

Determinants of Companies' Propensity to Patent

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Abstract

What determines companies to file patents? To answer this question we present a systematic review, in which 22 empirical studies published in scientific periodicals were selected. Based on the descriptive analysis of these studies, a framework is proposed that brings together a set of explanatory variables that influence the propensity to patent in internal and external factors. The cumulative results of the reviewed articles suggest a positive correlation of firm size and R & D with the propensity to patent. A unanimous result among the articles is that the Industrial Sector in which the company is inserted has a significant influence on the propensity to patent. Regarding the variables Collaboration Network and Competition, the results of the research were divergent, indicating a positive, negative or non-significant relationship. However, these determinants are still poorly understood due to the divergence of the research results.

Keywords: systematic review; industrial property; innovation.

1. Introduction

Innovation is a new or improved product or process (or combination thereof) that differs from what exists. Innovation-related activities include development, financial and commercial areas, and it is important for companies to obtain competitive advantages (OECD & Eurostat, 2018; Becheikh et al., 2006).

The term patentable refers to the legal requirement that an invention meet the three requirements: (i) novelty - the invention is not understood in the state of the art; (ii) inventive activity - the invention does not result evident or obvious manner from the state of the art; (iii) industrial application - the invention must be used or produced in any type of industry (BRASIL, 1996, Rodrigues & Oliveira, 2015, Amadei & Torkomian, 2009).

In this way, patents are indicators of inventive activities and are tools for analyzing the process of technological change, providing innovative companies with competitive advantages at industrial,

organizational and technological level (Fung, 2005; Blazsek & Escribano, 2016).

The propensity to patent differs between firms, industries and types of innovation (Bannò, 2016, Arundel & Kabla, 1998, Barros, 2015). Changes in the protection of intellectual property (IP) rights affect both the propensity to patent and the level of innovation (Nicholas, 2010). The changes between R & D can also modify the incentives to patent (De Rassenfosse, 2010) and collaborative partnerships are associated with increasing firms' ability to innovate, which leads to a greater propensity to patent (Gesing et al., 2015).

Investments related to R & D generate technological progress and innovation (ABGI, 2015). Fiscal Incentives for R & D are effective instruments adopted by many governments and may vary according to the economic situation of each country. These incentives are regulated by national laws and are operationalized by specific programs. The benefits attributed to this type of incentive vary according to the size of the company and allow tax deductions based on the expenses incurred for R & D development over a given period.

The decision to patent companies is related to innovations (Pérez-Luño & Valle-Cabrera, 2011). However, not all innovations are patented and the propensity to patent an innovation remains an open question (Fontana et al., 2013).

In this context, this article makes a systematic review of scientific publications on the determinants of companies' propensity to patent. The main objective is to identify the determinants of companies' propensity to patent their innovative activities.

2. Method

The need to present the state of the art in research, whether theoretical or practical, is a *sine qua non* for methodological adjustments, as well as definition of strategies to promote R & D. Systematic review, like other types of studies, is a form of research that uses the literature on a given subject as a data source (Sampaio & Mancini, 2007). Systematic reviews are useful to identify the main contributions and to assist in the orientation of new investigations (Sampaio & Mancini, 2007; Becheikh et al., 2006).

2.1 Search strategy

To identify published studies, a computerized search was conducted using keywords in three databases of scientific papers, Scopus, Scienc Direct and Web of Science. Scopus is a database of abstracts and citations of peer-reviewed literature, totaling more than 71 million records and about 23,700 journals (Scopus, 2019); Science Direct hosts more than 3,800 journals and more than 15 million peer-reviewed journals (Science Direct, 2019); and Web of Science has more than 33,000 journals (Web of Science, 2019).

In the search the following keywords were used: patent, propensity, probability, financial, economic and performance. The Boolean operator AND was also used to find the records containing all the terms separated by the operator and the quotation feature that makes it possible to retrieve the term exactly. Figure 1 summarizes and presents the sequence of search process.

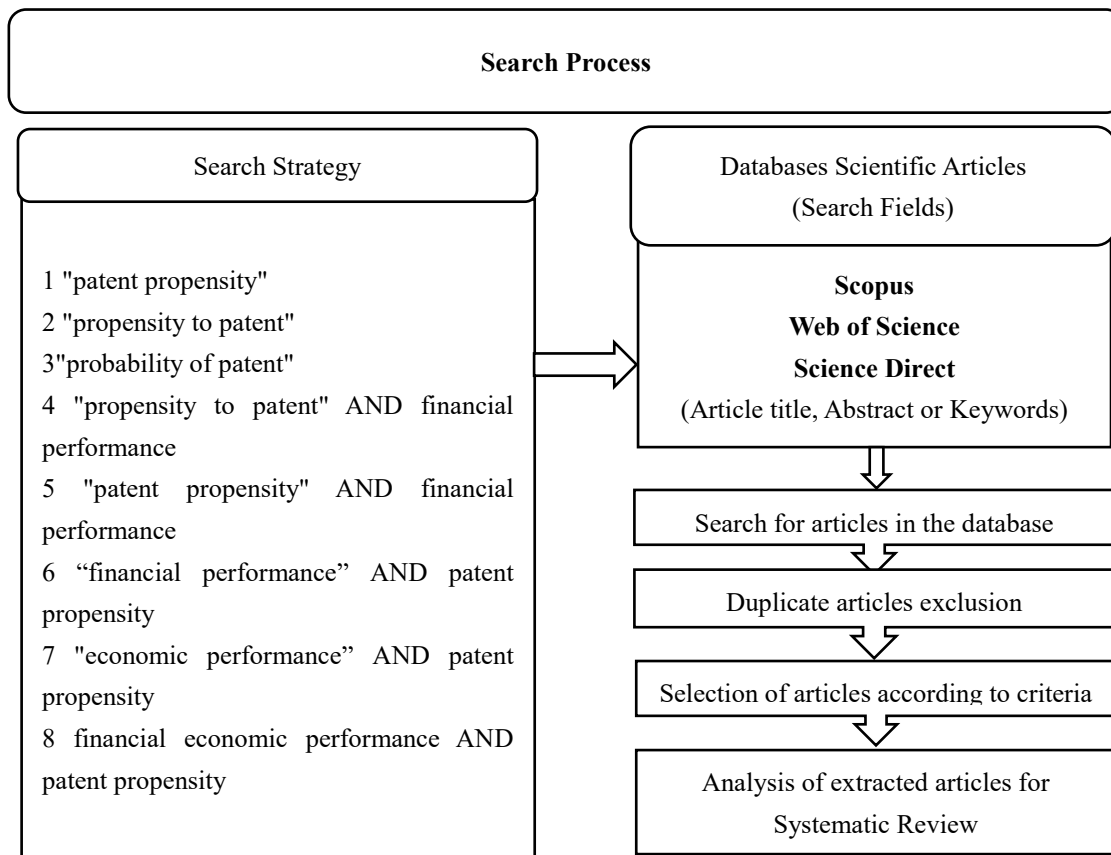


Figure 1. Flowchart of the search process.

2.2 Inclusion criteria

One of the most important steps of the systematic review is to establish inclusion criteria to select and evaluate potential studies (Alderson et al., 2004). To be included in this systematic review the article had to meet four criteria:

- a) To address in their results the determinants of companies' propensity to kick;
- b) Being an article published in a peer-reviewed journal, other forms of publication were not considered;
- c) Include an empirical study of a sample of companies. Theoretical studies were not maintained;
- d) Use methods of data analysis - both descriptive statistics and econometric methods.

2.2 Procedure

The potential articles identified in the computerized search were double screened. At the first screening, the duplicate records were removed using the R software (R Core Team, 2018). In the second screening, each article was reviewed by two authors and evaluated according to the inclusion criteria. Articles that met the criteria were selected. Finally, a database was created in a spreadsheet that contained: the reference of each article, the size of the sample, the nationality of the companies investigated, the statistical method used to analyze the data, the variables used in the research, objective and results obtained.

3. Results

The need to present the state of the art in research, whether theoretical or practical, is a sine qua non for methodological adjustments, as well as definition of strategies to promote R & D. Systematic review, like other types of studies, is a form of research that uses the literature on a given subject as a data source (Sampaio & Mancini, 2007). Systematic reviews are useful to identify the main contributions and to assist in the orientation of new investigations (Sampaio & Mancini, 2007; Becheikh et al., 2006).

3.1 Selection process

After searching the databases of scientific journals, 238 articles were retrieved, including 101 Scopus articles, 84 Web of Science articles and 53 Science Direct articles. The combinations of keywords and terms together with the quantitative of the retrieved publications are presented in Table 1 by searched database.

Table 1. Number of articles by terms used and combinations

Terms Used and Combinations	Scopus	Web of Science	Science Direct	Total
"propensity to patent"	51	38	21	110
"patent propensity "	31	26	14	71
"probability of patent"	13	8	16	37
"propensity to patent" AND financial performance	0	0	0	0
"patent propensity" AND financial performance	0	0	0	0
"financial performance" AND patent propensity	2	3	0	5
"economic performance" AND patent propensity	4	4	1	9
financial economic performance AND patent propensity	0	5	1	6
Total	101	84	53	238

The combination "Propensity to Patent" was that it had the highest number of publications in all the databases surveyed, followed by the combination "patent propensity" and "probability of patent". With a lower index of publications are the combinations "financial performance" AND patent propensity; "Economic performance" AND patent propensity; financial economic performance AND patent propensity.

No publications were identified for the combinations "propensity to patent" AND financial performance and "patent propensity" AND financial performance. In the first stage, 238 potential articles were retrieved for analysis, and 114 duplicate articles were excluded. In the second stage each of the remaining 124 articles were reviewed by two authors and evaluated, being 102 articles excluded for not meeting the inclusion criteria, remaining 22 articles classified for the research (Figure 2).

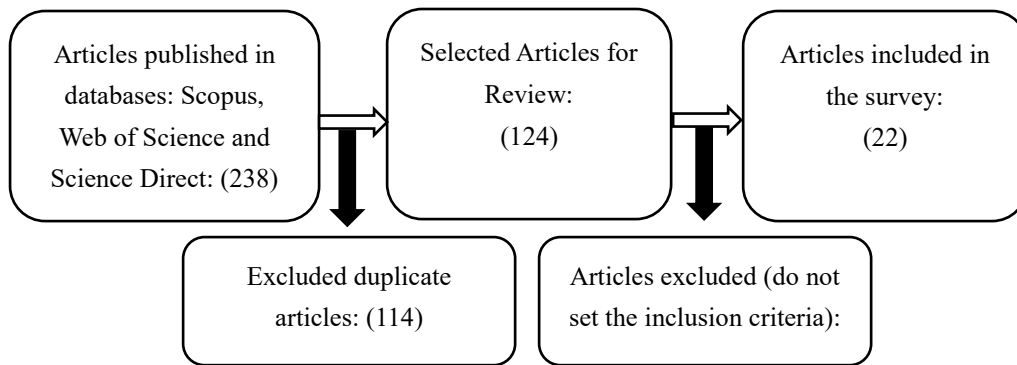


Figure 2. Article selection process.

3.2 General characteristics of the included studies

Analyzing Figure 3 on the distribution of the revised articles per year of publication, it is observed that 1983 was the year of publication of the first article on the determinants of propensity to patent companies. This article aimed to analyze the relationship between R & D expenditures in 1974 and patenting inventions of 443 US industrial companies (Scherer, 1983). After this single publication in 1983 only two publications occur in the 1990s and 2000. This situation with a limited number of articles and with years without publication only changes as of 2011 when there is a growth and a constancy in the publications, reaching an average of almost 2 articles per year for the period 2011-2018.

This trend indicates the consolidation and growth potential of publications on the determinants of companies’ propensity to patent in periodicals reviewed. Thus, an increase in the number of publications is expected in the coming years if this trend continues.

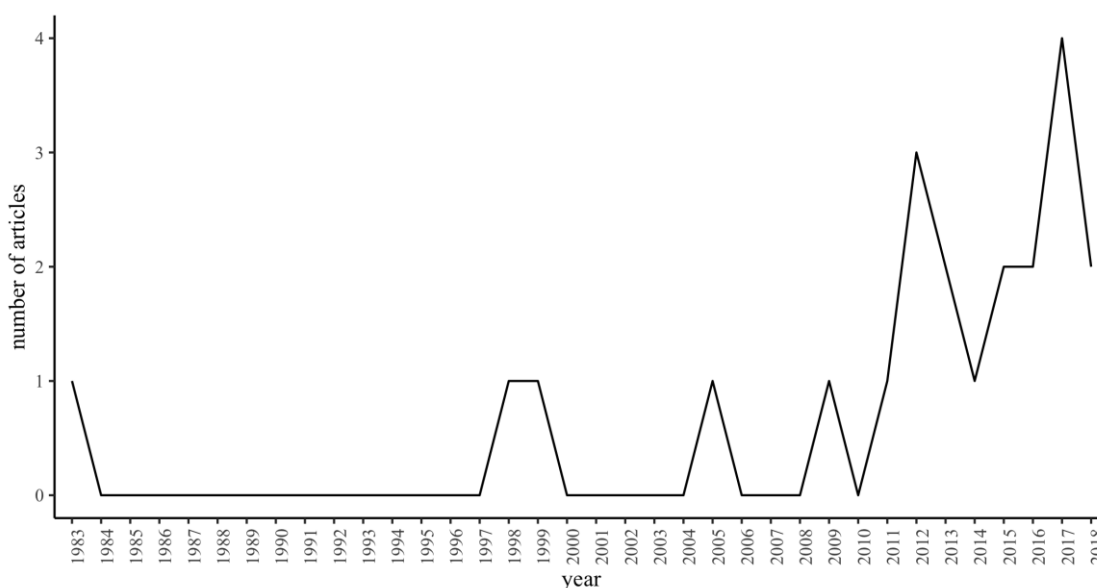


Figure 3. Distribution of articles reviewed by year of publication.

Table 2 shows the distribution of the articles by countries investigated. The United States of America (USA) was the most focused country, with 4 articles, followed by China, Spain and Italy, with three articles

each. Companies from Brazil and the Netherlands were investigated for 2 articles each. The other category comprises the countries that were investigated by only one article. In this way there is a diversification of the countries studied.

In terms of patent protection law, the USA enacted several laws, its first in 1790 (USPTO, 2019), and the basic structure of the current American Patent Act was adopted in 1952 (INPI, 2007). In 1999 the AIPA - American Inventors Protection Act was approved. The Patent Law of the People's Republic of China was passed in 1984 and revised by amendments in 1992, 2000 and 2008 (SIPO, 2019).

In Brazil in 1934, the regulation of the granting of patents was approved. In 1945 the Industrial Property Code was approved, being changed in 1969. In 1996 approved the industrial property law that is currently in effect.

Table 2. Distribution of articles by country investigated in a systematic review to evaluate the propensity to patent.

Country	Number of Articles	%
USA	4	16
China	3	12
Spain	3	12
Italy	3	12
Brazil	2	8
Netherlands	2	8
Others	8	32
Total	25	100

Note: the total adds more than 22 because some articles study more than one country.

Spain had its patent law enacted in 1986, and a new law was passed in 2015, coming into force in 2017 (OEPM, 2019). The grant of a Dutch patent is carried out by means of the patent law of 1961 being amended in 1968, 1979 and 1995 (Nederland, 2019). There are reports that since 1474 it was already about matters related to the Patent Law. In 2005, the Industrial Property Code (UIBM, 2019) was approved in Italy. The countries of Spain, Italy and the Netherlands are members of the European Union (EPO, 2019) and the European Patent Convention (EPC) has been signed since 1973 - a multilateral treaty establishing an autonomous legal system under which European patents are granted (INPI, 2007).

The distribution of the reviewed studies by region investigated, shown in Figure 4, compiles the data in Table 2 and indicates that European companies are the most studied, followed by Asian and North American companies and, to a lesser degree, Latin American companies.

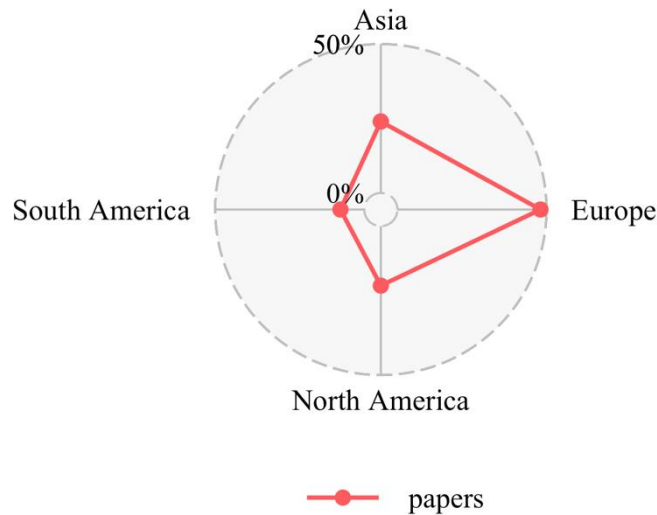


Figure 4. Distribution of articles by regions investigated in a systematic review to evaluate the propensity to patent.

At country scale, six of the fourteen investigated are European. This observation may be related to the Community Innovation Surveys (CIS) conducted in Europe over the last decade. The CIS consisted of innovation surveys carried out simultaneously in several European countries in different years. It is worth mentioning that, in the case of the USA and Canada, surveys using a similar approach to CIS was also carried out.

Among the articles in Europe that used firm-level data from the Community Innovation Survey (CIS), we highlight Gesing et al. (2015), which studied 6684 German companies operating in 21 different manufacturing and service sectors in the year 2008. Also worthy of note is the article by Brouwer and Kleinknecht (1999), which studied about 1300 companies in the Netherlands in 1992 in various sectors of the manufacturing. In Spain, Bolivar-Ramos (2017) studied 3101 technology firms in 2009 with data based on the Community Innovation Survey (CIS).

The list of references consulted by author name, periodical name and number of authors is presented in Table 3. It is noted that the journal Research Policy was the one that had the largest representation, with 4 (18.2%) of the articles published. Next comes the Journal of Engineering and Technology Management - JET-M and Technovation with 3 (13.6%) of the publications, respectively. Finally the Journal of Family Business Strategy with only 2 (9.1%) of the publications. The remaining 10 articles were all published in different journals, indicating that the articles are scattered in different journals and there is no concentration in specific journals.

Published studies on the propensity to patent were predominant in the academic field, among the 22 articles published, 44 authors are involved, of which 40 (91%) are linked to higher education institutions (universities), 1 linked to the Institute of Economic Research - IFO, 1 linked to the Institut national de la statistique et des études économiques - INSEE which is the official French body responsible for the collection, analysis and publication of data and information on the economy and society of France. In 2012,

the participation of 1 author related to Gesellschaft für Finanzund Regionalanalysen - GEFRA a private consulting and economic research company and 1 linked to the Beijing Intellectual Property Protection Association - BIPPA.

Table 3. List of references consulted by author name, periodical name and number of authors.

Referência	Journal	Número de autores
Agostini e Nosella (2017)	Management Decision	2
Alecke et al. (2012)	German Economic Review	4
Arundel e Kabla (1998)	Research Policy	2
Bannò (2016)	Journal of Family Business Strategy	1
Barros (2015)	Technovation	1
Beaudry (2014)	International Journal of Biotechnology	1
Blazsek e Escribano (2016)	Journal of Econometrics	2
Bolívar-Ramos (2017)	Journal of Engineering and Technology Management - JET-M	1
Brouwer e Kleinknecht (1999)	Research Policy	2
Chabchoub e Niosi (2005)	Technovation	2
Fontana et al. (2013)	Research Policy	4
Guan e Pang (2017)	China Economic Review	2
Han (2017)	Sustainability (Switzerland)	1
Huang e Cheng (2015)	Journal of Engineering and Technology Management - JET-M	2
Kato e Zhou (2018)	Technovation	2
Li (2012)	Research Policy	1
Li e Ni (2012)	Innovation: Management, Policy and Practice	2
Pacagnella Júnior et al. (2009)	Production	5
Pérez-Cano; Villén-Altamirano (2013)	EMJ - Engineering Management Journal	2
Pérez-Luño e Valle-Cabrera (2011)	Journal of Engineering and Technology Management - JET-M	2
Scherer (1983)	International Journal of Industrial Organization	1
Succurro e Costanzo (2018)	Eurasian Economic Review	2

The logistic regression model - logit model - represented the most used approach to investigate the propensity to patent in relation to the statistical and econometric techniques used by the articles. As shown in Figure 5, of the articles analyzed, 36.4% used the logit model as an econometric method. Considering

the Probit model, which differs from the logit model only by the cumulative distribution function, it is observed that 54.6% of the articles used discrete probabilities (logit or probit). It is observed that other types of regression models were also used, such as the multiple regression and negative binomial models that were used in 18.2 and 9% of the cases, respectively. The Poisson model, model PVAR, panel regression and simple regression were used only in one article.

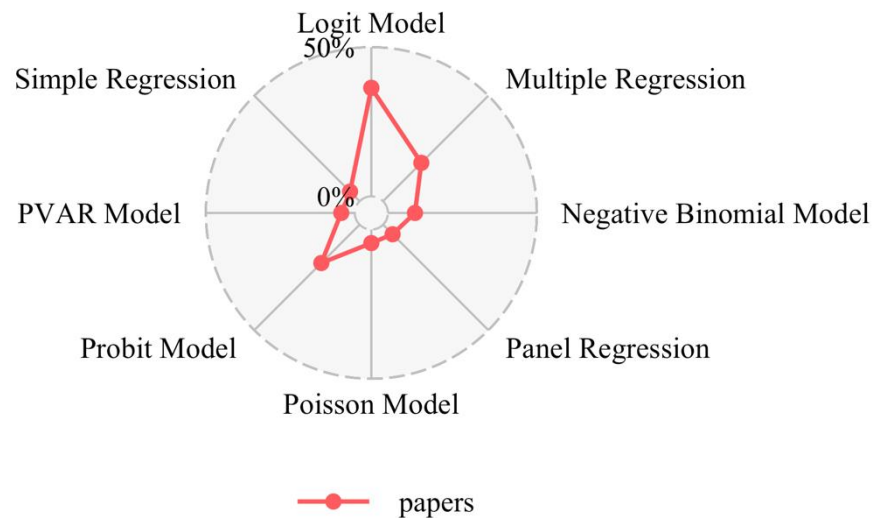


Figure 5. Econometric techniques used by the articles in a systematic review to evaluate the propensity to patent.

In all these models, the dependent variable propensity to patent was related to a set of factors considered as explanatory variables. It should also be emphasized that the studies performed a descriptive analysis of the data collected separately or in conjunction with the econometric analyzes.

3.3 Determinants of propensity to patent

The review of the 22 articles included in the systematic review brought a number of issues related to propensity to patent and its explanatory factors. The analysis of the studies generated the structure presented in Figure 4, which proposes a grouping of variables related to propensity to patent in explanatory factors internal and external to the companies. This structure is used to organize the presentation and discussion of the findings.

In the systematic review of the articles it was identified that more than seventy explanatory variables are used by the authors to investigate the determinants of propensity to patent. The explanatory variables used in the revised literature were classified into two groups: (i) internal determinants and (ii) external determinants of propensity to patent, according to the structure proposed in Figure 6.

This grouping considers the internal factors as the variables related to the characteristics of the companies that affect the propensity to patent whereas the external factors are variables related to the characteristics of the environment in which the company is inserted and that can influence the propensity

to patent (Emodi et al. , 2017).

To elaborate a more general and instructive framework, we identified the explanatory variables most frequently used by the articles reviewed and grouped into internal and external factors. Table 4 shows the variables most used as determinants of propensity to patent.

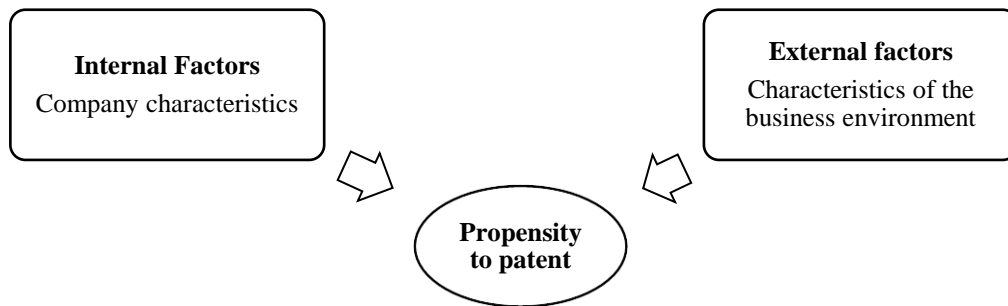


Figure 6. Grouping of explanatory variables for propensity to patent

Size and Research & Development (R&D) were the variables most often used as a determinant of propensity to patent. More than half (63.6% and 54.5%) of the studies included in the review considered firm size and R&D as an explanatory variable of propensity to patent. Considering only external factors, the variable Industrial Sector was the one that had the greatest use, with 10 articles representing 45.4% of the total revised.

Table 4. Main determinants of propensity to patent

	Variable	Number of Articles (%)	Positive	Negative	Not Significant
Internal factors	Size	13 (59.1)	11	0	3
	R&D	12 (54.5)	8	1	3
	Age	10 (45.4)	1	1	8
External factors	Industrial Sector	10 (45.4)	10	-	0
	Network Collaboration	5 (22.7)	3	0	2
	Industry competition	5 (22.7)	2	2	1

Among 14 articles was found in 11 articles the evidence that the size of the company has a positive impact on the propensity to patent, while in the remaining 3 articles the impact was not significant. It is also noteworthy that all 10 articles that analyzed the industrial sector of companies find evidence that the

propensity of the company to patent changes according to the sector in which it is inserted.

Regarding the variables collaboration network and competition, the results were divergent. While part of the research claims that these variables are positively and significantly correlated with the propensity to patent, other research finds that this relationship is negative or non-significant. The variable age was not significant in 8 of the 10 studies.

It should be noted that the explanatory variables that were used only by three or fewer articles are not included in Table 4, such as variables related to location, company strategies, regulatory framework, government incentives, economic indicators, among others. It is noteworthy that only one article considered the variables on the economic and financial situation of the companies. In the case, the article Bannò (2016) included only the indebtedness, productivity and profitability of the companies as economic-financial variables that influence the propensity to patent.

The propensity to patent companies is a process driven by innumerable internal and external factors. This systematic review evaluated the main internal and external variables that influence the propensity of companies to patent their innovations. The diversity of explanatory variables and methodologies used by researchers makes it difficult to compare and generalize the results in the analysis and understanding of this phenomenon.

It was also found a gap in the literature regarding the relationship between the company's financial and economic variables and the propensity to patent. In order to reduce this gap, future research should consider not only the traditional internal and external factors, but also examine the specific factors on the economic and financial situation of companies that can be better followed by managers and policy makers. The article by Silva et al. (2019) follows this line and studies how economic and financial variables influence the filing of patents by Brazilian companies.

4. Conclusion

Research on the propensity to patent companies is incipient. The explanatory variables most used by the reviewed studies were Size, R & D, Age, Industrial Sector, Network Collaboration and Competition. These variables address the main factors internal and external to companies that influence the filing of patents.

The cumulative results of the reviewed articles suggest a positive correlation of firm size and R & D with the propensity to patent. Another result is that the Industrial Sector in which the company is inserted influences the propensity to patent, being a significant variable in all the articles that considered the sector of the company. Regarding the variables Collaboration Network and Competition, the results of the research were divergent, indicating a positive, negative or non-significant relationship.

The strategies adopted in each country regarding the legal apparatus of intellectual property protection rights adopted over the years through laws, decrees, codes, reviews, as well as the public policies of fiscal incentive for investment in R&D, are legal instruments which assist and contribute to the patenting process.

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