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Imitation Risk and Market Attraction on Patent Applications

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Resumo

In this paper, we investigate to which extent the foreign applicants of patents are driven by the imitation risk of countries or by their market opportunities. We found empirical evidence on the relation between market attractiveness and patent applications through a cross-sectional study of 112 countries in the year of 2015. We relied on available secondary data from several institutions and international organizations to compose a dataset of 33 variables aggregate in three constructs: Patent Applications, Innovation Capacity and Market Attractiveness. Our analyses were based on the comparison of two types of patent applicants: residents and nonresidents. We put special lenses on the market construct by employing Factor Analysis to splitting it in four factors: Purchase Power, Market Scale, Consumption Drivers, and Consumer Outlook. Multiple Regression Models were employed to find that (1) market factors in a country are much correlated with its patents but has a major weight for nonresidents. (2) Whereas the Innovation Capacity is important for resident patent applications, it does not influence nonresident patent applications. And (3) scientific output, measured by technical and journal publications, is a direct influencer of domestic and a reverse influencer of foreign patent applications.

Imitation Risk and Market Attraction on Patent Applications

Abstract: In this paper, we investigate to which extent the foreign applicants of patents are driven by the imitation risk of countries or by their market opportunities. We found empirical evidence on the relation between market attractiveness and patent applications through a cross-sectional study of 112 countries in the year of 2015. We relied on available secondary data from several institutions and international organizations to compose a dataset of 33 variables aggregate in three constructs: Patent Applications, Innovation Capacity and Market Attractiveness. Our analyses were based on the comparison of two types of patent applicants: residents and nonresidents. We put special lenses on the market construct by employing Factor Analysis to splitting it in four factors: Purchase Power, Market Scale, Consumption Drivers, and Consumer Outlook. Multiple Regression Models were employed to find that (1) market factors in a country are much correlated with its patents but has a major weight for nonresidents. (2) Whereas the Innovation Capacity is important for resident patent applications, it does not influence nonresident patent applications. And (3) scientific output, measured by technical and journal publications, is a direct influencer of domestic and a reverse influencer of foreign patent applications.

Keywords: Imitation risk, Market attraction, Patent application, Intellectual property, Innovation environment

1. INTRODUCTION

Once an innovator reaches the outcome of his/her efforts on Research and Development (R&D) and finds a novel solution to a specific technological problem through a product or process invention, he, she, or a company, may decide to apply for a patent. Patents are publications in which the inventor disclosures his solution in details and receives from a governmental authority, as a compensation for this publicity, exclusive rights over the invention for a limited period of time. In its original roots, a patent is a mechanism of temporary protection against the risk of being copied (Kamperman Sanders & Shabalala, 2014; WIPO, 2003).

Many reasons, such as time, paperwork, costs, chance to fail, and the disclosure of the specifications may deter the inventor to patent and consequently expose the invention to imitation risks (Gambardella, Giuri, & Luzzi, 2007). On the other hand, patents may constitute a technological comparative advantage for inventors because they are properties based on legal monopolies, then valuable and tradable as intellectual property (De Marco, Scellato, Ughetto, & Caviggioli, 2017; Kani & Motohashi, 2012).

In this sense, there are market and risk forces that attract patent applications in a country: patentees may intend to protect his invention against copycats from the destination or may want to explore the domestic market in the destination (Fu & Yang, 2009; Blind, Edler, Frietsch, & Schmoch, 2006; Somaya, 2003; Huang & Cheng, 2015).

After deciding to patent, an inventor may choose a country and patent office for an application (Athreye & Cantwell, 2007). Although many efforts have been done towards more standardized procedures and legal bases, such as the rise of the World Intellectual Property Organization (WIPO) and international granting agreements, the extent of rights still varies extensively among countries (Dechezleprêtre, Ménière, & Mohnen, 2017; Süzeroğlu-Melchiors, Gassmann, & Palmié, 2017).

In this uncertain scenario, inventors with more resources, mainly companies through their R&D departments, implement some strategy to plan the destination of their patent applications based on risks and opportunities choices (Athreye & Cantwell, 2007; Gassmann & Bader, 2017). Blind et al. (2006) took a closer look at these patent strategies and found ‘patent

strategies abroad' on the second place in a rank of protection importance, followed by the third 'domestic patent strategies', beaten only by the lead time to patent (first placed in this ranking). As for the motives to patent, these scholars found 'protection from imitation' as the most important and internationalization motives among the top five in the ranking, corroborating to the connection between market and risk drivers to patent applications.

In this paper, we investigate the negative effects of the Innovation Capacity and the Absorptive Capacity of countries on intellectual property. We named these negative effects as the "Imitation Capacity" and posited that it increases the risk of copycat in aggregate. Then we investigate how inventors strike the balance between the risks of being imitated, through the Imitation Capacity of countries, and the market opportunities of destinations when implementing their international patent strategy (Van Zeebroeck & Van Pottelsberghe de la Potterie, 2011; Giarratana & Mariani, 2014).

Due to the difficulty found by researches on identifying the determinants of patent value *per se*, the patents literature have only recently focused on the factors that influence decision makers to apply for patents either domestic or internationally (Archontakis & Varsakelis, 2017; De Marco et al., 2017). Despite its significance, the imitation risk does not receive much attention on the holistic view of enterprise risk management, that focuses mainly on creative spillovers and knowledge leaking (internal risk source), but not the risks of copy, non-consensual acquisition of technology, counterfeit activities, and reverse engineering (external perspective) (COSO, 2004; ISO 2018; Oliva et al, 2019; Minagawa, Trott, & Hoecht, 2007; Giarratana & Mariani, 2014).

Following the context and gap presented, as well the increasing search for patenting internationally in recent decades (WIPO, 2011), the main purpose of this work is to answer if the imitation risk is more or less relevant than the market attractiveness of a country to foreign patentees. In addition, we explored if the market factors and Imitation Capacity variables have their net effect associated with foreign patent applications, on the country level of analysis.

This paper has two main contributions, one for the literature and other for decision makers. First, we advance studies on identifying factors that influence the application of patents abroad, as well as draw attention to the importance of imitation risk being considered by corporate risk management tools.

Second, we demonstrate to decision makers that imitation risk is international and imminent. This risk can be mitigated by applying patents either in the national or international market (Eaton & Kortum, 1996; Maurseth & Svensson, 2014). Therefore, when analyzing markets, companies also need to look at risks, especially in countries with better capacity for innovation, which consequently are the countries with good capacity for imitating (Chen, 2018; Xia & Liu, 2018; Milan, Iryna, & Karl, 2014; Minagawa et al., 2007; Giarratana & Mariani, 2014).

The remainder of this paper is structured as follows. The second section summarizes prior research about the imitation risk; market as an attractor of foreign patentees; the imitation capacity as the free rider side of absorptive capacity and innovation performance; and patents as a consequence of absorptive capacity and innovation performance. Then, the third section presents the methods, including methodological aspects, database composition and its characteristics and statistics, their purpose and assumptions. The fourth section reports the findings and, finally, in the fifth section, finds are discussed and conclusions highlights the implications for research and practice, as well as limitations and future research directions.

2. LITERATURE REVIEW

2.1. The Imitation Risk

Risk is a widely used term within several fields of study and its concepts are hard to define either on everyday language or in a specific area. To highlight only a few examples, in health and safety, risk is related with harmfulness. The finance area deals with fluctuations around a value, where risks are either positive or negative returns. And in decision theory, risk is based on probability distributions (Heckmann et al., 2015).

In the management area, several risks are recognized, such as strategic, operational, ethical, image, social, financial, technological, economic, environmental, of innovation and of sustainability (Oliva, 2016). Considering these and other risks yet to emerge, a prominent trend of studies have posit that the organization should understand and manage the whole arrangement of its risks in a holistic view (Kloman, 1992 e Bromiley 2014). Under this holistic umbrella, "risk is a variable that can cause variation from an expected outcome, and as such may affect the achievement of business objectives and the performance of the overall organization" (Lam, 2017, p. 4).

The holistic concept of risks represented by the above umbrella is the Enterprise Risk Management (ERM). The Committee of Sponsoring Organizations of the Treadway Commission defines ERM as:

> "A process, effected by an entity's board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and to manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives" [Committee of Sponsoring Organizations of the Treadway Commission (COSO, 2004, p. 2).

Among the vast list of risks that a company may recognize, the risk of imitation is of great concern in the innovation area (West and Bogers, 2014; Oliva et al, 2018). In a review of the literature on the motives to patent, Blind et al. (2006) found the 'protection from imitation' to be the traditional motive, in contrast to several strategic motives, such as the international market extension, the reputation and technical image, and the reaction to patent practices of competitors. These scholars surveyed 522 firms, sampling more than 40% of all German applications at the European Patent Office for the year of 1999, and composed an importance ranking of the motives to patent. 'Protection from imitation' figures the top of the ranking, followed by 'securing European markets', 'defensive blockade of competitors', 'securing national markets', 'improvement of technological image', 'offensive blockade of competitors', 'securing markets outside Europe', and other eight strategic motives.

Back in the 1990´s, Park (1997, p. 187) was among the first scholars to discuss the term "imitation risk" while studying the impact of intellectual property protections on the timing to innovation of countries. He found that "changes in imitation risk affect both the profitability of the existing technologies and the profitability of the future new technologies of countries".

The conceptual link to innovation and origin of the term "imitation risk" in the economic science is mainly explained by the free rider assumptions regarding the problem of a new entrant that may deliberately copy the original technology (Benoit, 1985). Following this trend of thoughts, Mukherjee and Pennings (2004) found the imitation risk to be higher for newly developed technologies when patents are long and imitation cost is low, and conversely, the imitation risk to be lower for higher quality products because they usually involve more

complex technologies. The later was built on Pepall and Richards (1994) positive relation between product quality and imitation cost.

A later review of the literature on the behavior of innovative firms and their relations to economic and organizational environments by Dubina (2011) shown that a consensus on intellectual property foreign exploration is inexistent and strategies of protection are sensitive to context and research designs. His research investigated 30 papers on the different aspects of innovative activity by the lenses of game theory to propose forward licensing as a strategy to increase firm profits.

Accordingly, in this paper we conceptualize the imitation risk as the non-consensual acquisition of technology and copycat, usually exploited by counterfeit products or activities and facilitated by reverse engineering (Minagawa et al., 2007; Giarratana & Mariani, 2014). In this sense, the management of the imitation risk depends on the abilities of firms to prevent potential competitors to market the same technology or invention, locally or internationally (Mukherjee, 2004).

2.2. Market as an attractor of foreign patentees

Once patenting in a specific country, innovation's inventor is protected in two ways. First, from imitators producing in that country and second, from outside imitators selling in that country. It means that to protect an invention worldwide, the inventor needs to patent in several countries (Eaton & Kortum, 1996; Maurseth & Svensson, 2014). The search for patenting international have been increasing in recent decades. WIPO (2011), for example, presented the number of patent families has increased by around 80% from 1990 to 2006, and more than 40% of all patent applications in the world's patent offices were from nonresidents in 2010.

Dunning's eclectic paradigm (OLI) supports some reasons for patenting abroad. The location condition concerned with the "where" of production explains that advantages of different factor endowments and market situations can be taken with internationalization. Some of these advantages include geographical factors, tax and exchange rate policies opportunities, legislation towards the production and licensing of technology, as well patent system (Dunning, 1977; Stoian & Filippaios, 2008).

Patenting in other countries can generate some opportunities as facilitated access to that market, higher level of technical efficiency and more market power. Furthermore, it inhibit effective competition (Dunning, 1977). According to Blind et al. (2006) "the higher the intensity of competition, the higher the likelihood to patent in order to protect the technological assets from imitation and to secure national and international market shares" (p. 665).

Market power is a patent effect on trade. According to Park (1997) patents applies to contemporaneously existing technologies as well as to future (potential) technologies.

Thus, it is hypothesized as follows:

H1: Foreign innovators apply for patents in a country to explore the local market opportunities in a market-seeking strategy.

2.3. The Imitation Capacity as the free rider side of Absorptive Capacity and Innovation Performance

Considering the management approach, we understand that the imitation risk at the firm level is adherent to the Cohen and Levinthal's (1990) concept of Absorptive Capacity. In this sense, the follower competitor (or imitator) must be able to appropriate the knowledge contained in the original innovation by recognizing, assimilating and applying it to build a competitive copycat.

By improving Cohen and Levinthal's (1990) model, Zahra and George (2002) included the contingent factor of "social integration", that influence the transformation of potential absorptive capacity into realized absorptive capacity. We may exemplify the social integration with the impetus of a company to imitate. Although a follower competitor may have all the capabilities to copy and market the original technology, the environment may impose (through an enforcement or ethical consensus) that a non-consensual marketing is socially unaccepted.

A Refined Model of Absorptive Capacity was later proposed by Todorova Durisin (2007) by mainly making the model dynamic and adding the value and power concepts to Zahra and George´s (2002) earlier model. In this framework, power plays an important role on the exploitation of knowledge in the absorptive capacity process. As for the imitation risk, a free rider behavior of individual or collective powerful source may influence the decision to either copy or exploit the original invention.

Considering the economic approach, (Baldwin, 1997) proposes that R&D is neither a necessary nor a sufficient condition for innovation in a firm but investment in R&D is a usual determinant of innovation performance at the country level. However, innovation is affected by pushing and pulling forces determined by human and capital factor inputs, institutional factors and other forces (Pavitt, 1980; Furman, Porter, & Stern, 2002; Faber and Hesen, 2004).

Considering these constraints and incentives for innovation, Fu and Yang (2009) analyzed 21 OECD countries through a stochastic frontier approach and distinguished 'basic innovation capacity' from 'innovation efficiency'. They considered as 'capacity' all input factors, such as labour force skills and availability of qualified research staff (Hoffman et al., 1998; Porter and Stern, 1999). They built on (Furman et al., 2002; OECD/Eurostat, 2005) grounds of the institutional and networking features of countries to aggregate the ability of putting the innovation capacity into practice. "Innovation efficiency thus reflects a nation's intangible capability for transforming direct, tangible innovation inputs into final commercially successful innovation outputs. It explains the difference between actual outcomes and expected innovation outcomes based on inputs alone." (Fu & Yang, 2009, p. 1205).

Taking together the aggregate amount of Absorptive Capacity of firms in a country and the tangible and intangible economic inputs of Innovation Capacity and Innovation Efficiency, we may reason that some countries are more competent to imitate, and/or offer more rewarding environments for copies. We named the free rider side of these early capacities as the "Imitation Capacity" of a country and posited that it increases the chance of the imitation risk of a country.

The Imitation Capacity is the aggregate capacity of a country to reverse engineer an invention, absorb knowledge form a new technology, explore a non-consensual acquisition of technology, bypass royalties, produce or market copycat or counterfeit (Minagawa et al., 2007; Giarratana & Mariani, 2014).

Thus, it is expected that countries with higher Imitation Capacity attract patents application of foreigners who employ an imitation protection strategy. From this, we propose the following hypothesis:

H2: The Imitation Capacity of a country attracts foreign patent applications.

2.4. Patents as a Consequence of Absorptive Capacity and Innovation Performance.

Fu and Yang (2009, p. 1204) assert that "the innovation performance of a nation is determined not only by the quantity of human and capital factor inputs into innovation, but also by institutional and other system factors. These factors constitute constraints and/or incentives for innovation". On the earlier discussion of hypothesis H2 we put focus on the constraints and discussed the dark use of Absorptive Capacity and National Innovation Performance to build the Imitation Capacity concept. Now we are going to overview the incentives for innovation on

the basis of country capacities. We call this concept as "Innovation Capacity", represented by the bright side of Absorptive Capacity and National Innovation Performance.

In order to place emphasis on determinants of basic innovation capacity, Fu and Yang (2009, p. 1205) stress that "variations in sectoral structure which may affect the role that each may play at an aggregate level. They insist upon this: this leads to variations in the incidence of patenting across sectors but also in underlying rates of R&D activity".

Fu and Yang (2009, p. 1205) also acknowledge the determinants of innovation efficiency, "the actual innovation performance of nations is determined not just by factor inputs, but by the efficiency of the inherently recursive process by which innovation opportunities are recognized". Thus, it should be interpreted as, according to Fu and Yang (2009, p. 1205) "the nation's intangible capability for transforming direct, tangible innovation inputs into final commercially successful innovation outputs".

It is also highlighted by Fu and Yang (2009, p. 1205) that

> (…) government policy and support for innovation, openness of the economy, the relative involvement of the business sector and public sector in R&D, the linkages between the science base and industries, the information infrastructure of the economy, and the strength of protection for intellectual property, are all important factors affecting the innovative efficiency of nations.

The perspectives above are corroborated by Sharma & Thomas (2008, p. 483), "due to globalization, countries are exposed to high levels of competition in domestic as well as foreign markets. Realizing this, nations are striving to improve their technological capacity. One of the major drivers of technological change is the R&D process". They also argue that "the efficiency of the R&D process can be the ratio of the R&D outputs and inputs. The major inputs to the R&D process are expenditure on R&D and scientific manpower. The outputs are patents and publications" (Sharma & Thomas, 2008, p. 483)

According to Dominique & Bruno (2003), the economic reason for government involvement is the presence of market disruption related with R&D. "Government may want to stimulate R&D performed by business, either to reduce the private cost of R&D (e.g. grants) or to help firms in understanding the technological opportunities that are available, thus reducing both the cost and uncertainty of research" (Dominique & Bruno, 2003).

This conjecture is also supported by Criscuolo, Narula, & Verspagen (2005, p. 417), "R&D facility's capacity to exploit and/or augment technological competences is a function not only of its own resources, but also of its efficiency with which it can utilize complementary resources associated with the relevant local innovation system".

Thus, it is hypothesized as:

H3: Residents apply for patents in their country as consequence of the domestic Innovation Capacity.

3. METHODS

3.1. Methodological aspects

This work is classified as a quantitative research, once data collected was quantified and measured (Martins & Theóphilo, 2009). Data sources are secondary and from public databanks. The database composition and its characteristics are detailed in the subsection below.

The main purpose of this work is to answer if the imitation risk is more or less relevant than the market attractiveness of a country to foreign patentees. In addition, we explore if the

market factors and Imitation Capacity variables have their net effect associated with foreign patent applications, on the country level of analysis.

To achieve these objectives we conducted a literature review about: (i) the imitation risk; (ii) market as an attractor of foreign patentees; (iii) the Imitation Capacity as the free rider side of Absorptive Capacity and Innovation Performance; and (iv) patents as a consequence of Absorptive Capacity and Innovation Performance.

Thus, we posit and test three hypotheses: (H1) foreign innovators apply for patents in a country to explore the local market opportunities in a market-seeking strategy; (H2) that the Imitation Capacity of a country attracts foreign patent applications; and (H3) residents apply for patents in their country as consequence of the domestic Innovation Capacity. Table 1 summarizes the literature review that supports our hypotheses.

Table 1: Hypotheses and its Literature Review support

Hypotheses	Literature Review
H1: Foreign innovators apply for patents in a country to explore the local market opportunities in a market-seeking strategy	Dunning (1977); Stoian and Filippaios (2008); Blind et al. (2006); Park (1996).
H2: The Imitation Capacity of a country attracts foreign patent applications	Minagawa et al. (2007); Giarratana and Mariani (2014); Fu and Yang (2009); Mukherjee (2004); Blind et al. (2006)
H3: Residents apply for patents in their country as consequence of the domestic Innovation Capacity	Fu and Yang (2009); Sharma, S. & Thomas, V. (2008); Dominique and Bruno, 2003; Criscuolo et al., (2005)

Source: prepared by the authors

Finally, to test these hypotheses we developed three concepts, namely Patent Application, Market Attractiveness and Imitation/Innovation Capacity, to model the dependence of resident and nonresident patent application as a function of the later two constructs. Considering the focus on the market phenomenon, we split Market Attractiveness into four factors: Purchase Power, Market Scale, Consumption Drivers, and Consumer Perspectives.

3.2. Database composition and its characteristics

Initial retrieved cases: 217 countries or autonomous territories in a timespan from 2012 to 2017. The World Bank was the main reference for country information, the ISO country code was used as the key field for data conciliation.

Feasible cross-sectional sample: 2015 was the latest year with most complete information. When data were not available for 2015 we used data from 2014 (19% of values) and, when variables were less sensitive to time, we filled the missing values with data from 2013 (7% of values).

Variables: Data for 30 variables were initially retrieved, 3 additional variables were computed, and other qualifying data were later added. Variables were gathered from the following public databanks: The World Bank database; OECD National Accounts data files; International Labour Organization (ILOSTAT) database; World Trade Organization (WTO); International Monetary Fund (IMF) International Financial Statistics and data files; United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics; World Bank, Doing Business project; USA National Science Foundation, Science and Engineering Indicators; United Nations Industrial Development Organization (UNIDO) Competitive Industrial Performance (CIP) database; United Nations, Comtrade database through the WITS platform; The Observatory of Economic Complexity jointly with MIT Macro Connections and the Center for International Development at Harvard University; and the

World Intellectual Property Organization (WIPO) Global Innovation Index. Table 2 depicts the collected variables.

Missing values - cases: We initially excluded all cases with more than 30% of missing data, resulting in 134 countries. Then, we selected all countries with data for the two Patent variables, given the aim of this study. The final selection comprised 112 countries with an overall 9% of missing values.

Univariate distributions: Variables were graphically analyzed by their distributions and assessed for normality with Kolmogorov-Smirnov and Shapiro-Wilk tests. Most of the variables were expected to be skewed because of the natural concentration in a few countries, such as population and GDP. When applicable, variables were transformed by Log_{10}, square root, or other simple calculation along with outlier analysis. Even the 12 variables that did not reach a normal distribution shown more central concentrations after transformations.

Table 2 - Variables in the database and constructs

Construct	**Variable (unit) [source code]**	**N**	**Years of data collection**	**Transform. applied**
Patent Application	Patent applications, nonresidents [IP.PAT.NRES]	112	2015-2014	Log 10 (x)
	Patent applications, residents [IP.PAT.RESD]	111	2015-2014	Log 10 (x)
Market Attractiveness	Charges for the use of intellectual property, payments (BoP, current US$) [BM.GSR.ROYL.CD]	98	changed into new variable	
	Net trade in goods (BoP, current US$) [BN.GSR.MRCH.CD]	108	changed into new variable	
	Population density (people per sq. km of land area) [EN.POP.DNST]	112	2015-2014	Log 10 (x)
	Domestic credit provided by financial sector (% of GDP) [FS.AST.DOMS.GD.ZS]	105	2015-2014	Log 10 (x)
	Household final consumption expenditure, PPP (current international $) [NE.CON.PRVT.PP.CD]	108	2015-2014	Log 10 (x)
	GDP (current US$) [NY.GDP.MKTP.CD]	112	2015-2014	Log 10 (x)
	GDP growth (annual %) [NY.GDP.MKTP.KD.ZG]	112	2015-2014	Sq Root (x)
	GDP per capita, PPP (current international $) [NY.GDP.PCAP.PP.CD]	112	2015-2014	Log 10 (x)
	Unemployment, total (% of total labor force) (national estimate) [SL.UEM.TOTL.NE.ZS]	104	2015-2014	Sq Root (x)
	Population, total [SP.POP.TOTL]	112	2015-2014	Log 10 (x)
	Merchandise trade (% of GDP) [TG.VAL.TOTL.GD.ZS]	112	2015-2014	Log 10 (x)
	Binding coverage, manufactured products (%) [TM.TAX.MANF.BC.ZS]	100	2015-2014	1 / cos (x)
	Inflation, consumer prices (annual %) [FP.CPI.TOTL.ZG]	110	2015-2014	Log 10 (x)

	Tariff rate, applied, simple mean, all products (%) [TM.TAX.MRCH.SM.AR.ZS]	102	2015-2014	Log 10 (x)
	Payment for intellectual Property Log (%GDP) created: [BM.GSR.ROYL.CD] / [NY.GDP.MKTP.CD]	-	2015-2014	Log 10 (x)/ GDP
	Net trade in goods (%GDP) created: [BN.GSR.MRCH.CD] / [NY.GDP.MKTP.CD]	-	2015-2014	Log 10 (x)/ GDP
	Household final consumption expenditure PPP PERCAPTA created: [NE.CON.PRVT.PP.CD] / [SP.POP.TOTL]	-	2015-2015	(x) / total pop.
Imitation/ Innovation Capacity (imitation as the risky side and innovation as the incentive side of Absorptive Capacity and Innovation Performance)	Ease of doing business index (1=easiest to 185=most difficult)	111	2015-2014	Reflected
	Economic Complexity Index	100	2015-2014	none
	Innovation Efficiency (ratio)	109	2015	none
	Global Innovation Index (0-100)	109	2015	Log 10 (x)
	Research and development expenditure (% of GDP) [GB.XPD.RSDV.GD.ZS]	88	2015-2014-2013	Log 10 (x)
	Scientific and technical journal articles [IP.JRN.ARTC.SC]	110	2015-2014	Log 10 (x)
	Medium and high-tech industry (% manufacturing value added) [NV.MNF.TECH.ZS.UN]	106	2015	Sq Root (x)
	Researchers in R&D (per million people) [SP.POP.SCIE.RD.P6]	78	2015-2014-2013	Sq Root (x)
	High-technology exports (% of manufactured exports) [TX.VAL.TECH.MF.ZS]	106	2015-2014-2013	Sq Root (x)
	Technicians in R&D (per million people) [SP.POP.TECH.RD.P6]	63	2015-2014	Not viable

Source: prepared by the authors.

Missing values – variables: The following data cleaning cut off outliers in 3 standard deviations, filled the 9% of missing values with average, and standardized values (mean=0; std. dev.=1 : Z-scores). This step was interactive with the previous transformations to increase normality.

Internal consistency: Cronbach's Alpha Min.: 0.808 and Max.: 0.848.

3.3. Statistics, their purpose and assumptions.

We conducted an Exploratory Factor Analysis (EFA) for data reduction on the *Market Attractiveness* construct (initial 13 variables) because it is also useful to prepare data for the following Multiple Regression Analysis (MRA). Then, we employed the MRA in two models: one for the resident and other for the nonresident application for patents as the dependent variables. Stepwise and counter-stepwise methods were run with all independent variables and market factors from the EFA to eventually model the willingness of a resident or a nonresident to apply for a patent in a given country (Hair, Black, Babin, & Anderson, 2010).

Assumptions: All variables are continuous, linearity was assessed by scatterplot analysis. Most of the data had shown linear distribution after data preparation. Outliers were trimmed when data was transformed. The final case/variable ratio was of 8.6 cases per variable. Spearman correlation matrix for the 15 variables of the *Market Attractiveness* construct were analyzed and allowed an EFA.

4. RESULTS

4.1. The Market Attractiveness factors

We employed an EFA for market attractiveness and found an optimized extraction of 4 factors with Varimax rotation and Kaiser normalization: Factor 1, named *Purchase Power* (24.7% of variance); Factor 2, named *Market Scale* (22.4% of variance); Factor 3, named *Consumption Drivers* (17.3% of variance); and Factor 4, named *Consumer Outlook* (11.5% of variance). As for extraction quality, the total variance explained was 75.88 with commonalities ranging from 0.996 to 0.567 and KMO of 0.791. Bartlett's Test Sig. was 0.000 and MSA ranged from 0.926 to 0.638.

MODEL 1 – Multiple Regression Analysis with all independent variables to predict patent application of nonresidents.

We conducted a MRA with *Patent Applications of Nonresidents* as dependent variable and all independent variables as predictors. The adjusted R square was 0.663 for this model with statistically significant linear relationship between Patent Applications of Nonresidents in a given country and the selected variables in this study $F(13, 98) = 17.778$, $p < .0005$, with N=112 and independence of residuals. The following Table 3 depicts the coefficients of this initial regression, where it is possible to recognize only four independent variables as significant predictors in the model, highlighted in bold.

Table 3 - Multiple Regression Analysis with all independent variables to predict patent application of nonresidents

	Unstandardized Coefficients		Standard. Coefficients			95,0% Confidence Interval for B	
	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
(Constant)	-2,492E-15	,055		,000	1,000	-,109	,109
MKT Factor 1 - Purchase Power	,396	,129	,396	3,056	,003	,139	,653
MKT Factor 2- Market Scale	,950	,124	,950	7,638	,000	,704	1,197
MKT Factor 3- Consumption Drivers	-,073	,095	-,073	-,764	,447	-,262	,117
MKT Factor 4- Consumer Perspectives	,019	,063	,019	,294	,769	-,107	,145
Z-BZ-ENV Economic Complexity 15	-,104	,115	-,104	-,910	,365	-,332	,123
Z-BZ-ENV Innovation Efficiency (ratio) 15	-,033	,090	-,033	-,374	,710	-,211	,144
Z-BZ-ENV Easy of doing Business reverse ranking (positive relation)	,021	,127	,021	,167	,868	-,230	,273

Z-R&D-EF IMPUT Research and development expenditure Log (% of GDP) 15-14-13	-,079	,105	-,079	-,749	,456	-,288	,130
Z-R&D-EF OUTPUT Scientific and technical journal articles Log 15-14	-,368	,150	-,368	-2,444	,016	-,666	-,069
Z-R&D-EF OUTPUT Medium and high-tech industry SQRT(% manufacturing value added) 15	,130	,104	,130	1,249	,215	-,076	,336
Z-R&D-EF IMPUT Researchers in R&D SQRT(per million people) 15-14-13	-,152	,089	-,152	-1,707	,091	-,328	,025
Z-R&D-EF OUTPUT High-technology exports SQRT(% of manufactured exports) 15-14-13	-,022	,077	-,022	-,289	,773	-,176	,131
Z-R&D-EF Global Innovation Index LOG	,432	,208	,432	2,070	,041	,018	,845

Source: prepared by the authors

MODEL 2 – Multiple Regression Analysis with significative independent variables to predict patent application of nonresidents.

We proceeded a backward process and final MRA with *Patent Applications of Nonresidents* as dependent variable raised its adjusted R square to 0.700. One outlier was identified and excluded (N=111). The regression model found statistically significant linear relationship between Patent Applications of Nonresidents in a given country and the selected variables in this study $F(3, 108) = 87.311$, $p < .0005$, with N=111 and independence of residuals. The following Table 4 depicts the coefficients of this final regression, where it is possible to find the only three independent variables that predict the final model.

Table 4 - Multiple Regression Analysis with significative independent variables to predict patent application of nonresidents

	Unstandardized Coefficients		Standard. Coefficients			95,0% Confidence Interval for B	
	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
MKT Factor 1 - Purchase Power	,589	,070	,598	8,423	,000	,450	,727
MKT Factor 2- Market Scale	,967	,093	,982	10,409	,000	,783	1,152
Z-R&D-EF OUTPUT Scientific and technical journal articles Log 15-14	-,374	,105	-,378	-3,567	,001	-,581	-,166

Source: prepared by the authors

As for model quality, we proceeded bootstrapping with 1000 samples and found very similar results. Homoscedasticity and normality of residuals were verified.

MODEL 3 - Best fit regression of alternative model: Patent Applications of Residents

To analyze the difference between Patent Applications of residents and nonresidents we composed an alternative model for comparison. We proceeded a backward process and final MRA with *Patent Applications of Residents* as dependent variable reached an adjusted R square

of 0.879. Two outliers were found and excluded. Thus, there is a statistically significant linear relationship between Patent Applications of Nonresidents in a given country and the selected variables in this study F(6, 103) = 133.152, p < .0005 with N=110, with independence of residuals. The following Table 5 depicts the coefficients of this final regression, where it is possible to find the six independent variables that predict this final model.

Table 5 - Best fit regression of alternative model: Patent Applications of Residents

	Unstandardized Coefficients		Standard. Coefficients			95,0% Confidence Interval for B	
	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
MKT Factor 2- Market Scale	,426	,065	,431	6,551	,000	,297	,555
MKT Factor 3- Consumption Drivers	-,102	,039	-,102	-2,606	,011	-,179	-,024
Z-BZ-ENV Innovation Efficiency (ratio) 15	,071	,040	,072	1,780	,048	-,008	,150
Z-BZ-ENV Easy of doing Business reverse ranking (positive relation)	,236	,056	,235	4,220	,000	,125	,347
Z-R&D-EF OUTPUT Scientific and technical journal articles Log 15-14	,411	,075	,412	5,459	,000	,262	,560
Z-R&D-EF OUTPUT High-technology exports SQRT(% of manufactured exports) 15-14-13	,118	,042	,119	2,805	,006	,035	,202

Source: prepared by the authors

As for model quality, we proceeded bootstrapping with 1000 samples and found very similar results. Homoscedasticity and normality of residuals were verified.

5. CONCLUSIONS AND DISCUSSIONS

First, we found statistical support to assume that foreign innovators apply for patents in a country to explore the local market opportunities. Our study of H1 shows that *Market Scale* is the main driver for patent applications of nonresidents in a given country, followed by *Purchase Power* and *Scientific and technical journal articles* (beta coefficients of 0.967; 0.589; and -0.374 respectively).

This result is supported by previous researches that found market size as a geographical reason for patenting abroad (Viotti, 2002). Furthermore, it is related with opportunities as easy access to that market and higher market scales (Dunning, 1977; Blind et al., 2006). Other advantage is its relation with market power, seen by Park (1997) as a patent effect on trade.

Although Market Factors were diverse for residents and for nonresidents, they were able to explain a high proportion of the variations in the sample, also supporting that residents apply for patents in their home country as consequence of the domestic Innovation Capacity, as proposed by H3. In this case, *Market Scale* is the main driver for patent applications in a given country, followed by *Scientific and technical journal articles*, the *Easy of Doing Business Index*, the *High technology exports*, the *Consumption Drivers*, and finally the *Innovation Efficiency Ratio* (beta coefficients of 0.426; 0.411; 0.236; 0.118; -0.102; and 0.071 respectively).

To support the results found in H3, essentially to what matters the *Innovation Efficiency Ratio*, Hong, Feng, Wu, & Wang (2016) state that "government grants can reduce the cost of R&D activities for firms and generate further innovation by motivating additional private R&D spending, and complement that claiming that government sponsorship has a positive effect on innovation". It is also observed that the scientific and technological journal articles are highly correlated with Innovation Capacity, especially to the concern of patenting in a given country. According to the World Bank database, out of the top five countries to file most international patent applications in the year of 2018, four of them were seen as countries with a high number of scientific and technical journal articles.

Surprisingly, we did not find robust evidence to support that the Imitation Capacity of a country attracts foreign patent applications when analyzing H2. Usual indicators of absorptive capacity and innovation performance available in the literature, such as R&D expenditure (Gassmann and Von Zedtwitz, 1999), the World Bank Doing Business Survey (Brockman, Khurana, Inder, 2018), complexity of economy (Sweet, Mehlig, 2015), efficiency of innovation and the Global Innovation Index (WIPO), size of high technology sectors (per value added and per exports) (Aditya, AnweshaAcharyya, Rajat, 2013) and number of researchers per million people (Viotti, 2002) were not found to be predictors of foreign patent applications (Pavitt, 1980; Furman et al., 2002; Faber and Hesen, 2004).

This result converge to part of the findings of Blind et al (2006), who confirmed the importance of the strategic motives to patent and predicted the rise of these motives in more complex technologies. We may infer that since the work of these scholars the overall technology have become more complex so that the traditional motive to patent (to manage the imitation risk), has become obsolete. In addition, these authors also found that protection from imitation was the first motive to patent at that time and our results suggest this is not valid anymore.

Considering that the investigation on the factors that influence decision makers when managing their patents is a recent field of study (Archontakis & Varsakelis, 2017; De Marco et al., 2017). And that we aim to contribute to this field by investigating the imitation risk of countries as a factor of patent application. We recall that the main purpose of this work was to answer if the imitation risk is more or less relevant than the market attractiveness of a country to foreign patentees.

By a joint analysis of H1 and H2 we conclude that the imitation risk, defined by the free rider use of Absorptive Capacity and Innovation Performance, thus the negative side of a country Innovation Capacity, is of less concern of foreign patentees than market opportunities. (Minagawa et al., 2007; Giarratana & Mariani, 2014).

As a confirmation of the Imitation Risk concept, we tested and analyzed its reverse effect on domestic patent applications. To do so we built the Innovation Capacity concept as the reverse side of the same phenomenon, or the incentive side of Absorptive Capacity and Innovation Performance according to H3. We found that *Market Scale* plays the highest role in patent applications for both models (beta coefficients of 0.967 for nonresidents and 0.426 for residents). Thus, we may also conclude that market size in a country is much correlated with its patents.

Finally, *Scientific and technical journal articles* was found important for the two models, and the reverse signal of coefficients in each model has two meanings. First, the positive coefficient in the resident model shows that the output of research, measured as publications, leads to domestic patent applications. Thus, we may also conclude that a country with more scientific publications also applies for more patents domestically. Second, as a variable of the Imitation Capacity, it shows a reverse effect on the imitation risk. Thus, we may also conclude that a country with more scientific publications receives less patent applications of foreigners. We suggest further research on the predictive effect of the scientific publications

on patents and propose the use of other scientific databases to compare author nationalities, research origin and international cooperations with patent outputs and applications abroad.

This study had two main improvements for both literature and decision makers: initially, studies on identifying factors that influence the application of patents abroad were developed, not forgetting the importance of imitation risk being considered by corporate risk management tools. Following, it is evidenced to decision makers that imitation risk is international and imminent. This risk can be mitigated by applying patents either in the national or international market (Eaton & Kortum, 1996; Maurseth & Svensson, 2014). Therefore, when analyzing markets, companies also need to look at risks, especially in countries with better capacity for innovation, which consequently are the countries with good capacity for imitating (Chen, 2018; Xia & Liu, 2018; Milan et al., 2014; Minagawa et al., 2007; Giarratana et al., 2014).

One big challenge of this research was the composition of a reliable database because of the several sources involved, the conciliation among different identities of countries in each source, the period of reported data, the consecutive brakes in the series by local authorities, and the methodological changes in surveys over time, to name a few. We were concentrated on checking and cleaning the data for our analysis and, for this reason, opted for a cross-sectional study. Then, we suggest further analysis on panel data for future studies and give notice for following scholars of the difficulties to compose an exhaustive data set.

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