011). We derive our understanding from organizational ambidexterity to explain whether formal firms increase, decrease or do not modify the level of R&D investment to adapt to the competition from unregistered firms (Darbi et al., 2016). Furthermore, this study contributes to the research on R&D investment by identifying the effect of a new variable (i.e., competition from unregistered firms) on formal firms’ R&D investment by Pavitt Taxonomy industrial sectors and level of property rights.

Based on propensity score matching through quasi-experimentation(Lee et al., 2017), we observed that a formal supplier-dominated industry that competes with unregistered firms invest less in R&D. However, other industrial sectors as science-based, scale intensive, and specialized suppliers do not reduce R&D investment. Furthermore, we found that the IPRI functions as a barrier for competition from unregistered firms. Formal firms that compete with unregistered firms invest less in R&D in a low-level IPRI environment. However, in a high-level IPRI environment, formal firms that compete with unregistered firms do not change their R&D investment decisions.

The remainder of this paper is organized as follows. In the following section, we present the theoretical framework and hypotheses. Next, we outline the methodology of the research. Subsequently, we report the results; this section is followed by a discussion. This paper ends by presenting the study’s conclusions, implications, and ideas for future research.

1. **Theoretical Framework**
   1. **Market dynamism and R&D investment in emerging markets**

The effect of unregistered firms is a new variable that alters the market dynamism of the industry(Darbi et al., 2016). In this sense, the formal firms decides whether or not to pay attention to the unregistered firms and therefore influences the R&D investment decision of formal firms in emerging markets (Darbi et al., 2016; Garg et al., 2003; Ocasio, 1997; Su, Xie, & Peng, 2010). The "parasite view" perspective points out that formal and unregistered firms compete when the firm are similar products and clients, however, from the viewpoint of "dual view" they do not compete, because they are different (Distinguin et al., 2016). To explain how formal firms invest in R&D to respond the effect of unregistered firms, we use the perspective of organizational learning ambidexterity(Raisch and Birkinshaw, 2008),which describes the difference between organizations that "pursue innovation" and those that are doing less (Raisch et al., 2009; Raisch and Birkinshaw, 2008).

Firms in emerging economies implement organizational learning ambidexterity by creating two business models, one to serve premium customers and the other for low-income customers (Winterhalter et al., 2015). The exploration routine implemented by the firms occurs through increased investment in R&D to learn through experimentation, innovation, and adaptability with a particular interest in premium customers. Conversely, the firm exploits by reducing R&D investment focusing on the existing knowledge and the specific needs of the clients at the base of the pyramid, which correlates to price sensitivity (i.e., ultra-low cost), where the unregistered firms predominate (Raisch and Birkinshaw, 2008; Subramaniam et al., 2015). To identify differences in R&D investment response by sector due to competition from unregistered firms, we classify formal firms into four groups in accordance with the Pavitt Taxonomy that is recommended in a firm-level innovation study (Becheikh et al., 2006). These groups are as follows: supplier dominated; science base; scale intensive, and specialized suppliers. Pavitt taxonomy allows us to identify the variety of patterns across industries (Becheikh et al., 2006; Bogliacino and Pianta, 2010; Pavitt, 1984). Moreover, we consider contingent factors, such as IPRI, that we expect to change the effect of competition from unregistered firms on the R&D investment decision.

* 1. **Competition from unregistered firms on the R&D investment of supplier-dominated industries**

Unregistered firms sell their products and services at low prices and experience a high acceptance rate by clients and society in emerging economies, where the "bottom of the pyramid"(BoP) has a daily income of approximately $2 a day and covers an average of 1 billion people (Chliova and Ringov, 2017; Mccann and Bahl, 2016; Subramaniam et al., 2015; Webb et al., 2014; Williams and Martinez-Perez, 2014). Moreover, unregistered firms enjoy cost advantages over formal firms; this advantage allows them to lower their prices and obtain market share from formal firms (Distinguin et al., 2016; Farrell, 2004; Perry et al., 2007). Therefore, the formal firms need to evaluate if pay or not attention to competition from unregistered firms and how this influences a firm’s decisions and actions, because the CEO have limited amounts of time and scarce resources (Garg et al., 2003; Ocasio, 1997). According to certain views unregistered firms are considered unproductive businesses (Distinguin et al., 2016). One view, ‘the parasite view’, considers unregistered firms direct competitors of formal firms, both compete for the same customers, products, and resources (Distinguin et al., 2016; McGahan, 2012; Mendi & Costamagna, 2017). In supplier-dominated industries, small firms are prevalent with low fixed costs and have moderately differentiated products and low entry barriers. Also, supplier-dominated industry innovation efforts are principally focused on the purchase of machinery and are rarely based on R&D activity (Arias-Ortiz et al., 2013; Bogliacino and Pianta, 2010; Flor and Oltra, 2005; Pavitt, 1984).Therefore, unregistered firms is capable to compete with formal supplier-dominated firms for the same costumers and products, thus, formal supplier dominated firms need to pay attention unregistered firms and meet the requirements of low-cost customers (Williams and Martinez-Perez, 2014). Formal supplier-dominated firms respond to competition from unregistered firms (Iriyama et al., 2016; Mccann and Bahl, 2016; Mendi and Costamagna, 2017) by increasing the separation (rather than integration) of their value chain activities (development, production, and sales) to serve customers (BoP) in the same business unit (Webb et al., 2014; Winterhalter et al., 2015). Consequently, the formal supplier-dominated industry reduces the exploration activity by separating the R&D department into two units, for the low-cost segment and the premium segment, taking advantage of existing knowledge. Therefore, we hypothesize the following:

**Hypothesis 1**. Formal supplier dominated industries that encounter competition from unregistered firms change their strategy to reduce investment in R&D in emerging markets.

* 1. **Competition from unregistered firms on R&D investment in science-based industries**

Conversely, the “dual view” perspective indicates that unregistered firms are highly different from formal firms, because, unregistered firms are more inefficient in productivity than formal ones; this is attributed to human capital and the low level of technological development that does not allow them to deliver sophisticated products, as demanded by target customers of the science-based industries (Distinguin et al., 2016; Fu et al., 2017; La Porta and Shleifer, 2008). In addition, the science-based industry requires human capital with specialized knowledge to serve a segment of customers that is not sensitive to price and that seeks differentiation through product innovation and technology (Williams et al., 2016).Therefore, unregistered firms do not represent a threat to formal firms such as science-based industry, because they do not compete for the same customers (Distinguin et al., 2016). Consequently, science-based industry do not pay attention unregistered firms, instead, science-based attention influences the rules of the games of this specific industrial sector (Garg et al., 2003; Ocasio, 1997).Thus, science-based industries do not divide their units of the value chain when confronting competition from unregistered firms; instead, they continue to focus their R&D investment, production, and sales activities on premium target customers (Winterhalter et al., 2015). Therefore, science-based industries do not change their R&D investment decision in the presence of unregistered firms. Thus, we hypothesize the following:

**Hypothesis 2**. Formal science-based industries that encounter competition from unregistered firms do not change their strategy R&D investment in emerging markets.

* 1. **Competition from unregistered firms on R&D investment of scale-intensive industries**

Following the “dual view” perspective, the firms that belong to a scale-intensive industry are very different from the unregistered firms (Distinguin et al., 2016). In scale-intensive industries, such as paper products and plastics are characteristic of high fixed costs; sell their products using economies of scale; have oligopolistic markets where technological change is usually incremental and serve different niches than do small firms (Bogliacino and Pianta, 2010; Distinguin et al., 2016; Rogers, 2004; Tello, 2011). Each of the features of a scale-intensive industry is antagonistic to the characteristics of unregistered firms. Therefore, a scale-intensive industry does not compete but, cooperates with unregistered firms by integrating them into their value chain to obtain inputs, such as in transport activities, at lower costs (Darbi et al., 2016). Thus, formal scale-intensive industries develop cooperative capacities that allow them to diversify their operations to better exploit their knowledge and to serve emerging markets that are price sensitive. Consequently, scale-intensive firms do not change their R&D investment decision in the presence of competition from unregistered firms. Thus, we hypothesize the following:

**Hypothesis 3**. Formal scale-intensive industries that encounter competition from unregistered firms do not change their strategic R&D investment decisions in emerging markets.

* 1. **Competition from unregistered firms on R&D investment of specialized suppliers**

In contrast to the cost orientation of the scale intensive industries (Bogliacino & Pianta, 2016; Castellacci, 2008; De Jong & Marsili, 2006), the specialized suppliers prioritize the strategy of technological competitiveness and thus have a developed level of technological capabilities realized through an adequate level of investments in R&D and a focus on downstream linkages as mechanisms to achieve competitive advantage (Bogliacino & Pianta, 2016; Castellacci, 2008; De Jong & Marsili, 2006). For example, relationships with specialized suppliers with other manufacturing industries such as science-based ones are given through B2B relationships that are based on trust and collaboration(Kelly and Scott, 2012). In this way, both of them can improve their competitive advantages (Kelly and Scott, 2012). Specialized suppliers are customer driven with a special interest in developing products that are tailored to other manufacturing industries. (Bogliacino & Pianta, 2016; Castellacci, 2008; De Jong & Marsili, 2006). Also, specialized suppliers tend to be small firms with greater flexibility to innovate and who have highly skilled personnel responsible for transferring tacit knowledge to those manufacturing industries that require it (Bogliacino & Pianta, 2016; Castellacci, 2008; De Jong & Marsili, 2006). Finally, legitimacy allows formal firms in the specialized supplier's sector to have access to more resources than the ones operating in the informal sector (Siqueira and Bruton, 2010). In sum, the mentioned-above characteristics of specialized suppliers are not possible to achieve by unregistered firms (Fu et al., 2017; Hoskisson et al., 2013). Therefore, specialized suppliers are likely to adopt the exploration strategy to meet the highly specialized needs of their customers, reducing the level of exploitation to maintain its competitive advantage. In this sense, these firms’ level of R&D does not decrease. Thus, we hypothesize the following:

**Hypothesis 4**. Formal specialized-supplier industries that encounter competition from unregistered firms do not change their strategic R&D investment decisions in emerging markets.

* 1. **Intellectual Property Rights Index (IPRI) context and the effect of competition from unregistered firms on the R&D investment**

The decrease of IPRI increase the threat of illegal imitation activity by unregistered firms {Formatting Citation}. (Distinguin et al., 2016). We argue that in supplier-dominated industries (such as food, textile, and beverage) where products are homogeneous, patent is difficult due to low complexity and customers are also served by unregistered firms. Thus, a formal supplier-dominated industry cannot legally exclude others from using the innovation created by its R&D (Barros, 2015; Cuervo-cazurra and Un, 2010; Grazzi and Pitrobelli, 2016). Therefore, in a weakly effective Intellectual Property Right Index (IPRI) context of emerging economies, the competition from unregistered firms likely affects formal firms’ R&D investment decisions, because, unregistered firms mimic or replicate formal firms technological innovation strategic (Bruton et al., 2012). Hence, the low level of IPRI encourages formal firms exploit its existing knowledge rather than explore to create knowledge. Thus, the formal firm invests less in R&D than firms that are not affected by competition from unregistered firms, focusing resources on production and sales force while reducing innovation (Subramaniam et al., 2015; Winterhalter et al., 2015).Thus, we hypothesize the following:

**Hypothesis 5a.** Formal firms that operate in low-level IPRI contexts reduce R&D investment in the presence of unregistered firms.

However, in an institutional context with a high level of IPRI as new develop economies like Chile decrease the imitation activities, we propose that the high technological dynamism that is characteristic of science-based industries such as chemicals, pharmaceuticals, and electronics are less likely to be imitated by unregistered firms (Arias-Ortiz et al., 2013; Bogliacino and Pianta, 2010; Pavitt, 1984). These industries focus on R&D to create or attract external sources of knowledge based on advances in science; it is likely impossible for unregistered firms to achieve patents (Arias-Ortiz et al., 2013). In addition, a high level of IPRI encourages a firm to explore new knowledge. Therefore, a firm does not invest less in R&D than do firms that do not encounter competition from unregistered firms. Thus, we hypothesize the following:

**Hypothesis 5b.** Formal firms that operate in the higher IPRI level context, in the presence of unregistered firms, do not change their R&D investment decision.

1. **Research Methodology**
   1. **Sample**

To test the hypotheses, we utilized the 2010 World Bank’s Enterprise Survey. This survey provides the world’s most comprehensive data on firm-level business environments in developing economies, with a representative sample of the private sector (World Bank, 2010). The data provide the possibility of studying formal strategic innovation behavior in the presence of unregistered firms. The Enterprise Survey data have been featured in prior published studies about competition from unregistered firms (Distinguin et al., 2016; Iriyama et al., 2016; Mccann and Bahl, 2016; Mendi and Costamagna, 2017). In addition, we gathered data regarding the IPRI of each country from the International Property Rights Index (2011)[[4]](#footnote-4).

Using the World Bank survey, we conducted an empirical study in 16 Latin American countries[[5]](#footnote-5). De acuerdo a la clasificación de S&P la muestra de estudio son 16 países de economías emergentes, caracterizados por su rápido crecimiento con foco a la apertura a libre mercado fostered by free trade agreements between Latin American countries and the biggest markets, such as EU, USA and Asia. Furthermore, over the past 15 years, most Latin America emerging countries experienced substantial growth rates, with significant advances in reducing poverty and inequality (International Monetary Fund. Western Hemisphere, 2014). Latin America’s middle class has been growing in size and, for the first time ever, more Latin Americans were part of the middle class in 2011 than the ones who lived in poverty (International Monetary Fund. Western Hemisphere, 2014). Latin America emerging economies presents specific characteristics such as: Underdeveloped institutions,unclear and inconsistent policies, inadequate governance, disjointed infrastructure, limited funding options, inhibiting culture, personalized networks, ill-funded and ambivalent education system, and reluctant internationalization, political instability, large informal sector are key element of Latin American economies which range from approximately 19.8% in Chile to 67.1% in Bolivia (Vassolo et al., 2011). (Manimala and Wasdani (2015). Also these Latin America emerging economies have a lower R&D intensity than do many other developed countries (Grazzi and Pitrobelli, 2016). Furthermore, previous innovation studies considered these 16 countries as a representative sample (e.g., Crespi, Tacsir & Vargas, 2016). In our study, we do not consider Brazil, because it is a BRICs (Brazil, Russia, India, and China) country with a different environment that traditional emerging markets (Cui et al., 2016; Hall et al., 2011). Also, Brazil belongs to a new category of economies called mid-range emerging economies for it has an adequate development of market institutions and the necessary economic infrastructure that facilitates high investment in R&D and develop capabilities to innovation which means a clear contrast to the other emerging economies of Latin America. (Becheikh et al., 2006; Hoskisson et al., 2013). Finally, Brazil was not included in the 2010 survey was it had just been surveyed in 2009 and World Bank generally do not survey a country more frequently than every 4-5 years.The, World Bank did not insert the innovation questions until 2010. (Crespi, G., Tacsir, E., & Vargas, 2016). Therefore, in our research, we considered the sixteen emerging countries of Latin America who cover almost the whole of this region in the year 2010 (Castellacci, 2015).

The data included 5876 manufacturing firms. Since the study was restricted to firms that invested in internal R&D, the final sample contains 2381 firms satisfying the requirements.

The study focused on manufacturing industries because they have the imperative to continually invest in innovation compared with other industrial categories such as services or non-profits (Allred and Park, 2007). Moreover, innovation is relatively more important in manufacturing industries than services where value-added originates and knowledge skills are relevant for innovation (Crespi and Zuniga, 2012). We present the main features of each country in Table 1, which shows descriptive statistics, providing a detailed list of the sixteen countries and their technological innovation (product and process or both) and expenditure on innovation as a percentage of total turnover from innovation. The Table 1 shows that there is a high percentage of firms that conduct technological innovation activities, both for products and for processes. However, the percentage of R&D investment is relatively low compared with developed economies. One of the reasons may be the effect of competition from unregistered firms and the low level of IPRI that can discourage investment in R&D

“Insert Table 1 here.”

* 1. **Measurement of variables**

Table 2 contains a detailed summary of each variable. The variables are observable and have different natures (Numerical and Dichotomous).

* 1. **Dependent variable**

We use the natural logarithm of R&D investment within the establishment. This variable allows us to evaluate the variation of R&D as a variable that captures the ability of the organization to adapt to the competition from unregistered firms. Moreover, R&D investment is a proxy of the absorptive capability (Arias-Ortiz et al., 2013; Wang and Ahmed, 2007) and is closely related to the organizational learning ambidexterity of the firm, which is the ability to explore knowledge through internal R&D investment or exploit external knowledge through the reduction in internal R&D.

* 1. **Independent variable**

We measure competition from unregistered firms using the survey information about practices of competitors in the informal sector as an obstacle to the current operations of the formal firms. The survey reported on a 4-point Likert scale, as follows: no obstacle=0, minor obstacle=1, moderate obstacle=2, major obstacle=3, and very severe obstacle=4. We convert the categorical variable into a set of dummies between zero and one: zero (0) if a firm do not compete with unregistered firms and one (1) otherwise (Mendi and Costamagna, 2017). We propose this variable as a treatment because it captures the effect of competition from unregistered firms on formal firms (Putniņš and Sauka, 2015).

In addition, our research considers important dimensions that previous research has not. First, following, Bogliacino & Pianta, (2010) and Pavitt, (1984), we consider industry heterogeneity by Pavitt sectoral taxonomy, and group the firms according to international classification the Rev 3.1 industrial classification as shown in Appendix A1 (Bogliacino and Pianta, 2010). Second, we consider the institutional context, specifically International Property Rights Index (IPRI). Based on the available data of the International property rights index by country, we assign the IPRI to each of the firms per country, then we create the high and low IPRI dummy variables the high IPRI takes the value of 1 when the IPRI is greater than the average and 0 otherwise in the sample countries.

* 1. **Variables to predict the effect of competition from unregistered firms**

After defining the dependent variable and the independent variable, the experiment is created through a treated group and control group based on similarity (Lee et al., 2017). Each group is provided a propensity score. To calculate the propensity score for whether or not firms are likely to be affected by competition from unregistered firms, we include various factors that may lead to a formal firm being more likely to be affected by competition from unregistered firms (Distinguin et al., 2016; Williams et al., 2016). The capacity utilization is defined as the percentage of use of the installed capacity. Formal firms that take greater advantage of their level of production are less likely to be affected by competition from unregistered firms (Distinguin et al., 2016; Perry et al., 2007; Williams et al., 2016). To control for export orientation, we consider a dummy variable that categorizes firms that sell less than 90% of their products in the domestic market as exporters and 0 otherwise (Williams et al., 2016). Firms that export are less likely to be affected by competition from unregistered firms because unregistered firms cannot compete in export markets due to technology, access to markets, and uncertain legal status (Gonzalez and Lamanna, 2007; Williams et al., 2016). We also include technological capabilities, such as quality certification and websites**.** We expect that firms that have a quality certification are less likely to be affected by competition from unregistered firms because unregistered firms have less possibility to access to technological innovation to improve quality (Williams et al., 2016). Quality certification is coded as a binary variable that takes the value of 1 if the firm has a quality certification, and 0 otherwise. Thus, the website is a binary variable that takes the value of 1 if the firm uses a website and 0 otherwise. To control for size effects, we use the log of the number of full-time employees.

“Insert Table 2 here”

* 1. **Propensity score matching method**

The competition from unregistered firms measure may be endogenous if unobserved firm-specific characteristics are simultaneously determining the firms' intensity of competition and R&D investment outcome (Lee et al., 2017; Mendi and Costamagna, 2017). Thus, we cannot precisely assess the effect of unregistered firms on R&D investment through a simple comparison of firms that compete and do not compete with unregistered firms (Lee et al., 2017). Although the evaluation of the firm´s R&D investment decision of the same firm in the two scenarios (affected and not affected by competition from unregistered firms) may be ideal, this type of randomized experiment is impossible (Lee et al., 2017). To overcome this limitation , we employ propensity score matching (Caliendo and Kopeinig, 2008; Lee et al., 2017), which allows comparison of the change in R&D investment between the treated firm and a control group by reconstructing original observational data in a quasi-experiment setting (Caliendo and Kopeinig, 2008; Lee et al., 2017).

The propensity score matching method allows us to reconstruct counterfactuals using observational data and identifying the appropriate control group (Caliendo and Kopeinig, 2008; Lee et al., 2017). The treatment and control groups are constructed by similarly calculating the propensity score (Caliendo and Kopeinig, 2008; Lee et al., 2017). We use a probit model to estimate the predicted probability of firms’ intensity competition from unregistered firms (Lee et al., 2017) based on various firm characteristics, such as exporter, size, quality certification, capacity utilization, and website (Distinguin et al., 2016; Gonzalez and Lamanna, 2007; Williams et al., 2016). Propensity score matching assumes that the treatment regarding the propensity scores derived from observable firm characteristics is randomized and exogenous (Caliendo and Kopeinig, 2008; Lee et al., 2017). We then match firms with competition to firms without competition from unregistered firms based on the predicted propensity scores of firms that are most likely affected by the competition from unregistered firms. Thus, in this study, the treatment group consists of formal firms that compete with unregistered firms, and the control group consists of similar firms that do not compete with the unregistered firms; in addition, they groups have similar propensity scores for predicting the firm’s intensity of competition. Then, we compare the R&D differences between the treatment and the control groups; we calculated the average treatment effect from the treatment (ATT) (Caliendo and Kopeinig, 2008; Lee et al., 2017). The ATT (average treatment effect from the treatment) reflects the R&D investment difference between the treated (formal firms that compete with unregistered firms) and control group (formal firms that do not compete with unregistered firms). We use the “teffects psmatch” command in the STATA 13 statistical package to measure the variation between the treatment and control groups (Lee et al., 2017).

1. **Results**

In Table 3 we show the summary descriptive statistics and pairwise correlations of the variables used in the probit analysis firm’s intensity competition from unregistered firms, we observe low or non-existent correlation between the independent variables. For each variable, we reported its average, standard deviation and minimum and maximum values. On average, firms in Latin America have smaller investments in R&D, and the capacity is medium. Most firms do not have a quality certification; similarly, the number of exporter firms is low. According to the size, most firms are small and medium. Regarding competitive pressure from firms in the informal sector, the average value is high with a value of 0.85. Thus, Latin American firms perceive competition with unregistered firms as a critical obstacle. Finally, the average level of IPRI remains low with a value 0.21.

“Insert Table 3 here.”

Table 4 displays the probit regression for formal firm´s intensity of being affected by unregistered firms. Thus, a firm that has a quality certification has a negative relationship (b = -0.22, p < 0.05); therefore, the firm decreases its likelihood of being affected by an unregistered competitor. Firms that export also have a negative relationship with competition from unregistered firms (r = -0.35, p < 0.01), indicating that a firm that exports decreases its likelihood of being affected by the competition from unregistered firms. Additionally, the production capacity of the firm has a negative relationship with the likelihood of being affected by competition from unregistered firms (r = -0.05, p < 0.02).

“Insert Table 4 here.”

Using the result of the probit model in Table 4, we calculated the propensity scores of a firm’s intensity of competition from unregistered firms to create the matched sample for a comparison of R&D investment after the formal firm is affected by competition from unregistered firms.

In Table 5, we show the change in R&D investment for both the treatment (the firm that encounters competition from unregistered firms) and the control (the firm that does not encounter competition from unregistered firms) groups in accordance with the taxonomy of Pavitt and IPRI. The average treatment effect on the treated (ATT) notes the difference in R&D investment between the treatment group and the control group. Furthermore, in Table 5, we observe that firms reduce their R&D investment in the whole sample. However, this result changes if we consider the Pavitt typology classification and IPRI (International Property Rights Index) subgroups. In Table 5 shows Model 2, for the Pavitt typology classification subgroups (supplier dominated; science based; scale intensive; specialized suppliers), the ATT (average treatment effect on the treated) of supplier-dominated industry; the R&D investment decreases and is statistically significant (b=-0.42, p=0.03). This result is in accordance with previous research that showed that firms that compete with unregistered firms have a significant adverse effect on NPD (Mendi and Costamagna, 2017). Therefore, Hypothesis 1 is not rejected. However, in Table 5 shows the ATT (average treatment effect on the treated) of science-based industry the R&D investment is negative (b=-0.70, p=0.26) but is not statistically significant. Therefore, Hypothesis 2 is not rejected. The results in Table 5, also show, the ATT (average treatment effect on the treated) on scale intensive industry; R&D investment is negative (b=-0.35, p=0.37) but is not statistically significant. Therefore, Hypotheses 3 is not reject. Moreover, in Table 5 shows the ATT (average treatment effect on the treated) of specialized suppliers (b= -0.15, p=0.53) the R&D investment is negative and not statistically significant. Therefore, Hypotheses 4 is not rejected.

Finally, Model 3, for IPRI (International Property Rights Index) information we classified firms into high and low IPRI subgroups. In Table 5 shows the ATT (average treatment effect on the treated) in a low IPRI environment subgroup; these firms decreased investment in internal R&D and are statistically significant (b=-0.41, p=0.01). Therefore, Hypothesis 5a is not rejected. Finally, Table 5 shows the ATT (average treatment effect on the treated) in high IPRI environment subgroup, these firms do not change their investment decision in R&D, because, the result is not statistically significant (b=-0.31, p=0.13). Therefore, Hypothesis 5b is not rejected.

“Insert Table 5 here”

Additionally, to verify the quality of the match between the treated group and the control group, we conduct post-estimation tests with the pstest command in STATA 13. It is found that after the match, the observable variables are not significantly different. Consequently, the treated group and the control group are systematically equal; refer to Appendix A2.

1. **Conclusions, Implications and Future Research**

In the context of emerging economies in Latin America, where on average there is a high degree of informality and a low institutional level (Vassollo), we found that the effect of unregistered firms on R&D investment form manufacturing firms depends on the industrial sector and the IPRI institutional context. According to the Pavitt taxonomy, the strategic R&D investment behavior of manufacturing firms change by reducing investment in R&D when confronted by competition from unregistered firms, except in a set of industries explained below. In our research, formal supplier-dominated industry will invest less in R&D due to competition from unregistered firms with the purpose of serving low-cost clients that are also serving unregistered firms. The reduction of R&D investment demonstrates the capacity for ambidextrous organization in supplier-dominated industries by focusing on both clients (premium and low-cost) in emerging economies. However, science-based, scale-intensive and specialized supplier firms are not affected by competition from unregistered firms, because they serve a different type of client (Baldwin, 1997; Tello, 2011). Moreover, in firms with a science-based labor (input) supply has highly specialized knowledge that cannot be captured by unregistered firms. Finally, the sectors where science-based, scale-intensive and specialized supplier firms operate have higher barriers to entry based on high fixed costs and machinery (Gonzalez and Lamanna, 2007). In this case, formal firms collaborate with unregistered firms to lower their production or distribution costs (Darbi et al., 2016). Thus, organizational ambidexterity in science-based and scale-intensive industries occurs through a product co-development decision on internal and external product development via the integration of both formal and unregistered firms in the distribution (Darbi et al., 2016; Winterhalter et al., 2015) to reduce the product costs through services or distribution activities (Darbi et al., 2016). By integrating unregistered firms into the value chain of formal firms, knowledge is absorbed, allowing the formal firms to reduce the costs of non-strategic activities (e.g., distribution) and at the same time, to increase or maintain its internal R&D (Raisch et al., 2009). Finally, the effect of competition from unregistered firms varies according to the IPRI (Intellectual Property Right Index) context. In a weakly effective IPRI context as traditional emerging economies, the competition from unregistered firms reduces R&D investment, because, in this context, unregistered firms mimic or replicate formal firm’s innovation. However, in a highly effective IPRI context as new developed emerging economies firms maintain their levels of R&D investment, because high IPRI context encourages a firm to explore new knowledge.

This previous theoretical explanation allows us to propose practical implications. Managers of firms in emerging economies where price-sensitive clients predominate (Williams and Martinez-Perez, 2014) must take into account two important variables for their innovation strategy: competition from unregistered firms and the level of IPRI. Firms in these contexts need to develop new capabilities according to the type of sector in line with Pavitt's taxonomy to serve low-cost and premium customers. One of the dynamic capabilities that formal firms can develop when face competition from unregistered firms is the ambidexterity, ambidextry allows formal firms balance the tension of promoting innovation to serve both types of market segment (low-cost and premium) (Raisch et al., 2009; Raisch and Birkinshaw, 2008), specifically supplier dominant industry that serve these two market segments low-cost and premium. On the other hand, the development of ambidexterity allows technology-based firms such as science-based and specialized supplier to limit imitation due to causal ambiguity, this to protect competitive advantage by restricting copying (Reed and DeFillippi, 1990). For policymakers, an understanding of the behavior of formal and unregistered firms is vital as it will allow them to establish better policies to enhance the capabilities of both types of firms to collaborate and to improve their performance (Darbi et al., 2016). For example, policymakers must encourage formal firms to increase their level of differentiation to avoid competition with the unregistered firms, as well as improving the level of IPRI (Intellectual Property Right Index). Moreover, policymakers must reduce formalization requirements, so that unregistered firms can access formal institutions to become formal ones and to integrate into the formal value chain to develop new skills at both types of firms.

Finally, although competition from unregistered firms can be important for innovation strategy decisions, our research is admittedly limited in certain respects, which may necessitate future research efforts.

First, we are careful regarding making any causal claims based on our study, because we relied on a cross-sectional dataset. Moreover, the propensity score matching approach only allows one to control for certain key observable characteristics. It does not eliminate all alternative explanations for a difference in firms’ strategic behavior between the two groups (treated and control). Future research may investigate the effect of competition from unregistered firms on R&D investment using panel data.

Second, we used R&D investment to proxy organizational ambidexterity under the context of organizational learning; it may not fully capture organizational ambidexterity. Future studies may develop new constructs to capture this effect more fully. Additionally, it is possible to explore the effect of competition from unregistered firms on organizational ambidexterity using other contexts such as technological innovation, organizational adaptation, strategy management and organizational design (Raisch and Birkinshaw, 2008).

Third, our results apply to this particular context of the 16 Latin American emerging countries selected. It would be interesting to extend our research to other contexts such as BRICS or new classifications of emerging economies, due to the heterogeneity of countries in emerging economies. We have only evaluated the heterogeneity by industry type and IPR level.

Four, the propensity score matching is a methodology used to evaluate the impact (magnitude and significance) of the unregistered firm on the innovation activities of the formal firms and understand the general variables in this phenomenon, but not to explain the particular mechanism of this effect. Then, future research can use other causality methodology, such as structural equations models, to evaluate the potential mediator and moderator variables that explain the particular mechanism.

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**Table 1.** Descriptive statistics for innovation

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Peru** | **Chile** | **Mexico** | **Colombia** | **Argentina** | **Bolivia** | **Panama** | **Paraguay** | **Uruguay** | **Venezuela** | **Ecuador** | **El Salvador** | **Honduras** | **Guatemala** | **Nicaragua** | **Costa Rica** | **Total** |
| Number of observations | 706 | 715 | 1,115 | 669 | 681 | 128 | 109 | 151 | 337 | 75 | 118 | 139 | 168 | 335 | 132 | 298 | 5876 |
| **Technological Innovation (as % of total firms):** | 78.3 | 67.7 | 56.5 | 76.2 | 79.1 | 50.0 | 8.3 | 48.3 | 63.5 | 56.0 | 61.0 | 58.3 | 45.2 | 64.5 | 35.6 | 71.8 | 65.1 |
| Product (%) | 64.4 | 55.9 | 47.1 | 60.2 | 69.0 | 39.1 | 6.4 | 42.4 | 52.8 | 34.7 | 53.4 | 47.5 | 36.3 | 53.7 | 29.5 | 62.1 | 54.0 |
| Process (%) | 60.9 | 48.5 | 38.7 | 56.7 | 53.5 | 37.5 | 5.5 | 29.1 | 42.4 | 42.7 | 40.7 | 46.8 | 33.9 | 42.1 | 22.0 | 44.6 | 49.6 |
| Share of firms that introduced a new-market product innovation | 37.7 | 30.2 | 23.1 | 31.8 | 34.5 | 25.0 | 1.8 | 23.8 | 23.1 | 9.3 | 30.5 | 23.0 | 20.8 | 25.1 | 18.9 | 30.5 | 28.0 |
| **Expenditure on innovation by type (as a % of total turnover of innovation)** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| R&D internal (%) | 5.3 | 2.9 | 1.5 | 5.3 | 9.1 | 10.1 | 21.3 | 2.6 | 4.6 | 30.3 | 2.8 | 2.2 | 10.6 | 3.9 | 0.2 | 3.1 | 11.1 |
| Share of firms that performed R&D internal (%) | 53.1 | 38.9 | 34.6 | 55.9 | 52.4 | 38.3 | 2.8 | 29.1 | 29.4 | 24.0 | 43.2 | 35.3 | 22.6 | 34.9 | 17.4 | 40.3 | 40.5 |
| **Share of turnover from product innovations (as a % of total turnover)** | 8.3 | 9.5 | 6.0 | 0.5 | 9.8 | 8.9 | 0.1 | 12.9 | 7.9 | 4.9 | 15.5 | 12.9 | 13.5 | 12.0 | 27.9 | 24.0 | 3.1 |
| **Human Resource (as a % of total permanent workers in sector)** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Share of workers with secondary school (%) | 79.2 | 83.3 | 76.5 | 79.8 | 84.7 | 84.1 | 66.4 | 84.7 | 94.7 | 85.1 | 78.5 | 91.2 | 87.5 | 87.3 | 80.0 | 85.9 | 81.4 |
| Share of workers who has at least a bachelor degree (%) | 20.8 | 16.7 | 23.5 | 20.2 | 15.3 | 15.9 | 33.6 | 15.3 | 5.3 | 14.9 | 21.5 | 8.8 | 12.5 | 12.7 | 20.0 | 14.1 | 18.6 |
| **Share of firms that co-operation with other enterprises or science and technology institutions (%)** | 19.1 | 22.9 | 12.5 | 22.0 | 22.2 | 23.4 | 5.5 | 13.2 | 14.2 | 24.0 | 19.5 | 20.9 | 16.1 | 20.6 | 14.4 | 20.8 | 18.5 |
| **Public programs (Share of firms that received financial support and made innovation)(%)** | 6.0 | 20.7 | 15.2 | 18.4 | 19.5 | 14.1 | 44.4 | 15.1 | 16.4 | 9.5 | 23.6 | 24.7 | 9.2 | 10.6 | 19.1 | 11.2 | 15.5 |
| **Total sales (MM-US dollar) /1** | 10,300 | 15,500 | 84,400 | 274,000 | 18,200 | 878 | 29,500 | 915 | 2,650 | 96,300 | 2,150 | 7 | 626 | 1,940 | 315 | 1,840 | 539,521 |
| /1. Exchange rate of year 2010 | | | | | | | | | | | | | | | | | |
| Source: Enterprise Survey's World Bank for Peru, Chile, Mexico, Colombia, Argentina, Bolivia, Panama, Paraguay, Uruguay, Venezuela, Ecuador, El Salvador, Honduras, Guatemala, Nicaragua, Costa Rica.  Own Elaboration | | | | | | | | | | | | | | | | | |

**Table 2.**

Variable’s definitions and operationalization

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Category** | **Sub-Category(Country)** | **Item-Description** | **Variables** | **References** |
| **Dependent** | R&D investment internal | Expenditures of R&D that were performed within this establishment | Numerical | (Helfat, 1997; Su et al., 2010) |
| **Independent** | Size | Full-time individuals worked in this establishment | Numerical  Numerical | (Demenet et al., 2016; Gonzalez and Lamanna, 2007; Perry et al., 2007; Williams et al., 2016) |
| Capacity utilization | Output produced as a proportion of the maximum output possible if using all the resources available |
| Exporter | Percentage of this national sales were less than 90 % (1), otherwise (0) | Dichotomous |
| Quality certification | Does this establishment have an internationally-recognized quality certification? |
| Web site | At the present time, does this establishment use its own website? |
| **Treatment** | Competition from unregistered firms | Zero (0) if a firm do not compete with unregistered firms and one (1) otherwise | Dichotomous | (Distinguin et al., 2016; Gonzalez and Lamanna, 2007; Iriyama et al., 2016; Mccann and Bahl, 2016; Mendi and Costamagna, 2017) |
| Own elaboration | | | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 3.**  Descriptive statistics and correlations | |  |  |  |  |  |  |  |  |  |  |  |  |
| Variable | Obs. | Mean | Std. | Min | Max | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1. R&D investment internal | 2381 | 9.86 | 2.09 | 0.75 | 21.1 | 1.00 |  |  |  |  |  |  |  |
| 2. Competition from unregistered firms | 2365 | 0.85 | 0.36 | 0.00 | 1.00 | -0.14\* | 1.00 |  |  |  |  |  |  |
| 3. Intellectual property right index | 2381 | 0.21 | 0.41 | 0.00 | 1.00 | 0.05\* | -0.07\* | 1.00 |  |  |  |  |  |
| 4. Exporter | 2381 | 0.34 | 0.47 | 0.00 | 1.00 | 0.18\* | -0.14\* | 0.04 | 1.00 |  |  |  |  |
| 5. Size | 2381 | 4.17 | 1.45 | 1.10 | 10.0 | 0.56\* | -0.11\* | -0.01 | 0.26\* | 1.00 |  |  |  |
| 6. Capacity | 2366 | 71.73 | 19.07 | 2.00 | 100 | 0.08\* | -0.08\* | -0.03 | 0.04\* | 0.19\* | 1.00 |  |  |
| 7. Quality certification | 2375 | 0.38 | 0.48 | 0.00 | 1.00 | 0.39\* | -0.11\* | 0.05\* | 0.23\* | 0.45\* | 0.04\* | 1.00 |  |
| 8. Web site | 2380 | 0.82 | 0.38 | 0.00 | 1.00 | 0.29\* | -0.04\* | -0.00 | 0.10\* | 0.32\* | 0.08\* | 0.25\* | 1.00 |
| \*p<0.05  Own elaboration |  |  |  |  |  |  |  |  |  |  |  |  |  |

|  |  |
| --- | --- |
| **Table 4.**  Probit model of competition from unregistered firms. |  |
| Dependent variable: Competition from unregistered firms. | |
| Exporter | -0.35\*\*\*(0.068) |
| Size | -0.039(0.026) |
| Capacity | -0.05\*\*(0.02) |
| Quality certification | -0.22\*\*(0.073) |
| Web site | 0.001(0.093) |
| Constant | 1.79\*\*\*(0.16) |
| Pseudo R2 | 0.037 |
| Log likelihood | -969.32 |
| Observations | 2344.00 |
| Standard errors in parentheses |  |
| \*p<0.10,\*\*p<0.05,\*\*\*p<0.01  Own elaboration |  |

**Table 5.** **Results of the hypothesis.**

R&D investment of firms that face competition from unregistered firms vs. formal firms do not compete with unregistered.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Model 1 | Model 2 | | | | Model 3 | |
|  | Whole sample | Pavitt taxonomy | | | | International Property Rights Index | |
|  | All sectors | Supplier Dominated | Science-Based | Scale Intensive | Specialised suppliers | High | Low |
| ATT | -0.41\*\*\* | -0.42\*\* | -0.70 | -0.35 | -0.15 | -0.31 | -0.41\*\* |
| N | 2344 | 1310 | 412 | 440 | 182 | 494 | 1850 |
| \*p<0.10, \*\*p<0.05, \*\*\*p < 0.01 | | |  |  |  |  |  |

The ATT reflects the difference in the R&D investment decision between formal firms that compete unregistered firms and firms do not, are statically significant. Furthermore, the negative value means that firms that compete with unregistered firms reduce R&D investment.

Own elaboration

**Appendix A1.**

Classification according to Pavitt taxonomy

|  |  |  |  |
| --- | --- | --- | --- |
| **ISIC.Rev3.1** | **Science-Based** | **Number** | **Percentage** |
| 24 | Manufacture of chemicals and chemical products | 408 | 17.1% |
| 33 | Manufacture of medical, precision and optical instruments, watches and clocks | 8 | 0.3% |
|  | **Sub- Total** | **416** | **17.4%** |
|  | **Supplier Dominated** |  |  |
| 15-16 | Manufacture of food products and beverages | 573 | 24% |
| 17 | Manufacture of textiles | 141 | 5.9% |
| 18 | Manufacture of wearing apparel; dressing and dyeing of fur | 212 | 8.9% |
| 19 | Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness, and footwear | 41 | 1.7% |
| 20 | Manufacture of wood and products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials | 25 | 1.0% |
| 28 | Manufacture of fabricated metal products, except machinery and equipment | 266 | 11.2% |
| 36-37 | Manufacture of furniture; manufacturing n.e.c. | 73 | 3.1% |
|  | **Sub- Total** | **1331** | **55.8%** |
|  | **Scale intensive** |  |  |
| 21 | Manufacture of paper and paper products | 22 | 0.9% |
| 22 | Publishing, printing, and reproduction of recorded media | 61 | 2.6% |
| 23 | Manufacture of coke, refined petroleum products, and nuclear fuel | 6 | 0.3% |
| 25 | Manufacture of rubber and plastics products | 211 | 8.9% |
| 26 | Manufacture of other non-metallic mineral products | 83 | 3.5% |
| 27 | Manufacture of basic metals | 38 | 1.6% |
| 34 | Manufacture of motor vehicles, trailers, and semi-trailers | 24 | 1.0% |
|  | **Sub- Total** | **445** | **18.8%** |
|  | **Specialised Suppliers** |  |  |
| 35 | Manufacture of other transport equipment | 4 | 0.2% |
| 31 | Manufacture of electrical machinery and apparatus n.e.c. | 35 | 1.5% |
| 29 | Manufacture of machinery and equipment n.e.c. | 150 | 6.3% |
|  | **Sub- Total** | **189** | **8%** |
|  | **Total** | **2,381** | **100%** |

Own elaboration

**Appendix A2.**

Balancing tests for the whole sample.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable |  | Treated | Control | p>|t| |
| Size | U | 4.1135 | 4.5545 | 0 |
|  | M | 4.1135 | 4.1176 | 0.93 |
| Exporter | U | 0.31316 | 0.49861 | 0 |
|  | M | 0.31316 | 0.31467 | 0.918 |
| Quality certification | U | 0.35199 | 0.50693 | 0 |
|  | M | 0.35199 | 0.34897 | 0.842 |
| Capacity | U | 71.124 | 75.155 | 0 |
|  | M | 71.124 | 71.122 | 0.998 |
| Web site | U | 0.81341 | 0.85873 | 0.039 |
|  | M | 0.81341 | 0.80535 | 0.518 |

U: Unmatched M: Matched

Own elaboration

1. http://www.imf.org/external/datamapper/NGDPD@WEO/OEMDC/ADVEC/WEOWORLD [↑](#footnote-ref-1)
2. <http://www.enterprisesurveys.org/data/exploretopics/informality> [↑](#footnote-ref-2)
3. Only surveys that have been posted during 2010-2017 and that adhere to the Enterprise Surveys Global Methodology were used to compute these regional and "all countries" averages. [↑](#footnote-ref-3)
4. https://internationalpropertyrightsindex.org/about [↑](#footnote-ref-4)
5. Argentina, Bolivia, Colombia, Mexico, Panama, Peru, Paraguay, Uruguay, Venezuela, Chile, Ecuador, el Salvador, Honduras, Guatemala, Nicaragua and Costa Rica. Their combined GDP is equal to 54 % of the total GDP of Latin America. [↑](#footnote-ref-5)