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Gabriel Lima Silva Queiroz

The role of alliance portfolio diversity on firm innovation and performance: the case of Colombia.

Dissertação de Mestrado

Dissertation presented to the Programa de Pós-graduação em Administração de Empresas of PUC-Rio in partial fulfillment of the requirements for the degree of Mestre em Administração de Empresas.

Advisor: Prof. Fábio de Oliveira Paula

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Abstract

Queiroz, Gabriel Lima Silva; Paula, Fábio de Oliveira (Advisor). **The role of Alliance portfolio diversity on firm innovation and performance: the case of Colombia**. Rio de Janeiro, 2020. 94 p. Dissertação de Mestrado – Departamento de Administração, Pontifícia Universidade Católica do Rio de Janeiro.

The objective of this work is to contribute to the literature on strategic alliances and innovation performance. Specifically, it aims to investigate the role of Diversity in Alliance portfolios and its impact on firm performance.This study seeks to replicate and adapt relationships of constructs observed in other articles to a Latin American country. It uses structural equation modeling (SEM) through micro-data provided by the National Innovation Research of Colombia based on the Oslo manual.This dissertation elaborates on a "cross-sectional" study of the selected country, makes a brief revision on past models and proposes a new one to assert about its hypotheses. The work has meaningful observations that supports the impact of Diversity both on the innovation and financial perfomance. Relationships between different types of innovation and the construct Absorptive Capacity were also studied.

Keywords

Absorptive Capacity; Innovation performance; Alliance Portfolio; Colombia; SEM;

Resumo

Queiroz, Gabriel Lima Silva; Paula, Fábio de Oliveira. **O papel da Diversidade do Portfolio de Alianças no desempenho e inovação das firmas: Caso da Colômbia**. Rio de Janeiro, 2020. 94 p. Dissertação de Mestrado - Departamento de Administração, Pontifícia Universidade Católica do Rio de Janeiro.

O objetivo desse trabalho é contribuir com a literatura de alianças estratégicas e desempenho de inovação.Especificamente, pretende investigar o papel da Diversidade nos portfolios de Aliança e seu impacto no desempenho das firmas.Este estudo busca replicar e adaptar relações e construtos observados em outros artigos para um país latino americano. É utilizado modelo de modelagem de equações estruturais (SEM) através de micro-dados fornecidos pesquisa nacional de Inovação da Colômbia baseadas no manual de Oslo. A presente dissertação desenvolve um estudo "cross-sectional" do país selecionado, faz uma breve revisão dos modelos anteriores e propõe um nova modelo para estudar suas hipóteses. O trabalho tem observações significativas que apoiam o impacto da Diversidade, tanto na inovação como no desempenho financeiro. Foram também estudadas as relações entre os diferentes tipos de inovação e a Capacidade Absortiva de Construção.

Palavras-Chave

Capacidade Absortiva; Desempenho de Inovação; Portfólio de Alianças Estratégicas ; Colombia; SEM;

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List of Abbreviations

AC	Absorptive Capacity
AVE	Average Variance Extracted
CFA	Confirmatory Factor Analysis
CR	Composite Reliability
DANE	Dirección Nacional de Estadística
EFA	Exploratory Factor Analysis
FP	Financial Performance
GII	Global Innovation Index
IP	Innovation Performance
MLE	Maximum Likelihood Estimate
OECD	Organization for Economic Co-operation and Development
PCA	Principal Component Analysis
Edit	Colombia Innovation Survey
R&D	Research and Development
SEM	Structural Equation Modeling
WoS	Web of Science

1.Introduction

Innovation has become a popular topic in the new century since Schumpeter and his concept of creative destruction (Schumpeter, 1942). One evidence of the importance of this thematic is that the World Bank claimed in the report "Global Innovation Index", which calculates innovativeness of countries, that innovation is the building block of dynamic economies and "a central driver of economic growth and development" (Dutta *et al.*, 2018). Moreover, a recent article from the consulting firm McKinsey & Company stated that the world now is living in "the age of innovation", digital technology is disrupting all different types of industries and high-performance companies being leaders or first followers (Kazaks, Shi e Wilms, 2017). This statement reinforces the necessity of the firms to dedicate strong efforts to innovate.

However, it is important to understand that innovation is an intricate challenge. Although firms see innovation as a form of achieving competitive advantage and spend high amounts of money in research & development (R&D) while doing so, many don't generate the expected innovation outputs. There are organizations more effective in their innovation processes and R&D endeavors than their counterparts. Apple, for example, in 2015 has invested less money in R&D than its competitors, while creating more innovation outputs (Satariano, 2015). Corroborating this, Steve Jobs, founder of the company, once said in an interview for Fortune Magazine:

> *Innovation has nothing to do with how many R&D dollars you have. When Apple came up with the Mac, IBM was spending at least 100 times more on R&D. It's not about money. It's about the people you have, how you're led, and how much you get it.* (Kirkpatrick e Maroney, 1998)

A similar phenomenon may be observed in countries like Singapore and the United Arab Emirates, that produce fewer innovation outputs by dollar spent in R&D than some counterparts like Switzerland (Global Innovation INDEX,2019).

The study of innovation is not new to the academy. Throughout the years, scholars have been considering innovation as a source of sustainable competitive advantage (Anderson, Potočnik e Zhou, 2014; Han, Kim e Srivastava, 1998; Nonaka, 1994; Schumpeter, 1942) with a strategy focused on innovativeness extensively applied by many firms during this period. Consequently, the study of innovation has been helping firms, policymakers, managers and strategic theorists understanding and improving performance for more than 70 years.

The contemporary literature continues focusing on the relationship between innovation performance (IP) and financial performance (Kostopoulos *et al.*, 2011; Paula, 2017; Paula e Silva, 2018b), which has been applied to the new demands of the 21st century. In a globalization landscape, new technologies have easy access to multiple markets, leading to an increase in competition and opportunities for firms. Also, with the high frequency of innovations, no industry is safe from new technologies that can "disrupt" its market (Christensen, Raynor e Mcdonald, 2015). The continuous study about how to improve IP can provide answers about how firms can create and sustain competitive advantage in such a complex environment.

The previous arguments reinforced the idea that innovation must be developed by firms to achieve competitive advantage and that large investments in R&D are not enough to guarantee a high IP. One reason is that firms do not have all the necessary resources and knowledge to innovate. Thereby, they must rely on alliances to acquire it. (Hagedoorn, 2002) stated that firms that used alliances in their research efforts have developed more positive results in IP. Akin to it, subsidiaries of multinational companies in emergent countries can provide a good opportunity for alliance knowledge research as they can use their setup to find resources not available in internal markets. (Figueiredo e Brito, 2011)

Alliances may be dyadic, in which two partners have a relationship to develop some activity, such as shared R&D; or formed by multiple organizations

(Dyer e Singh, 1998; Gulati *et al.*, 2000). In the case of alliances with multiple actors, the social network theory uses the concept of ego-networks or alliance portfolio to discuss how to achieve superior performance (Eisenhardt e Ozcan, 2009; Wassmer, 2010). Ego-networks consist of social networks in which a focal firm has multiple connections with other organizations, which represents multiple partnerships or alliances. A portfolio of partners may help to acquire more information that is important for innovation, but, at the same time, increase managerial complexity by the asymmetry and heterogeneity of multiple types of partners (Bae e Gargiulo, 2004). These alliance portfolios can have multiple configurations (Bae e Gargiulo, 2004; Tsai, 2009, 2001) each one affecting in different ways the information acquired and codified for each focal firm.

Macedo-Soares, Barboza e Paula (2016) discussed several characteristics of an alliance portfolio that could influence innovation performance, for instance, centrality, size, stability, and volume of resources, alliance, and partner and country types. Among them, they highlighted the importance of diversity. The existence of partners from different geographic location, organizations, industries, with different resources, etc. help the firm to collect more information fueling its innovation efforts. But the management of such a complex portfolio of partners may increase costs and complexity, meaning that diversity must likely increase IP up to an optimum level above which the benefits are overcome by them. Thereby, the authors concluded that the relationship between the diversity of the alliance portfolio and IP is an inverse U-shaped curve, in which IP is lower in the extremes and higher in an average level (Goerzen e Beamish, 2005; Jiang, Tao e Santoro, 2010; Macedo-Soares, Barboza e Paula, 2016).

To get an advantage from external knowledge, companies should possess an appropriate competence to fully integrate this knowledge with those already available internally. Cohen and Levinthal (1990) proposed that this competence is the **Absorptive Capacity (AC)**, which is an ability to turn such external knowledge into commercial outputs. This competence is a function of prior knowledge, education of employees, and past research inside the firm.

One of the most important concepts that relate to learning, innovation, and consequently influences the AC is the type of knowledge that the employees of a particular company possess (Cohen e Levinthal, 1990). As learning is firstly a cognitive task, the knowledge of a research member has a significant impact on how the firm can develop meaningful insights from the *informational* inputs (Easterby-Smith *et al.*, 2008).

Another important factor that influences innovation is the environment, including the firm's country. Tojeiro-Rivero e Moreno (2019) argued that countries or geographic locations could have agglomeration externalities between companies and organizations leading to knowledge spillovers thus helping foster innovations. For these authors, regional context also mediates how well firms can transform inputs from networking activities into innovation.

Also in countries and regional context, Bell and Pavitt (1992) study about developing countries, called by the authors "Latecomers", who need to make a technological catch-up (ibid.; Dutrénit, 2006; Figueiredo, 2003). Firms from those countries are supposed to make an effort to rapidly develop innovation capabilities to innovate and compete at national and international markets, as they, initially, do not have these resources.

Coursera, one of the leaders in online learning, mapped in a data-driven report, the kinds of skills employees and enterprises must have to compete in the "Fourth Industrial Revolution"(Coursera, 2019). The report addresses industry 4.0, a new type of technology paradigm, which has been using automation and artificial intelligence to transform the way businesses and innovation are made. In such a map, Latin America is considered to have a "low-average skill", with weak education in math and sciences, and a "weak innovation environment". This particular characteristic makes Latin-American countries an interesting environment to test the relationship between the diversity of Alliance portfolios, AC on Innovation performance and its effects on financial performance.

Among the countries of Latin America, that have this "technological catch-up challenge" this study chose Colombia. Considering the previous discussion, this dissertation has as its main goal to answer the following research question, attempting to collaborate with the extant literature and contribute to the study of innovation in emerging countries:

In which degree does diversity of the firm's alliance's portfolio influence product and process innovation performance, and financial performance of Colombian Manufacturing firms?

1.1 Main goal and secondary goals

This dissertation proposes to analyze the innovative context of manufacturing firm's characteristics in Colombia. The main goal is to investigate the relationship between the diversity of a firm's alliance portfolio and absorptive capacity with product and process innovation performance and the influence of the former on financial performance.

As secondary goals, the dissertation proposes:

I) Describe an extensive literature, detailing how innovation studies in Academia, from the definition of how new paradigms such as Open innovation support the process of researching and developing innovation inside companies.
II)Propose hypotheses on how all concepts previously described impacts the innovation performance.
III) Briefly describe past models and introduce a new model to assert about the suggested hypotheses. There is also proposed new proxies to measure the constructs.
4) Conduct this multivariate model to see if the findings support the hypotheses. Finally, analyze the findings and develop a discussion on how it relates to previous observations from the literature.

1.2 Relevance of the study

The investigation on how the process of R&D is conducted can lead to a better understanding of how firms can differentiate from their competitors and develop meaningful impacts on its performance. This work's premise is that the conditions observed in studies of well-developed countries can be replicated, making other companies and countries results comparable. Hopefully, it can provide insights on how to better develop business in such "less developed" environments.

It is easy to notice an effort in the innovation management field to study the context of countries within the top 20 ranks on the global innovation index (Garriga, Krogh, Von e Spaeth, 2013; Laursen e Salter, 2006; Randhawa, Wilden e Hohberger, 2016). Instead, this dissertation intends to work with the similar constructs created and tested in such environments while trying to replicate it in latecomer countries. This work makes an effort similar to studies like (Macedo-Soares, Barboza e Paula, 2016; Macedo-Soares, Paula e Mendonça, 2017; Paula, 2017).

The main theoretical contribution is to update the model first introduced by (Macedo Soares, Silva Barboza e Oliveira Paula, de, 2016) and later developed in (Macedo-Soares, Paula e Mendonça, 2017; Macedo Soares, Silva Barboza e Oliveira Paula, de, 2016; Paula, 2017; Paula e Silva, 2018b), which tests the relationship between the diversity of alliance portfolios and IP. This dissertation argues that diversity in alliances portfolio can lead to better efficiency in achieving innovation and better financial and organizational performance. Another contribution is including financial performance in the model, by allowing to test the consequences of innovation on a firm’s competitive advantage.

To achieve this goal, this work developed a comprehensive model and analysis of how organizations who engage in R&D efforts, are successful in creating innovations. It proposed a diversity construct alliance portfolio with

three proxies, that, to the best of our knowledge has not been previously proposed and discusses its impact on innovation and firm performance.

Lastly, on theoretical implications, a contribution is the use of the proposed framework in a Latin American country. This application can inspire other researchers to do comparisons in different contexts.

For practical implications, this work can help policymakers to acquire new insights on how to develop innovation through direct alliances with companies and innovation promotion programs and universities. It also can provide managers a better perception of how internal and external knowledge fuels innovation, thus helping them to work with and use different types of R&D strategies. For instance, firms may choose more wisely the research resources and capabilities to balance R&D effort, whether by focusing on open innovation (Chesbrough, 2003) or traditional internal development. Lastly, there is a belief that through this work a great contribution to the practice is the management consideration of Alliance portfolio strategy.

1.3 Delimitation of the study

The first delimitation is the consideration of the type of firm: only manufacturing firms were selected in this analysis. The use of manufacturing companies is due to their bigger presence of these innovation surveys and well used in the Academia (He e Wong, 2004; Laursen e Salter, 2006; Pavitt, 1984; Tsai, 2001). A second delimitation is geographical, only firms in Colombia were used in the study by virtue of the easy access of data through the their website(Dane, 2020).

Another one is that the study is a cross-sectional analysis. In short, it only uses data from one innovation survey(EDIT-Colombia). Thus, using only a two-year timespan as the respondents must provide data from the current year of the questionnaire along with the past year. The survey from the year 2016(also covering 2015) was selected because of its availability.

The next delimitation is that this study takes into account only the Colombia's survey(Dane, 2020) based on Oslo Manual (Oslo Manual, 2018) due to its replicability and comparability with other studies. Other possible existent surveys in the countries analyzed were not considered.

When talking about innovation performance, it accounts for only product and process innovation based on Oslo Manual as proxies (Macedo-Soares, Barboza e Paula, 2016; Oslo Manual, 2018), mainly due to its simplicity and availability of data. Other types of innovation, such as marketing and organizational innovation, were not the focus of this study.

1.4 Organization of the study

This work, including this **Introduction**, is composed of six chapters. The second chapter is the **Literature review** which describes the literature that is relevant to the goals and discussion of this present study.

The third one addresses **Method,** composed by a description of the collection and preparation of data, the description of the variables, and the choice and operationalization of the multivariate model. The fourth is **Results** which describes the empirical results of the analysis. The fifth is **Discussion** where there is a discussion on how the results of the previous chapter relate to the findings to the extended literature.

Further, the sixth chapter is the **Conclusion** that presents the final consideration, discusses some limitations of the research, and opens the agenda with proposals for future research. The last chapter is the **Bibliographic references.**

2.Literature Review

2.1 Defining Innovation

The study of innovation has started in the field of Economics with a particular rise in volume around the 1960s when researchers trying to make sense of technological and economic changes used innovation as a vector (Fagerberg e Verspagen, 2009). Schumpeter in his book "Capitalism, Socialism, and democracy" has stated the following about capitalist economies:

> As a matter of fact, capitalist economy is not and cannot be stationary. Nor is it merely expanding in a steady manner. It is incessantly being revolutionized from within by new enterprise, i.e., by the intrusion of new commodities or new methods of production or new commercial opportunities into the industrial structure as it exists at any moment. Any existing structures and all the conditions of doing business are always in a process of change. (Schumpeter, 1942, pag.31)

The vector of these changes would be later defined. Despite great relevance, Schumpeter's book did not include a clear definition of what innovation would consist of. Neither there was any contrast between **inventions** and **innovations**. Kenneth Arrow, another economist, would interpret invention broadly as the production of knowledge (Arrow, 1962).

This discrimination would come latter in works like (Pavitt, 1984), which utilized innovation as a new or better product or process commercialized or used by companies. (Roberts, 1988) stated that innovation is comprised of two stages, the first one being the companies or individuals creating an invention, and the second being exploiting the innovation for commercial ends.

Further, in the literature development, innovation has received an extent taxonomy in studies like (Dewar e Dutton, 1986) with **radical innovation** vs **incremental innovation**. Radical innovation is characterized by any innovation that involves revolutionary changes in the technology while incrementation innovation is composed of minor improvements or simple adjustments in current technology.

Schumpeter in another seminal book "The Theory of Economic Development"(Schumpeter, 1983) addressed innovation, or in his words "new combinations" as:

> This concept covers the following five cases: (1) The introduction of a new good – that is one with which consumers are not yet familiar – or a new quality of a good. (2) The introduction of a new method of production, that is one not yet tested by experience in the branch of manufacture concerned, which need by no means be founded upon a discovery scientifically new and can also exist in a new way of handling a commodity commercially. (3) The opening of a new market, that is a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before. (4) The conquest of a new source of supply or raw materials or half-manufactured goods, again irrespective of whether this source already exists or whether it has first to be created. (5) The carrying out of the new organization of any industry, like the creation of a monopoly position (for example through trustification) or the breaking up of a monopoly position. (Schumpeter, 1983, pag.250)

This work would be one of the pioneers in expanding the concept of innovation beyond the idea of just creating new products. The insightfulness of new organization configuration and new process would be carried along by innovation studies.

Utterback and Abernathy (1975) took it further when studying the development of the innovation process. According to them, the innovation lifecycle is composed of different levels of intensity of product and process innovation, each one is associated with the development stage of the

respective innovation (see Figure I). At the beginning (fluid stage), the investment in product innovation is high as the technological patterns are not yet defined. As it is defined, the level of product innovation drops, and the level of process innovation increases to lower production costs (in the transitional stage). When the technology matures (specific stage) investments in both types of innovations are low. Firms are supposed to be more productive "process-wise" as they become more capital intensive further in the stage of development. As this process develops, new organization configurations are expected, and firms should be able to retain more process innovations.

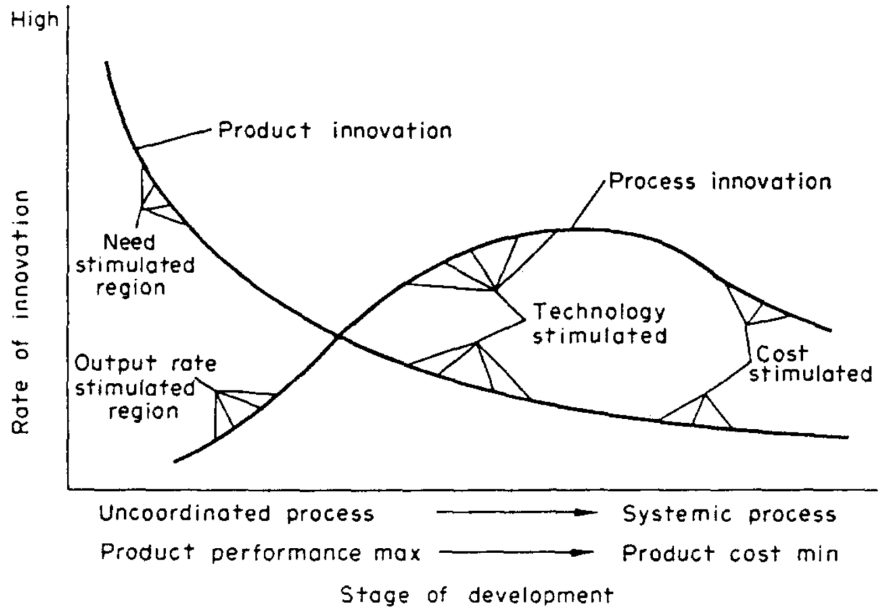

Figure 1- Innovation and stage Development (Utterback e Abernathy, 1975)

This division in two different types of innovation leads to even further dissection: (Henderson e Clark, 1990) address innovation in product development into four categories:

(I) Radical innovation- New dominant design and a new set of core concepts

(II) Incremental innovation- Refines and updates an established design without changing the linkages between the concepts or the core concepts. Ex. New batteries in cellphones

(III) Modular innovation – Modifications in the core concepts but maintaining the linkage between then. Ex. Analog to digital cellphones
(IV) Architectural Innovation- Change a product's architecture without changing the core concepts.

Today, the concept of innovation has different meanings throughout different research domains and authors(Lopes e Carvalho, de, 2018). In a critical essay (Garcia e Calantone, 2002) debate how important is to have a common definition of the study object. Likewise, they argue that regardless of all these typologies, the study of innovation has somewhat found an overlap in multiple studies of distinctive scholastic domains:

> In empirical research, hypothesis building regarding innovation types has also discounted relevant prior research that does not use the same terminology as the research being undertaken. This leads to 'new' findings that are in fact rehashes of previous work (Garcia e Calantone, 2002)

Hence, there is one important preliminary task when talking about a subject examined for years: to properly define its different concepts. In this manner, an effort made by OECD (Organization for Economic Co-operation and Development) created a manual that provided an international standard of innovation, making it easier to collect comparable data among multiple countries: the Oslo Manual (Oslo Manual, 2018).

According to it, innovation is classified in four types: **Product Innovation** (a good or service that is new or significantly improved); **Process Innovation** (a new or significantly improved production or delivery method); **Marketing Innovation** (a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing) and **Organizational Innovation** (a new organizational method in business practices, workplace organization or external relations).

2.2 Innovation and knowledge

Innovation is considered by many authors as the bedrock of organizational survival especially in fast-changing environments (Han, Kim e Srivastava, 1998; Nonaka, 1994; Tamer Cavusgil, Calantone e Zhao, 2003). However the process of developing is itself hard to capture, many times there is no easy or explicit answer on how some firms develop a new product or solution where others can't. This has to do with the cognitive aspect and different forms of knowledge.

David e Foray (2003) discussed the knowledge-based economy. Nowadays, with Information Communication Technology (ICT), there are radical changes in the way knowledge is produced and shared, with the ever-increasing in the speed of applied research tools such as prototyping and in the speed of distributing knowledge.

At the contemporary age of fast learning, it is also important to state the difference between *codified* and *tacit* knowledge. Codified knowledge is when the knowledge can be reduced to "information" so it can be spread and replicated throughout the organization by informational channels. Tacit knowledge, on the other hand, is the type of knowledge that cannot be stated in an explicit form (like personal skills) therefore being more complex to be shared through the firm. The latter, then, is usually shared through mentorship and social interactions.

Nonaka (1994) argued that, although knowledge is created by individuals, organizations help to amplify and articulate it. According to him, there is a dynamic process where knowledge is created by individuals and developed and "crystalized" by the organization. The movement towards codifying knowledge is the core of organizational learning. Therefore, to understand the challenge of innovation nowadays, it is important to investigate how firms can codify and learn throughout the huge volume of informational inputs.

A good cognitive trait is to have proficiency in searching, acquiring and codifying knowledge. When talking about innovation, Drucker (1954) is one of the first authors to call attention to the importance of the organization's innovation capability as a driver of superior performance. In competitive markets, products are characterized by short product life cycles and a great number of products and process innovations thus leading to a cycle where firms with greater innovation capability are always in a better position for introducing innovations. In short, the author stated that by the mechanism of "learning by doing", companies that are better in learning are more able to develop new knowledge that leads to better learning and innovation capability.

Likewise, Tamer Cavusgil, Calantone e Zhao (2003) proposed that tacit knowledge is the main contributor to developing a better innovation capability. The process of tacit knowledge transfer among partners might help companies acquire more of it, helping to develop a greater innovation capability. Such traits should positively affect the innovation performance of firms.

The difference between tacit and codified knowledge indeed can help to better understand how an organization leverages internal individual knowledge to develop innovations. (Kogut e Zander, 1992) an organization's study argued that through social cooperation firms develop cumulative knowledge that is used in the expansion of new markets through innovation. In their article knowledge is divided into information (knowing what a concept means) and know-how (knowing how to apply the concept). The former is usually proprietary (governance of data, patents) and the latter is more difficult to be transferred since some knowledge is not easily codified.

One application of how to acquire not easily codified knowledge is in (Gambardella,1992).It describes a case study of Pharmaceuticals companies in the 1980s. The author argued that the process of creating new knowledge inside of companies and collecting external sources of knowledge from Academia is close related to in-house scientific research. Drug firms who had

invested in R&D and made their research laboratory more like academic departments were able to better exploit science developed inside and outside of the organization.

2.3 Open Innovation and Absorptive capacity

The usual approach of a firm to develop new scientific knowledge and innovate is investing in internal research and development(R&D). The more a firm invests in internal (in-house) knowledge the better it should be in developing new applications (Belussi, Sammarra e Sedita, 2010; Berchicci, 2013; Paula e Silva, 2018b).

The academy, however, argues that not only the internal knowledge can affect innovation but also external sources that can provide a meaningful amount of information (Laursen e Salter, 2006). Companies when searching for outside knowledge can have multiple venues (breadth) and different intensities in each one (depth). Thus, not only the investment in external sources (external R&D) matters but also the process of managing it.

Yet, the level of focus in external and internal R&D has been subjected to debate. Cassiman e Veugelers (2006) suggested a possible complementary relationship between both internal and external R&D. Complementarity, by these authors, is when the marginal returns of one increase when the intensity of the other increases ie, companies with more investment in internal R&D should have more returns when doing external R&D and vice-versa. This was further tested in Belgium manufacturing firms from the Community Innovation Survey (follow Oslo Manual) of 1993.

Berchicci (2013) has questioned (Cassiman e Veugelers, 2006) whether internal and external R&D are complementary or substitutes. His article's main contribution is the investigation of the moderating role of R&D capacity in both types of R&D and innovation performance. The findings using Italian surveys consists that firms that possess both internal and external R&D activities have better innovation performance. Among those firms, the ones

that invest more in external than internal research perform worse than their counterparts. Therefore, the amount of external research must cover the monitoring cost of external alliances and opportunity cost for further opening up R&D borders is greater for firms with greater internal R&D capacity.

Focusing on this "new" external source of knowledge, Chesbrough (2003) created the term *open innovation* to the innovation developed or fueled by information from outside the firm in conjunction with internal R&D and knowledge. The author suggested that, at the moment, firms used to do more frequently "closed innovation", which means that ideas and processes were made within firms' boundaries(Hippel, Von, 2005) (Figure II).

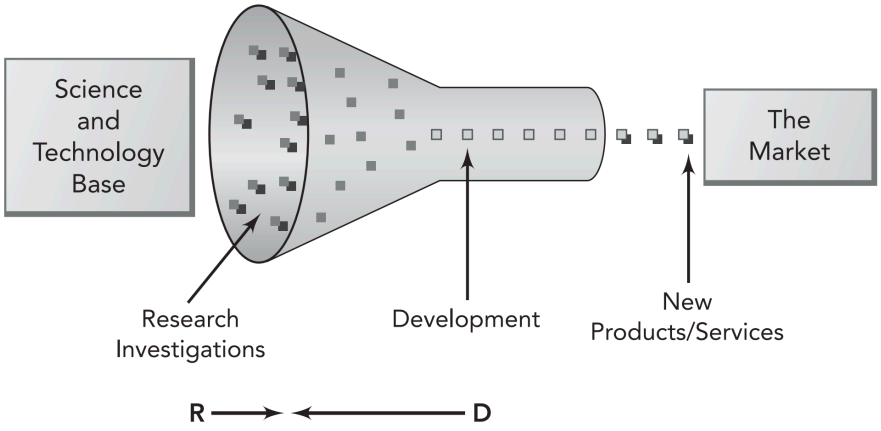

Figure 2-Closed Innovation Process (Chesbrough, 2010,pag.69)

With the new paradigm of Open innovation, firms should use external ideas along with internal ideas and use internal and external market paths to develop their business (Chesbrough, 2010)(Figure III).

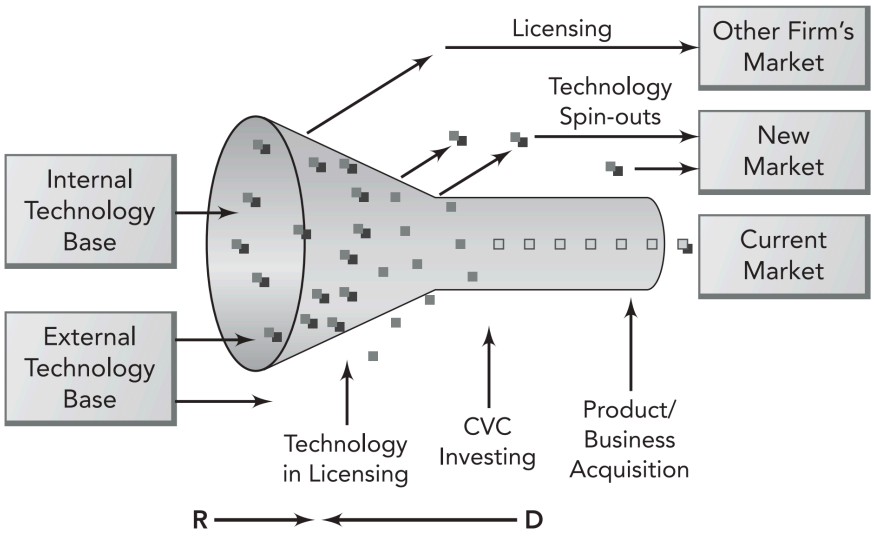

Figure 3- Open Innovation Process (Chesbrough, 2010, pag.70)

This concept represented a new paradigm shift on innovation. Instead of focusing on the boundaries of the organization and the strict expenses in R&D, companies now might fuel their ideas with an increasing flow of information from outside in places like hackathons and from stakeholders.

Almirall e Casadesus-Masanel (2010) on a theoretical simulation development, investigated when open innovation is better than regular innovation. The firm has to decide whether it controls all the product management or open its technology and adopt solutions or ideas provided by different players. When doing open innovation, the companies should account for the discovery of new combinations and the "divergence" which means the quantity of control on how value is retained by the original firm. There is always a trade-off between these two and the optimum selection should be made by each "developer", who can choose open-system or a closed approach to innovation. Further, the enterprises can choose how they manage such relations between different players or "outsiders".

The study of alliances between different players has also been studied by the strategic management field and is related to how "open" is the process of innovation. Particularly in (Doz, 1996), there is an investigation case of new

business and alliances focusing on new product development. The relation between firms is observed through learning and collaboration's lenses. In this paper, three cases analysis shows different ways of how alliances possess an evolutionary attribute, in other words, the process adapts and change throughout time, as the governance, asymmetry and coordination challenges change.

Even so, understanding how firms can utilize such external knowledge in their favor is mandatory to understand better the connection between it and innovation. Since (Cohen & Levinthal, 1990) seminal work, this phenomenon has been better explained by a construct called Absorptive Capacity (AC) which is detailed in the next section.

AC consists of the ability to exploit external knowledge, moreover the evaluation and utilization of it for commercial ends. Such ability is a function of prior related knowledge, such as training of the employees and could be a byproduct of previous R&D endeavors (ibid.).

Similarly, the article of (Hagedoorn e Wang, 2012) argued that substitution could be possible between absorptive capacity and high levels of internal R&D with AC serving as complementary between both types of R&D.

Absorptive Capacity

Previous knowledge can help a firm to acquire new cognitive associations and therefore knowledge mainly because "memory is associative" (Easterby-Smith *et al.*, 2008). This process is usually mediated by individual gatekeepers (Allen, 1984; Cohen e Levinthal, 1990), those who are responsible to evaluate the external environment and codify the available information so that all the other members of the group can understand it.

Zahra e George (2002) made an effort to reconceptualize the construct in four dimensions. AC is envisioned as four different dynamic capabilities: through routines and processes the organization "can acquire, assimilate, transform

and exploit knowledge". The article also stated that there is difference between the first part of the AC (acquire and assimilate, which forms the potential AC) and the second one (transform and exploitation, which forms the realized AC), as many firms are more efficient in finding commercial ways to exploit its innovations. Finally, the social integration mechanism is moderators between potential and realized AC.

In a new development, (Todorova e Durisin, 2007) suggested that the relationship between absorptive capacity, knowledge and competitive advantage should be rooted on the cognitive basis first introduced in (Cohen e Levinthal, 1990). The article proposed moderators of this relationship: social integration mechanisms that happen inside of firms; power relationships that happen inside of social networks; and regimes of appropriability. This development adds social network analysis in the cognitive process of generating new knowledge within organizations.

Somewhat related to the AC construct, Arora e Gambardella (1994) investigated the role of internal capabilities (scientific and technological knowledge) in the ability to collaborate through research alliances. The work made empirical research on biotechnology firms, as they are known to demand high expertise and possess a high frequency of research alliances (Pisano, 1990)

At the "make-buy" decisions for R&D projects, firms that have in-house production capability should always choose to develop their ventures. On the contrary, these authors argued that firms that invest in internal research should be more likely to enter external alliances. There is a suggestion of firms carrying a good "scientific capability" (the function of the number of scientific publications by employees) having a greater ability to evaluate good projects and alliances.

This capability is related to AC, which definition can be interpreted as the connector between the external sources of knowledge and the in-house development of ideas (Dahlander e Gann, 2010).

Here, is important to note that innovation is not perceived as a purely organizational phenomenon, where companies do it individually without any external output. Since authors like (Chesbrough, 2003; Hippel, Von, 2005), there is a claim on the necessity of external actors to provide new types of knowledge.

Dahlander e Gann (2010) argued that the recent popularity of "openness" is a related to four reasons: it reflects the contemporary aspect of working patterns where employees are always changing organizations; the globalization and increasing division labor; improved market institutions like property rights and venture capitalists; and new technologies that grant new ways of collaboration like open-source codes. These authors wrote about four types of openness The first two are associated to firms pushing innovation inputs to other: outbound innovation, related to how firms reveal internal resources to the external environment without immediate financial rewards; and selling or licensing out resources developed in other organizations; the last two are linked to collecting(pulling) external sources: inbound innovation-non pecuniary- related using external ideas and technologies to fuel in-house innovations; and inbound innovation-pecuniary-acquiring input to the innovation process at the marketplace.

The "openness" is studied based on the use of the construct absorptive capacity that helps to explain the process of how firms make sense of this external knowledge and develop and exploit new combinations, ideas, products, and services. (Paula, 2017; Zhang, Yuan e Wang, 2019)

For example, Lin *et al.* (2012) proposed that firms with a high level of absorptive capacity benefit more from R&D alliances. Three aspects of absorptive capacity are used to explaining better innovative performance: knowledge acquisition, assimilation, and exploitation.

Referring to the acquisition, the proportion of R&D alliances in the firm's portfolios is directly related to the amount of exposure to new information.

Related to the assimilation part, one main influential factor is the technological distance (Gilsing *et al.*, 2008); and related to exploitation is that high levels of investment in internal R&D that allows achieving greater returns(Berchicci, 2013; Lin *et al.*, 2012). Because of the relationship between internal R&D and exploitation of external knowledge, the former is used in the literature as one of the main proxies of AC (Cohen e Levinthal, 1990; Hagedoorn e Wang, 2012). The hypothesis that a high level of internal R&D is highly correlated to a high absorptive capacity, positively moderating the innovative performance of alliance portfolio is supported by several authors, such as (Escribano, Fosfuri e Tribó, 2009; Lin *et al.*, 2012; Macedo Soares, Silva Barboza e Oliveira Paula, de, 2016).

2.4 Alliances and Portfolios

To have a greater understanding of how external knowledge and AC impact the innovation endeavor of companies, it is necessary to understand the sources from which firms acquire this particular type of knowledge. Thus, this section deeply describes strategical alliances as the sources of external knowledge flows. The idea of alliances is represented in the literature into the two types, dyadic strategic alliances and alliances portfolio (a set of dyadic alliances from a focal firm), both discussed in this chapter.

Dyadic strategic alliances have long been studied in the literature (Chan *et al.*, 1997; Doz, 1996; Morrison e Mezentseff, 1997) to affect innovation and financial performance of companies. They, to create greater value in a commercial transaction, look for alliances with other firms. The reason behind such behavior is that Alliances are considered effective strategies to overcome skill and resource gaps of uncertain and dynamic environments(Morrison e Mezentseff, 1997). Another important reason is learning, as alliances provide different meaningful new combinations of external and internal knowledge and value to its consumers (Haus-Reve, Fitjar e Rodríguez-Pose, 2019; Morrison e Mezentseff, 1997).

This practice is used in most industries, if not all: banking, manufacturing, and computer software are some of the many examples where the use of strategic alliances has become ubiquitous (Chesbrough, 2010; Schilling, 2016). This strategic device has also led to a growing stream of research (Gulati, 1998) which led to multiple definitions of it.

In a broader sense, all alliances are collaborations and they can consist of multiple ranges of partners. Despite the use as synonymous between both terms (alliance and collaborations) some authors try to differentiate it (Martínez-Noya e Narula, 2018). Strategic alliances are defined along the lines of being any sort of collaboration with the intent of producing innovation, or superior performance (Narula e Hagedoorn, 1999).

Another definition of strategic alliances is that they are medium or long term agreements between organizations, where two or more firms combine resources (cash, technology, etc.) for some agreed set of activities (R&D, manufacturing, marketing) (Pisano, 1989). Similarly, Gulati (1998) defines alliances as voluntary agreements that involve the sharing or co-development of products, technologies or services.

Researching about the context in which firms are even more involved in collaborations agreements, Narula e Hagedoorn (1999) optimistically stated that four characteristics of alliances were observable along with a greater sample of this activity. At the time of the publication, the end of the 1990s, the following aspects were briefly described as:

(I) Collaboration was being considered a first best-option for innovation to a greater number of firms;
(II) Collaboration in R&D was being considered normal behavior by most organizations;
(III) Collaboration was increasingly being made with both local and overseas partners;

(IV) Collaboration was being made according to different organizational modes, like non-equity agreements more adaptable to each company's reality.

Narula and Hagedoorn (1999) believe that this behavior observed in firms is led by two causes: a cost-saving motivation and a strategic motivation where these partnerships can help put the organization in a better position to increase long-term profits. The authors illustrated the argument in how multinational companies used alliances to expand overseas. Alliances were supposed to help overcome barriers of entry and ways to manage the cost and risks of innovation in competitive markets.

Motivations behind Strategic Alliances:

Further in describing the reasons why firms choose to share resources with other organizations, one of the main reasons is the increased complexity of technology(Mariti e Smiley, 1983). These authors classified several motivations behind the decision:

I) *Technology transfer*- a one-time transaction of information to transfer technology in exchange for money or other considerations could help firms acquire new resources or products.

II) *Technological complementarity*- long term agreements where firms could share knowledge to develop new products or services.

III) *Marketing agreements*- any agreements that could help the firms to better achieve their marketing and distribution goals.

IV) *Economies of scale*- referred to production and distribution efficiencies. Usually, a firm would specialize in a particular component thus leading to better economies of scale and learn by doing.

V) *Risk-sharing*- could provide a better way of dealing with uncertainties as risk is shared between the parts.

In another aspect, Schilling stated one noteworthy reason behind this strategy: "A great portion of innovation does not arise from single firms, but instead from the collaborative efforts of organizations and individuals" (Schilling, 2016,pag 60). Also focusing on innovation, Chan *et al.* (1997) argued that through alliances firms could obtain skills and resources to develop innovation faster than developing in-house. Alliance enabled a great ability to companies in general: "The ability […] to focus resources on its core skills and competencies while acquiring other components or capabilities it lacks from the marketplace"(Chan *et al.*, 1997,pag 199).

According to (Mowery, Oxley e Silverman, 1996) the motivations of alliances were: (I)firms may need to spread costs and risks of innovation;(II) firms may acquire new technical skills or technologic capabilities;(III) collaboration of users and suppliers; and (IV) coordination among competitors.

In line with the rationality behind long term agreements of "technology cooperation", Hagedoorn (1993) illustrated reasons like access to complementary technologies, access to new markets, and reduction of innovation time-span, among others. Factors like the type of research done in the respective sector, and the strategic goals (markets and technology-mediated objectives) affected the cooperation's attributes. For instance, basic research is usually done in-house; and long-term intensive R&D relations may lead to complex contract agreements among parts.

Not only the reasons for strategic alliances are investigated in the literature. In an effort to identify what drives alliance formation, Chung, Singh e Lee (2000), studied why firms allied with certain partners. According to them, resource complementarity, when companies strive for different resources to enhance their performance and the creation of value is one of the main reasons why alliances are created among particular firms. The study also hypothesized different ways that the social position of the firms impacts the alliances: social status, direct and indirect ties are observed to impact the alliance formation.

The same “social grounding” aspect was reflected in (Dyer e Singh, 1998) whose argument was that the characteristics of a firm are often linked with the network of relationships in which it is embedded. That’s because sometimes the crucial resources to achieve superior performance is located outside the firm’s boundaries. Discussing dyadic relations, the authors described how idiosyncratic combinations among partners could lead to relational rents and competitive advantage.

Other than just learning, collaborations/alliances can represent lower transaction costs and share of efforts and resources (Kogut, 1988; Powell, Koput e Smith-Doerr, 1996). According to (Powell, Koput e Smith-Doerr, 1996), firms pool resources mainly due to (I) the risk vs the return(the make-or-buy decision); and (II) the social aspect of learning. Other goals of such collaborations may include gain or access to new markets and technologies and increased speed in the launch of new products in the market.

In the financial context, Chan *et al.* (1997) studied the financial aftermath of alliances depending on the characteristics of the firms. Specifically, non-equity strategic alliances were studied where both horizontal alliances (between firms from the same three-digit SIC group) and non-horizontal alliances were found to increase the equity values of the partnering firms.

On the governance aspect, alliances can have multiple configurations ranging from a complex governance structure to simple agreements as follows (Schilling, 2016): (I)Joint ventures – entails a new entity with equity investments from both partners; (II) Strategic Alliance – alliances where resources and capability are transferred/shared without an equity contract(non-equity strategic alliances) or with an equity position in one or other(equity strategic alliances); (III) licensing- one firm grant the right of using a particular resource to another company in exchange for financial compensation; (IV) outsourcing- the use of another organization to perform a function or service; and (V) collective research organizations (Powell, 1990; Schilling, 2016).

Despite multiple ways of collaboration, each firm may choose a particular type of alliance to better support its business endeavors (Hagedoorn, 1993; Powell, Koput e Smith-Doerr, 1996). Aspects ranging from types of assets and complexity of the research may turn to reach the firm's goals into a cumbersome activity, therefore choosing the configuration wisely is mandatory (Sampson, 2004).

Gulati (1998), on considerations about the firm's alliance governance, proposed that, in collaborations among organizations, both appropriability and predictability of the outputs have impacts on the configuration of the alliances. Both risks need to be taken into account when choosing the preferable type of governance. For instance, a detailed contract, as well as a trustworthy relationship developed along multiple interactions may be approached to control both aspects.

Regarding this subject, Pisano (1989) tried to shed light on why companies seemed to prefer joint ventures instead of regular contracts. Partial ownership provided by joint-ventures is better when the relationship among partners is filled with uncertainty, transaction-specific capital, and other difficulties.

One of the benefits of strategic alliances, Brouthers e Brouthers (2003) also used transaction theory to discuss how firms distinct joint venture or fully owned approaches in international new markets entry mode. Using one of the main aspects of this particular theory, the authors argued that *asset specificity* affects the entry mode. Other aspects like whether the organization is a manufacturing or service firm; behavioral and environmental uncertainty were found to impact the entry mode.

In another development of the research, Sampson (2004) studied the aftermath of alliances depending on which type of governance was chosen. The type of contract was found to impact positively when taken transaction cost theory into account. However, the cost of the bureaucracy of strict contracts and high moral hazard leads to a reduction of the collaborative benefits.

Alliances Portfolios

Another way firms pull external sources are through a collection of strategic alliances, called **alliance portfolios** (George *et al.*, 2001).In an illustration of its importance, Gulati (1998) on his study about strategic alliances, proposed the use of a network-based framework to predict how successful in the future partnerships can be. The social network that the firm is located affects the frequency of new interactions, the type of governance and how the relationship evolves through time.

To understand these phenomena of network Walter Powell's essay (Powell, 1990) stated that are three main paths for production or coordination instead of the two elected from transactional cost theory: **markets** – where individuals exchange, buy and sell goods; **networks**- resources allocation and transactions are made through social interactions **and hierarchy** – where firms are responsible for the production due to transactional costs. Whereas the relation among parts is long term, services and products are not easily measured, reputation and entangling obligation linger between transactions, the best coordination process is a network.

This networking aspect of Alliances is closed related to articles that have been focusing on the portfolio of alliances. The idea of a portfolio is a development of the social network theory used in the discussion of firms that not only have one relationship but a plethora of it (Hagedoorn, 2002; Jiang, Tao e Santoro, 2010). There are arguments that portfolios help increase learning at the cost of a higher coordination effort. In this stream of the literature, firms' dyadic relations give space to portfolios and social networks. (Gulati, 1998) stated that even though alliances are essentially dyadic, the process and the outcomes are explained by social networks. (Gulati *et al.*, 2000) explain it better: in a context of inter-organizational relationships as determinants of firm innovation, examining the networks of relationships can provide meaningful observations of facets not detected by an "atomistic" view of firms.

One important aspect of alliances is that usually firms search for multiple alliances, in this fashion synergies and potential trade-offs are usually overlooked in studies that focus only on singular strategic alliances (George *et al.*, 2001). Gulati *et al.* (2000) also promoted this facet, where portfolio consisted of both sources of strengths and weakness which could explain different profitability among companies.

When Eisenhardt e Ozcan (2009) introduced the reasons behind the adoption of portfolios, they used the example of Apple Inc which used multiple alliances among other companies to change its market positioning while leveraging its strength in architectural design. The researchers did a multi-case study on wireless game companies and found that high performing firms and portfolios were created with particular architectures that encourage strong ties among partners since its genesis.

One of the reasons behind the different outcomes from the portfolio strategy is the management of these multiple ties. One case of such is (Haus-Reve, Fitjar e Rodríguez-Pose, 2019) who studied whether different types of collaborations (university, joint-ventures with competitors) can help Norway firms in the innovation pathway. It was found that at least on this analysis different types of collaboration are not complementary but substitutes, firms will look for specific alliances in detriment of others. When more complex is the number of alliances, the harder to understand nuances and applicability for companies.

In another contribution, Xu e Cavusgil (2019) claimed that depending on the firm's goals(exploitation or exploration) different configurations of portfolio and alliance strategy may arise. As discussed in (March, 1991) firms may choose to deepen their understanding of core competency(exploitation) or to explore new ventures from their already existent knowledge(exploration). Organizations that can do both competitive goals are so-called ambidextrous.

Xu e Cavusgil (2019) then divides knowledge into two types: Knowledge breadth(exploration) and knowledge depth(exploitation) while asking what

type of configuration helps to achieve growth in the respective knowledge. A firm's alliance configuration should be formed according to the willingness of knowledge sharing between partners and their capability to absorb it. Depending on the intention, a company might look for different levels of knowledge redundancy. For instance, firms interested in exploitation might have connections with other firms of a similar background while withholding certain information to avoid opportunistic behaviors.

The authors also stated the multiple characteristics of R&D strategic alliance found in the literature and how each affects both type of knowledge: i.e. vertical vs horizontal alliances; partner diversity; *partner relatedness*; multiple- partner alliances; and multi-technology alliances.

Horizontal alliances are the ones with competitors, vertical are those with channel members along the value chain (suppliers, sellers, etc.). Firms who look for horizontal alliances, deal with great knowledge redundancy which affects the level of novel knowledge, making it better for firms not interested in exploration venues.

Partner diversity is related to the number of distinctive partners within a particular portfolio. High level of partner diversity should be expected with great knowledge breadth development. Partner repeatedness is when firms prefer an alliance with the same partners over time, indicating the willingness of creating a relational capital.

Multiple partner alliances are named in the literature as portfolios when the company tries to manage relations with multiple organizations, and multi-technology addresses the diversity in technology between partners. The article supports that all this different configuration is related to the preference in knowledge accumulation by the firms. Summarily, the article supports that all these different configurations are related to the preference in knowledge accumulation by the firms.

Corroborating with the idea that that firms should strive for better portfolio management (Faems, Looy e Debackere, 2005) found the impact of external sources on innovation performance depends on the nature of partners. Firms that engage in multiple inter-organizational agreements(diversity) are more effective in innovation performance both in terms of exploiting existing technologies and exploring new ones.

Another study that accounts for the firm's goal when doing external research is, (Pellegrini, Caputo e Matthews, 2019). This specific study takes the concept of relational rents first introduced in (Dyer e Singh, 1998) related to competitive advantages generated by inter-organizational relationships to a portfolio context. Precisely, the authors deal with how relational rents are created and distributed in an alliance's portfolio. Multiples propositions are listed concerning the age of the firm, the intent of the research and the configuration of the networks affecting the rents.

To better understand this new portfolio approach on external relations, Wassmer (2010) elaborated an overview of the alliances' portfolio research agenda. He defined three clear approaches used in the literature to define portfolio: (I)The aggregate of all strategic alliances of a focal firm; (II)All Direct ties with partner firms(ego-networks); (III) Accumulated past alliance experience

The bibliographic study in (Macedo-Soares, Barboza e Paula, 2016) of alliance portfolio, absorptive capacity, and innovation performance found a positive impact on innovation performance through determined alliance portfolio configurations. Some of these configurations are diversity, centrality, size and partners' types, all affected the relationship.

(I) Diversity of alliance's portfolio deals with the variety of multiple partners that a particular firm works with.

(II) Centrality consists of the positioning of the firm in a particular portfolio. The more indirect and direct partners the better is the innovation capacity of a particular portfolio

(III) Size of the portfolios also impact the amount of knowledge within the network

(IV) Partners types, like the technology distanced partners, impacts the Portfolio output.

Taking this study into consideration, the objective of this dissertation is to investigate the relation of the diversity of alliance portfolios in innovation performance. For this reason, the following section deepens the concepts of this characteristic of the alliance portfolio and its impacts.

Diversity in Alliances Portfolios

Alliance Portfolios facilitate the development of new products, services, and capabilities through various knowledge inputs from different partners. The configuration of these different and diverse inputs impacts the output of such collaborations. Therefore studying diversity is a critical issue when dealing with the performance of Alliances portfolios(Hagedoorn, Lokshin e Zobel, 2018).

Eisenhardt e Ozcan (2009) used the concept of diversity as the diversity of ties in a Portfolio/Social network: different types of ties strength-wise like how many venues the collaboration is working, and the number of different types like how many different companies and institutions the firm is collaborating with.

Similarly, Hagedoorn, Lokshin e Zobel (2018) argued that is imperative to use multiple dimensional perspectives of diversity. The two dimensions used by these authors are the number of different partners types (i.e customers, suppliers, competitors, universities, governments, etc) and the relevance of each partner as knowledge sources.

A similar argument is found in (Macedo-Soares, Barboza e Paula, 2016), where diversity is observed in a literature review to be one of the factors of alliance portfolio configuration with the most impact on innovation

performance. After extensive research on high impact journals, the authors elected four dimensions of diversity:

I)**Functional Diversity** is related to the different roles in collaboration. For example, one company might be responsible for marketing and the other as the product provider.

II)**Geographical Diversity** regards the partnerships among companies from a different geographical location (foreign countries).

III) **Institutional Diversity** consists of the institutional environment behind the partnerships. Formal institutions (government regulations) and informal (norm, values) regarding each partner's background affect the levels of innovation.

IV)**Technological Diversity** concern the technology distance among partners.

Despite the positive impact of diversity, the understanding of different types can help explain why some firms can achieve more outputs out of strategic alliances. Parkhe (1991)studied the role of diversity on international interfirm alliances, where the high rate of failures could be linked to big social and corporative diversity amid firms. The article asserts about the taxonomy of the diversity whose two types are related to different outcomes in business exchange. The first type deals with complementary strengths and differences that lead to successful partnerships; diversely, the second type consists of aspects that negatively impact the relationship like country/corporate culture difference and contrasting strategic orientations. By using the longevity of the partnerships as a favorable outcome of the international alliances the author argued that only through an organizational learning effort firms can better adapt to existing partners, leading to better effectiveness from these alliances.

In a like manner, diversity on types of partners, governance, geographical and more are shown to have influenced the innovativeness of firms. In (Jiang, Tao

e Santoro, 2010) is argued that although diversity in alliance portfolio increases complexity and coordination costs, it also provides learning and resources benefits. The same is stated by (Macedo-Soares, Paula e Mendonça, 2017).

Jiang, Tao e Santoro (2010) also studied different types of diversity and its impact. For instance, different **partner types** have an inverted u-shaped relation with firm performance; **functional diversity,** regarding the range of activities for which the firm uses alliances, has a positive relationship with the performance. For example, activities can include marketing, conjoint R&D effort, distribution of products/services, and manufacturing. In short, the more diverse are the firm's connections activities in different partnerships, the more supplemental knowledge it can aggregate.

Another type of diversity used in the authors' study is the **governance diversity**, which describes the variety of structures firms use to manage the portfolio**.** The bigger the number of different governances, the more complex it is to manage the alliances despite providing a better way of coordination. This difficulty justifies the recommendation found in (Capaldo e Messeni Petruzzelli, 2011), which says that firms should accumulate knowledge in the same types of governance.

This intrinsic characteristic of impacting both in positive and negative ways is also described in the research of (Goerzen e Beamish, 2005), where a particular type and level of diversity are proposed. They concluded that Portfolios in a better position to succeed are the ones on the middle ground – highly focused network with similar partners and quite diverse with some different partners. According to the authors, multiple reasons are culture, previous experience, challenges of knowledge appropriation and the need for synergies.

Therefore, the question that arises is how much and what type of diversity, firms should look for. Hagedoorn, Lokshin e Zobel (2018) reflected on the environmental conditions responsible for optimum outcomes of diversity.

The authors used both portfolios and knowledge base literature, to come up with a cognitive perception behind the behavior of firms inside the Alliances portfolio. For example, they argued that firms that deal with multiple partners are more inclined to shift their focus to knowledge outside their organization/network. However, this particular type of novelty knowledge depends on the kind of new partners and relationships to fully exploit it.

In this context, the **modularity of the knowledge** (whether the knowledge can be divided into independent blocks) and the **scope of knowledge distribution** (how many people/entities are required to distribute the knowledge) should affect the output of these alliances. Those aspects of each industry are expected to moderate the impact of the diversity on the innovation performance of companies.

Another important aspect responsible to moderate the relation between diversity and innovation performance is the AC. On partner diversity,(Lin *et al.*, 2012) claimed that the characteristics of the portfolio alliances affected the dimensions of Absorptive Capacity and therefore the innovation performance. More specifically, the proportion of R&D alliances in a portfolio, and technologic distances among partners impacted the dimensions of the Absorptive Capacity. The authors argued that technological distance does impact the benefits of a strategic alliance if the distance is too high or too low it severely affects the level of knowledge created and shared, hence a moderate distance among partners is preferred. For instance, in similar partners, the overlap between companies might bring less new knowledge.

Summarily, the diversity in portfolios, is not linear related to better performance, when companies have a wide range of partners the cost of coordination severely increases. The literature review conducted in(Macedo-Soares, Barboza e Paula, 2016) seems to pinpoint multiple observations on the literature of diversity on alliances portfolio that can have an inversed-U shape relation with innovation performance. This configuration indicates an optimum level of diversity, after that, the benefits are surpassed by the

complexity of the relations. In (Macedo-Soares, Paula e Mendonça, 2017) similar results were found when surveying Brazilian firms.

In a similar fashion, Duysters *et al.* (2012) used organization learning theory to verify on what degree firms learn to manage this diversity on the portfolio. The construct of diversity used by these authors accounts for alliance (dyadic vs multi-partner) and partner (national vs international) attribute**s**. The work used alliance capability as the ability of firms to manage an alliance portfolio successfully along with previous experience in alliances as moderators in the relationship between diversity and performance. The study found a nonlinear relationship in an inverted U shape configuration, the authors briefly stated two main reasons it:

I. As firms set their sights on expanding through strategic alliances, the ability to take advantage of learning opportunities decrease. Further, the more complex the portfolio the higher risk of leakage and knowledge spillover. At a certain, the benefits, who are decreasing as the portfolio grows, are outweighed by the downsides.

II. The more diverse is a portfolio, the more difficult is to manage the resources and attention to each partner. It might be troublesome for firms to align the strategy of each alliance, especially in case of a conflicting request from each partner.

Carree, Lokshin e Alvarez Alvarez (2019) also investigated the non-curvilinear relationship(inverse u-shaped) between diversity in portfolio(Portfolio breadth) and innovative performance. For these authors, two variables are observed to moderate the relationship, both internal R&D spending(related to AC) and firms size. In regards to the moderation aspect of AC, Paula e Silva, da(2017) studied low-tech and high-tech Italian firms and have found a statistically significant role.

2.5 Impacts of innovation on Financial Performance

Understanding the impacts of innovation are necessary to understand why firms search for it in the first place. Behind the motivations of innovation, the idea of better positioning in the market has been around since Schumpeter (Schumpeter, 1983). This intrinsic relationship can be summarized (Ateljevic e Trivić, 2016) who stated that innovation makes firms produce better quality services and products with few resources and through innovation, firms can better position in the market. The very possibility of implementing a monopolistic gain was behind Schumpeter's thinking.

Nevertheless, implementing an innovation does not guarantee an extraordinary financial return. Teece (1986) notably described the process where firms exploit the innovation and the reasons why sometimes imitators profit more than the innovators. Three main vectors were argued to be responsible for determining which company should be successful when dealing with innovation:

I)The regime of appropriability – environmental factors that affect the ability to exploit a particular innovation, it ranges from the nature of the technology, nature of the knowledge to legal mechanisms of protection

II) Dominant design paradigm – After some time and interactions, the standard design demanded by the market usually emerges. This standard might be detrimental to the first innovator as the imitators might own a better design in the eyes of the consumers.

III) Complementary assets – in most cases, the successful commercialization of the innovation requires coordination with complementary assets (for instance marketing and post-sale relationship).

However, a positive relationship between innovation and sales does not necessarily indicate better financial performance. The impact on profits has more influential factors than the sales of innovative products or services.

Marketing position and organization characteristics also impact on the consequences of innovation. Recognizing the complexity of the relationship between innovation and performance is essential to understand the impacts of R&D efforts. Whether selling innovative products/services has an impact on the profits depends on aspects outside purely technology ones. Marketing positioning and organization configurations are supposed to affect the outcomes of innovation (Teece, 1986; Venkatraman e Ramanujam, 1986).

For instance, on one hand, Simon Feeny e Rogers (2003) argued that investing in R&D and patent applications do impact the valuation of the companies. In the other hand, (Guan *et al.*, 2006; Saliba de Oliveira *et al.*, 2018) found the relation between both to be inconclusive.

In a contextual view, the field of strategy is closely related to the study of performance: Strategy is viewed as the tool used by companies to differentiate from competitors and create a sustainable advantage for the company(Porter, 1996).In the same scope, Performance is considered at "the heart of strategic management", as the measurement used in strategic management to evaluate how well are the strategies in achieving this goal(Venkatraman e Ramanujam, 1986).

Yet, the studies in business performance have a huge variety in scope and definition: from a transaction cost theory (Williamson, 1979) to resource based-view(Peteraf, 1993; Wernerfelt, 1984), firms are supposed to compete in markets and strive for superior performance. The link between innovation and superior performance is fairly studied in studies like(Faems *et al.*, 2010; Rothaermel, 2001). Scholars like (Tsai, 2009), used the concept of absorptive capacity to assert its moderation role on the performance of product innovation. Tsai's study concludes the innovative sales productivity is impacted by collaborative networks.

Up until now, this dissertation has talked about constructs that help understand the process of creating innovation, however, innovation also stands for exploiting this "new combinations" in a commercial way. West e

Bogers (2014) argued that despite having a good research effort in elucidating how the external knowledge and the open innovation stands in the process of implementing innovation, there is a dearth in content addressing the financial impact of it. The question on external sources of innovation affects the financial performance of firms surely represents a valid concern to firms and strategists planning on deploying R&D efforts. After all, superior financial performance is what the majority of the shareholders expect in the long term.

Likewise, Cheng e Huizingh (2014) used financial performance as an innovation performance dimension. Their study achieves a confirmation on open innovation being related to better financial performance (profitability and return of investment) with the caveat of the moderating role of the market and strategic orientation.

Rosenbusch, Brinckmann e Bausch (2011) on a meta-analysis of the impacts of innovation on small and medium(SME) company's performance argued that: age of the firm, type of innovation and cultural aspect, whether the society in which the company is located has more individualism or collectivism, all impact the performance. Nonetheless, dedicating more internal R&D resources are found, in the literature, to positively impact SME performance. The following relations with performance are also studied on this study: the impact of "innovation orientation" as the strategical tendency to engage and support innovation which consequences are more R&D spending, better manufacturing methods, and others; The cost of coordinating external alliances may be a great burden to SME overcome in developing meaningful financial impacts through innovation.

At the portfolio level, Faems et al. (2010) argued that past studies imply an indirect positive relationship between alliances and financial performance. In the article, there is an argument on alliances requiring frequent monitoring to manage potential conflicts. A framework which divides positive and negative consequences of alliances portfolio is proposed: There are "value-enhancing" and "cost-increasing" effects and both should affect financial performance:

By these authors, product innovation is closely linked with a gain on market share, the financial aspect is observed in the cost of personnel per value-added. In this paper, there is an explicit hypothesis that product innovation performance implies more value generated with the same number of employees (lower the share of personnel cost in value-added). However, the more complex the alliance portfolio gets, the more alliance management skills are required. These skills likely incur costs of hiring managers and governance control, thus increasing the share of personnel cost. Further, the cost of personnel is directed related to the profit margin, the diversity negatively affects the bottom line of firms.

On the positive side of diversity, Baum, Calabrese e Silverman (2000) studied Canadian biotechnology firms, they speculated that startup firms could leverage their performance through alliances, efficient networks(portfolio) and due diligence in aligning with partners with great return in learning with minimum risk of rivalry among other partners in the same network. Their findings support the idea that size, age of firms and their networks affect the startup financial performance. Also on the heterogeneity of the firms, Tomlinson (2010) used a firm's size, age, and sales growth revenue as control variables to estimate the level of innovation on alliances, a positive relationship between innovation and sales growth was supported.

On the broader organizational performance, Belderbos, Carree e Lokshin (2004) also studied the impact of cooperative R&D: Alliances are found to impact labor productivity and productivity in innovative (new to market) sales. The research proposal is that each type of partner (competitors, suppliers, customers, and universities) help the firms achieve its two main goals of innovation effort: cost reduction and market expansion. The study concludes that supplier and competitor cooperation affect labor productivity growth, while cooperation with universities and competitors relates to new to market sales. The findings strongly supported that competitors and university collaborations impact the financial performance of firms.

Nonetheless, the connection between innovation and financial performance needs some precautions, (Lichtenthaler, 2016) proposed a new framework of innovation's integration with a firm's performance by taking into account the interdependencies among multiple types of innovation. The model divided innovation in first-order(first implementation) and second-order(analogous to dynamic capabilities)(Teece, 2007) each one affected the performance output. On Lichtenthaler's model, there are contingency factors that moderate the impact of innovation output in financial performance. Among these factors are social integration and market conditions.

Also in productivity, Carvalho e Avellar (2017) encountered a relationship between innovation and production (productivity per employee) performance among Brazilian companies. Huergo e Jaumandreu (2004) carried an investigation on process innovation affecting productivity growth. This may seem intuitive, but the study found that the age of the firm does impact the gain created by the increment of the innovation: New or incumbent firms are more impacted by process innovation than bigger and more established ones.

In a study about the financial impact of R&D on small and medium enterprises during financially turbulent periods, Teirlinck (2017) argued that the relationship between the financial performance and R&D configurations must be seen in a long term perspective. Depending on the time-lag, R&D must offer both positive and negative relations with financial revenue. The work measures financial performance with a ratio that includes liquidity, solvency, profitability and other value-added indicators and despite contributing with new ways to measure the construct, it was not able to provide a conclusive and clear relation between them.

On a similar note of the controversial impact of innovation on the firm's performance, Saliba de Oliveira *et al.* (2018) notice that in Brazilian firms, even if firms can develop innovation there might be no financial gains in short term, thus reflecting the risky nature of innovation. Paula (2017) also advocates the use of big time-lag between innovation and financial performance to fully evaluate the impacts on financial performance.

2.6 Previous Models

Considering all the literature mentioned previously, this part collects and describe some previous noteworthy models that influenced this dissertation's model and hypotheses:

Macedo-Soares, Barboza e Paula (2016) made an analytical model based on the literature review to study emergent countries. Taking into account Alliances portfolio dimensions/characteristics (diversity, composition, modalities) and capabilities (Absorptive capacity) the model proposed relation with firms' innovation performance(Figure IV).

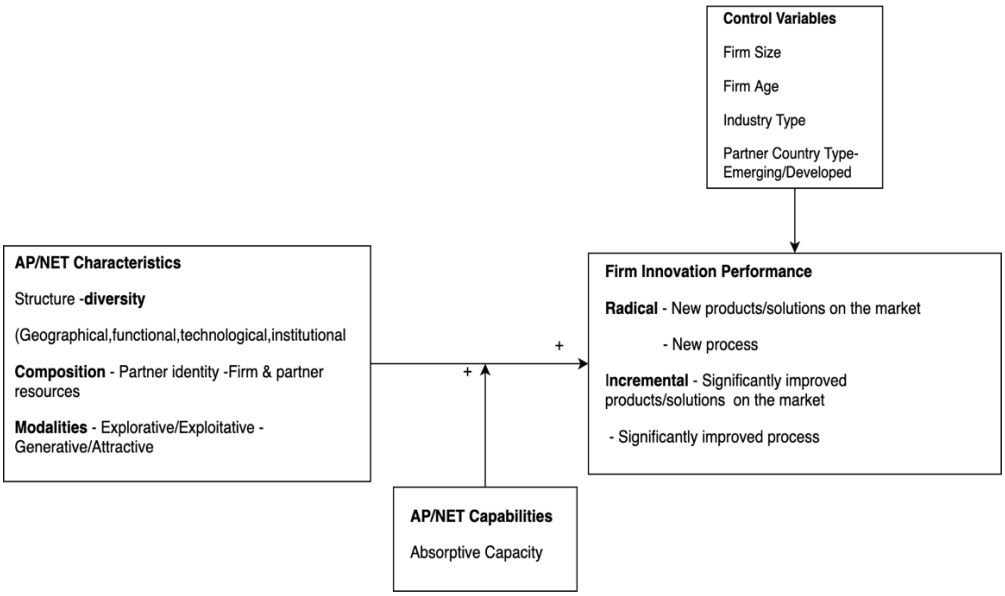

Figure 4- Model (Macedo-Soares,Barboza e Paula, 2016)

In this particular model, **diversity** was categorized in four different types: Geographical diversity- takes account for international alliances; Functional- stands for different partners with different activities; Technological diversity- technology distance between partners in classes of partner's patent; and institutional-different institutional entities in partners.

The **composition** of the network was related to the focal firm's identity status and its access to the partner's innovation resources. And The **modality** of the network in whether it was explorative (search for new knowledge), exploitive (to better exploit existent resources), generative (to generate a new technology) or attractive (to attract multiple new knowledge sources).

The model proposed as control variables: Firm size, Age, industry type and Country Type. Radical and incremental innovation were used as proxies for Innovation performance.

One similar model was tested in (Macedo-Soares, Paula e Mendonça, 2017), but did not test **Institutional diversity** due to the impossibility of collecting data of foreign partners**.** The work used a survey developed to capture data for the proxies of absorptive capacity. This particular survey was applied to Brazilian firms and also collected secondary data from Finep's beneficiary's(Finep, 2019), a local agency that finances research on Brazil.

The authors used multiple regression analysis to check the proposed relationships. They concluded that Diversity did not present any impact on the innovation performance, the relationship of aspects of the partners like partners' identity and resources also failed to produce innovation impact. However, the proposal of AC moderating and linearly impacting innovation was partially accepted.

In another similar model, Paula e Silva (2018b) adapted the first model to mainly discuss innovation and financial impacts of Brazilian Firms(Figure V). Using multiple simultaneous regression in Structural equation modeling, the authors investigated the impact of External R&D on both dimensions.

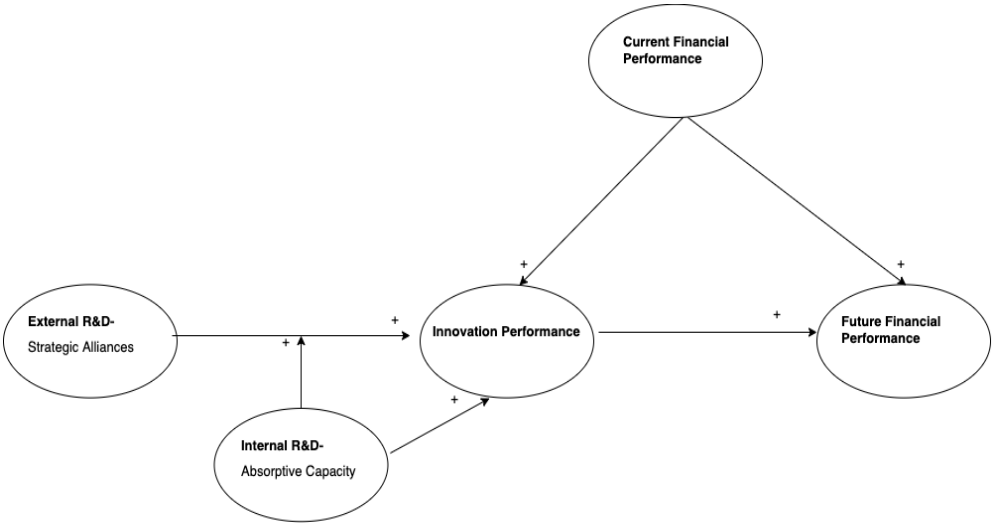

Figure 5- Model (Paula e Silva, 2018b)

The authors were successful in supporting the following hypotheses: (I) External R&D (Strategic Alliances) directly impact Innovation performance; (II) Absorptive Capacity moderates the relation between External R&D. On the other hand, the authors found a negative relationship between innovation performance and Future Financial performance.

2.7 Proposed model and hypotheses

Considering all the literature mentioned previously, this dissertation proposes the model to achieve its main and secondary goals. This present model is an adaptation of the model proposed in (Macedo-Soares, Paula e Mendonça, 2017) that tested Diversity in Alliance portfolios' impact on Brazilian firms' innovation. It consists of three main constructs and two variables (representing Product and Process Innovation) based on the literature review(Figure VI):

Diversity on Alliances Portfolio reflect the three types of diversity: Geographical Diversity (the alliances with partners of different countries/continents); Partners diversity (the alliances with different types of partners like competitors, suppliers, and others) and Functional diversity (the different goals in alliance)

Absorptive Capacity is the amount of effort used within the companies to search and develop innovations. (Paula, 2017).

Financial Performance is related to all the positive impacts of innovation on the. Financial performance.

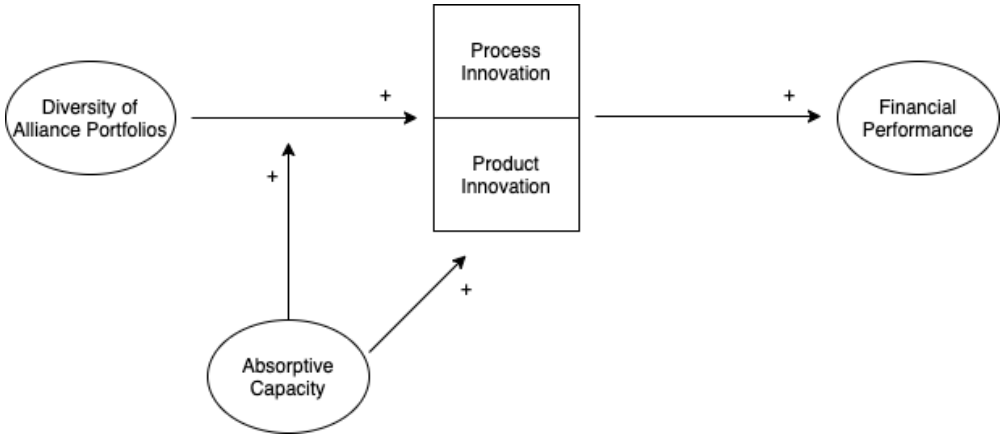

Figure 6- Proposed Model

This work proposes the following Hypotheses:

Hypothesis 1a. The firm's alliances portfolio diversity has a direct impact on its product innovation

Hypothesis 1b. The firm's alliances portfolio diversity has a direct impact on its process innovation

Hypothesis2a. A firm's absorptive capacity positively moderates the relationship between its alliance's portfolio diversity and product innovation.

Hypothesis2b. A firm's absorptive capacity positively moderates the relationship between its alliance's portfolio diversity and process innovation.

Hypothesis 3a. The greater a firm's absorptive capacity, reflected by greater spending on research and development, the higher is its product innovation.

Hypothesis 3b. The greater a firm's absorptive capacity, which reflected by greater spending on research and development, the higher is its process innovation

Hypothesis 4a. Product innovation has positive impacts on firm financial performance.

Hypothesis 4b. Process innovation has positive impacts on firm financial performance.

3.Methodology

This chapter describes how the research was conducted. In this regard, it states the sequential steps done in this work, the sampling, the operationalization of the constructs and the method used.

3.1 Sequential steps of the research

I) A review of the literature to develop a conceptual model and Hypotheses to test the research questions (previous section);
II) Collecting data from colombian firms. The data were obtained from the secondary databases described in section 3.2 (microdata from national innovation surveys)
III) The proposition of the proxies to operationalize the constructs of the conceptual model based on the literature review.
IV) Running the descriptive statistical techniques on the sample.
V)Checking assumptions necessary for the multivariate
statistical methods applied in the next steps;
a. Running a confirmatory factor analysis (**CFA**) to confirm that the dimensions which formed the constructs were valid and reliable, that each dimension effectively describes one aspect of the construct and does not describe any aspect of the other constructs;
b. Running a structural equation modeling (SEM) with maximum likelihood estimation to test the hypotheses.
VI) Interpretation and discussion of the results.

Figure VII shows a methodological diagram representing the method steps conducted in this dissertation.

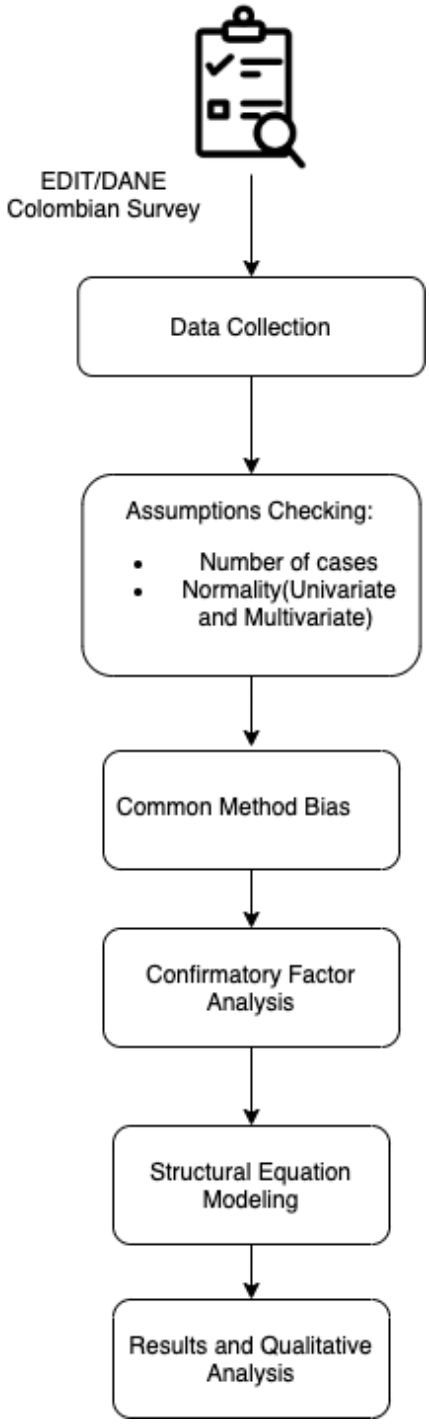

Figure 7- Methodological Diagram

3.2 Samples and Data Source

The sampling was non probabilistic as took into account only manufacturing firms who answered the surveys and conducted innovation development activity (developed innovations or intended to). The observable and measurement components used as proxies to operationalize the constructs are described in the next section.

Colombia samples were obtained from the Encuesta de Desarrollo e innovación tecnológica (EDIT) (Dane, 2020), a national survey collect in a two-year timespan. The microdata from the respective survey is gathered through open access to the government's agency website. The respective survey of the year 2015-2016 was collected; Because a significant number of respondents did not fully disclose revenue, only firms who answered the revenue in both 2015 and 2016 were selected. This decision is due to many of the constructs (described in the next section) are operationalized by variables that take revenue into account. The Colombian sample ends up with 807 firms.

3.3 Constructs and proxies

The scales that comprised the measurement model are based on past research (Macedo-Soares, Barboza e Paula, 2016; Macedo-Soares, Paula e Mendonça, 2017; Paula e Silva, 2017, 2018a; b). All constructs with the exception of AC were considered reflexive, based on the theory that latent constructs cause the behavior of the measured variables(Hair *et al.*, 2014). The use of the proposed proxy in the formulation of the AC is described in the next section, all proxies were based on the literature review presented in the previous chapter. The following table presents the description and proxies of each construct for Colombia (Table 2).

Construct proxies – Colombia (2015-2016)

Construct	Proxy name	Proxy format
Product Innovation	Total New or improved goods/services – **IprodTotal**	Formula: Total number of new goods or service + total number of improved goods or services
Process Innovation	Total new or improved process- **IProcTotal**	Total Number of process innovations introduced

Absorptive Capacity	Average Internal R&D spending/total revenue -Int R&D- **IntR&D**	0 – 100%
	Average R&D personnel level of education- **QualisPers**	Formula: [Num of doctors*4 +Num of masters*3 +(Num of Undergrads +Num of specialization) *2 + Num of technical degrees] /4
	Average R&D training spending/total revenue- **InttrainR&D**	0-100%
	Average Personnel involved in R&D- **PersR&D**	0-100%
Diversity	Partners diversity- **Divers.Parc**	Formula: (Suppliers + Clients + competitors + consultants + universities + technology Development centers + Research Centers + Technological parks + Regional Competitive Center + International organizations + Government)/11
	Geographical Diversity- **Divers.Geo**	(Suppliers/Foreigner partners + Clients/Foreigner partners + Competitor /Foreigner partners + Consultants/Foreigner partners + Universities/Foreigner partners + Technology development centers/ Foreigner partners + Technological parks/Foreigner partners + Regional competitive center/Foreigner partners + International organization/Foreign partners + government/Foreign partneres)/11
	Functional Diversity- **Divers.Func**	Formula: total (Machinery and equipment Acquisition + Information and communication technology + Innovation marketing + Technology Transfer + Technical assistance and Consultancy +Engineering and Industrial Design +Education and Specialized training)/**Divers.parc**/8

	%Revenue from innovation/Total Revenue- **%Innov/Rev**	0-100%
Financial Performance	%Exportation of innovation/Total Revenue- **%Exp/Ver**	0-100%

Table 1- Colombia construct proxies

Notably, The diversity proxies are based on the constructs proposed in (Macedo Soares, Silva Barboza e Oliveira Paula, de, 2016). The diversity in Alliances portfolios has three dimensions:**The partners diversity** takes into account the different types of partners the firm has relationships with; The **Geographical diversity** regards the number of different partners both on the same country(local) and foreigners partners; **Functional diversity** regards the reason behind these alliances.

3.4 Statistical Method

This section describes the method used to test the hypothesis along with all the stages necessary to proceed. To study the relationships among multiple variables and constructs that are not directly observed, this research employed structural equation modeling (SEM). Briefly speaking, this method is a family of statistical models whose goals is to explain the relationships among multiple variables. Constructs that are unobservable or cannot be measured directly also called latent factors (represented by multiple variables) are employed on multiple equations analyses seeking to paint the relations between them. (Hair *et al.*, 2014)

The SEM method estimated a series of separate, but interdependent, multiple regression equations simultaneously by specifying the structural model on the statistical program AMOS/SPSS. This method needs a well fundamental theoretical basis as the relations are specified a priori (before the model). As a consequence, this current research is organized in the steps summarized in the 3.2 section and further explained in this present one.

Before proceeding in the steps of analysis, there is a need to state that only cases where respondents answered all the questions concerning the variables used in this research were selected so that no missing value analysis was required.

The Structural Equation Modeling (SEM) was chosen to test the research hypotheses due to its ability to examine a series of dependence relationships simultaneously(Hair *et al.*, 2014). All the quantitative analysis was conducted in SPSS 23 and AMOS 23:

The first step after data collection was an exploratory phase on the variables' behavior. In this regard, there was the calculation of descriptive statistics of the sample's variables. Next, all variables were standardized (by calculating the Z-score) to make comparisons more easily observable. Then, Person's correlations were run to check underlying relations among them. This first descriptive part provided insights about the sample.

A couple of tests were run to assess further these and other assumptions, notably the multivariate normality among the variables as they are required to a SEM (Maximum Likelihood estimation). The first formal tests were the Kolmogorov and Shapiro-Wilk tests on univariate normality. If those tests rejected the null hypothesis of normality, it indicated a non-normal distribution and as a consequence also rejected multivariate normality(Hair *et al.*, 2014). Unfortunately, due to the skewness of data that is usually seen on the survey's data all variables did not present a normal distribution. However, the Maximum Likelihood estimation which is proven to be robust to violations of the normality assumption (Olsson *et al.*, 2000).

Another important checking was searching for the common method bias (CMB). For this goal, two methods were used. First, Harman's single-factor test, as indicated by (Podsakoff *et al.*, 2003). The procedure was also done through an EFA with the number of factors to be extracted fixed at 1. If the single factor generated does not explain more than 50% of the variance, there was no indication of CMB. A second test conducted was the common latent

method (ibid.), where a common factor (CF) was used to detect the common variance among all the variables on the model. Regression lines were created with all the variables and CF and later constrained to the same regression weights; the estimates found indicates the common variance.

As the next step, it is necessary to check if the set of observable variables can are appropriate to identify the latent constructs. The analysis considers the absorptive capacity (AC) as a formative construct and utilizes variables observed in the literature to calculate it. First, we conducted an exploratory factor analysis (EFA) model, intended to produce perpendicular factors to calculate the final AC indicator by the square-root of the sum of all squared factors. The EFA, using principal component analysis, was conducted only on the proxies of absorptive capacity based on literature research (see Table 1). The varimax orthogonal rotation was selected, and the number of factors was chosen by Kaiser's criterion eigenvalues and the scree-plot method.

Once with the perpendicular factors, the factors were calculated by summated-scales of the variables whose loadings were 0.7 or more. After, the construct's indicator was calculated by the square root of the summated scales squared as indicated by the formulas below:

$$AC1\ (Colombia) = (ZintR\&D + ZInttrainR\&D)/2$$
$$AC2\ (Colombia) = (-ZQualisPers + ZPersP\&D)/2$$
$$AC_{total}(Colombia) = \sqrt{AC1^2 + AC2^2}$$

In the particular model, as shown in Table 5 from the results section, zQualispers (Qualification of the personnel) showed a similar but inverted load with the variable Zint.train (Training Intensity), hence the first variable was multiplied by -1 when calculating the summated scales for its factor. Using each factor extracted from the EFA, it was created two variables representing the dimension of AC, and both are used to formulate the final construct.

The next step was conducting a confirmatory factor analysis (CFA). The goal was to test how well these proposed proxies represented the constructs (Hair *et al.*, 2014). The model used the variables related to the constructs Diversity and Financial Performance.

Due to the fact that in the analysis of structural equation modeling and CFA there are estimates of various parameters of the model's covariance matrix ($\hat{\Sigma}$) which are compared to the sample covariance(S) matrix, the following tests are made to assert the model fit (Sawyer *et al.*, 1984):

Firstly, this study utilized the Chi-square test (χ^2) as an absolute fittest. This particular one provides a test of the closeness between $\hat{\Sigma}$ and S, the smaller the value of the χ^2 compared to the degree of freedom indicates the better is the fit of the model. Secondly, related to the indices of incremental fit this work utilizes the following thresholds: CFI (Comparative fit indexes) above 0.9(Hair *et al.*, 2014) (Bentler,1990); The CMIN(CMIN/DF) below five; and RMSEA (Root mean square error approximation) less the 0.08 (Hutchinson e Olmos, 1998).

The following considerations about the validity of the constructs were made on the CFA. On convergent validity, all standardized loads of the variables should be higher than 0.7, and all the constructs' average variance extracted (AVE) should be higher than 0.5. On discriminant validity, the AVE of each construct should be greater than the squared estimation correlations between two constructs. Also, the construct reliability (CR) coefficient should measure above 0.7 for all constructs(Fornell e Larcker, 1981). Finally, on nomological validity, the between construct's variances should be according to the theory, all the variances should be significant and low. The calculations of both CR and AVE are depicted in the following formulas (Hair *et al.*, 2014), where λ is the factor loading of the estimates and n is the number of observed variables:

$$CR = \frac{(\sum_{i=1}^{n} \lambda_i)^2}{(\sum_{i=1}^{n} \lambda_i)^2 + (\sum_{c=1}^{n} \delta_i)}$$

$$AVE = \frac{\sum_{i=1}^{n} \lambda_i^2}{n}$$

Lastly, for discriminant validity, each squared estimated correlation among constructs should be lower than the AVE extracted for each one. For nomological validity, the behavior of the covariances should be according to the theory.

Afterward, structural equation modeling (SEM) was utilized to investigate the hypothesis. SEM is a statistical multivariate methodology that uses a series of structural(regression) equations simultaneously and pictorial modeling to have a clear conceptualization of the theory understudied. (Byrne, 2016; Hair *et al.*, 2014). Other benefits of the SEM methodology: contrary to other multivariate techniques, SEM provides estimates of the error parameters making it reliable when dealing with it; The possibility of studying structural relations between variables not directly observed makes this method safe when investigating the proposed research questions.

To represent moderation between Absorptive Capacity and Diversity, it was used as the mean-centering technique described in (Little, Bovaird e Widaman, 2006). By this technique, a new construct was made of the standardized multiplication of the variables of Diversity with the Absorptive Capacity, reduced by its mean. The errors were also correlated and included in the SEM analysis.

Finally, the model was evaluated through multiple models fit indexes, namely chi-square, CFI, RMSE, as well as the parameters estimated for the relations of the variables. The same limits for the indicators used for the CFA were used for the SEM. The parameters estimated were used to assert about the support of this dissertation's hypothesis.

4.Results

From the sample of 7947 firms that answered the survey, only 807 firms devoted effort to innovate between 2015 and 2016 and disclosed their financial records. Of these, 640 firms introduced successfully at least one new product or process innovation which represents 70.56 % and the other 29.44% haven't been able to it despite the intention.

Descriptive Statistics – Colombia Sample		
	Mean	Std. Deviation
IprodTotal	2.34	5.482
IProcTotal	1.05	4.369
IntR&D	0.0486337657	.2842355147
QualisPers	1.331.062.414	0.568499706
InttrainR&D	0.0050399100	0.0456305977
PersR&D	0.0812521749	0.1168984252
Divers.Parc	0.0974428298	0.1523567994
Divers.Geo	0.0359355638	0.0869249987
Divers.Func	0.1014082172	0.1526609801
%Innov/Rev	6.60	13.845
%Exp/Rev	5.22	15.326

Table 2- Descriptive Statistics - Colombia

Looking the table 2 is possible to assert the following considerations:

- **IprodTotal**- Indicates the sum of all product innovation(quantity). Observing the mean, it is possible to claim that in average the firms were able to introduce 2.34 product innovation(mean);
- **IProctotal-** Indicates the sum of all process innovation(quantity). It can be in average firms were able to introduce at least 1.04 process innovation;
- **IntR&D-** Firms that aim to innovate usually spend around 5% of its revenue in internal Research & Development;
- **InttrainR&D-** The Mean is less than 0.005 indicating that firms did not invest heavily in R&D training;
- **PersR&D-** The mean of 0.0812 indicates that usually only 8.12% of the personnel is involved in Research & development;

- **%Innov/Rev –** the Innovation represented 6% of the revenue with the maximum 100%;
- **%Exp/rev-** the revenue from innovation represented 5.22% in the export sales with a maximum of 100%;

Table 3 shows the person's correlation among variables. By using the z-scores of all variables, is possible to avoid scale problems and to better compare variables.

Correlation of Z-scored Variables

	ZiprodTot	ZiprocTot	ZrevGrowth	ZrevInov	ZexpInov	ZintR&D
ZiprodTot	1	.370**	-0.025	0.218**	0.151**	0.084*
ZiprocTot	0.370**	1	-0.014	0.065	0.022	0.069
ZrevGrowth	-0.025	-0.014	1	-0.031	-0,02	0.021
ZrevInov	0.218**	0.065	-0.031	1	0.594**	0.051
ZexpInov	0.151**	0.022	-0.02	0.594**	1	0.028
ZintR&D	0.084*	0.069	0.021	0.051	0.028	1
ZinttrainR&D	0/005	0.003	-0.008	0.023	0.015	0.737**
ZPersR&D	0.078*	0.008	-0.019	0.152**	0.182**	0.117**
ZqualisPers	0.130**	0.031	0.04	0.070*	0.068	0.058
Zdivers.Parc	0.314**	0.256**	-0.035	0.167**	0.179**	0.004
Zdivers.Func	0.199**	0.154**	-0.035	0.156**	0.150**	0.025
Zdivers.Geo	0.276**	0.248**	-0.019	0.124**	0.177**	-0.001
	ZinttrainR&D	**ZPersR&D**	**ZQualisPers**	**Zdivers.Parc**	**Zdivers.Func**	**Zdivers.Geo**
ZiprodTot	0.005	0.078*	0.130**	0.314**	0.199**	0.276**
ZiprocTot	0.003	0.008	0.031	0.256**	0.154**	0.248**
ZrevGrowth	-0.008	-0.019	0.04	-0.035	-0.035	-0.019
ZrevInov	0.023	.152**	0.070*	.167**	0.156**	0.124**
ZexpInov	0.015	.182**	0.068	.179**	0.150**	0.177**
ZintR&D	.737**	.117**	0.058	0.004	0.025	-0.001
ZinttrainR&D	1	.076*	0.031	-0.013	-0.011	-0.019
ZPersR&D	0.076*	1	-0.152**	0.018	0.094**	0.023
ZqualisPers	0.031	-.152**	1	.225**	0.167**	0.125**
Zdivers.Parc	-0.013	0,018	0.225**	1	0.735**	0.720**

Zdivers.Func	-0.011	.094**	0.167**	0.735**	1	0.546**
Zdivers.Geo	-0.019	0.023	0.125**	0.720**	0.546**	1

Table 3- Pearson's Correlations

**- Correlation is significant at the 0.01(2-tailed).

*- Correlation is significant at the -.05 level(2-tailed).

The next step of the analysis was to execute an EFA on the variables that we intended to create the construct of Absorptive Capacity. Two factors were extracted (Table 4). Noticing the negative factor loading in ZqualisPers, a linear transformation was performed to invert the variable was already stated in the previous section

Absorptive Capacity – Exploratory Factor Analysis		
Variables	Factor 1	Factor 2
ZintR&D	0.930	
ZinttrainR&D	0.932	
ZqualisPers		-0.774
ZPersR&D		0.743

Table 4-Absorptive Capacity- Factors extraction

A noteworthy result of this exploratory stage is that Product Innovation (**IprodTot**) relates to Process Innovation (**IprocTo**t), revenue from innovation (**RevInov**) and most of the other variables as expected.

Once the construct of AC was formulated, the work proceeds to check the assumptions of the normality: both Kolmogorv-Sminorf and Shapiro-Wilk tests were taken. It is possible to observe at the (table 5) how these tests rejected the null hypothesis of normality. Despite that, the SEM through maximum likelihood estimation is robust in the absence of normality (Olsson *et al.*, 2000)

	Kolmogrov-Sminorf (Significance)	**Shapiro-Wilk** (Significance)
Zdivers.Geo	0.000	0.000
Zdivers.Parc	0.000	0.000
ZqualisPers	0.000	0.000
AC	0.000	0.000
ZiprodTot	0.000	0.000
ZiprocTot	0.000	0.000
ZintR&D	0.000	0.000

ZintTrainR&D	0.000	0.000
ZPersR&D	0.000	0.000
ZexpInov	0.000	0.000
ZrevInov	0.000	0.000

Table 5- Normality tests

The next step was to investigate the possible existence of common-method-bias. As described in the method section, two methods were used for it. First, Harman's Single-factor analyze returned the variance of the common factor of 22.47%. The second method, the latent factor which consists of the common estimation of all variables through a regression of a common factor, returned 0.216 (Table 2), that, squared, presents a common variance of 4.67%. Both methods indicate that common-method bias is not an issue. (Table 6).

Latent Factor estimation		
	Estimate	P
AC >Common Factor	0.216	0.057
ZiprodTot> Common Factor	0.216	0.057
ZiprocTot	0.216	0.057
Zdivers.Geo	0.216	0.057
Zdivers.Parc	0.216	0.057
ZqualisPers	0.216	0.057
ZexpInov	0.216	0.057
ZrevInov	0.216	0.057

Table 6- Latent Factor estimation

With the main assumptions already checked, there is a need to verify if the variables selected are a good representation of the constructs. In this regard, the following step was to run the CFA (Figure VIII). The Model contains only the latent variables (Diversity and Financial Performance), with its proxies: **ZrevInov**, **ZexpInov**, **ZdiversParc**, **ZdiversFunc**, **ZdiversGeo**, **ZdiversParc**. The model sets financial performance (Financial Perf) and Diversity (Divers) as exogenous/not observable variables. The following measurement of model fit can be observed in (table 7)

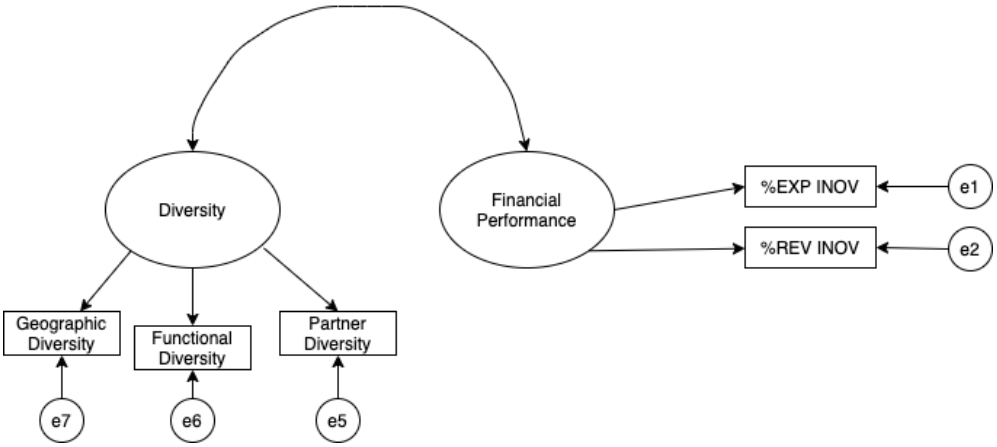

Figure 8- Confirmatory Factor Analysis - Colombia

MODEL FIT – CFA Colombia

Chi-Square			
	Chi-square	Degrees of freedom	Probability Level
Result(default model)	6.536	4	0.163
Fit measures			
Model	CFI	CMIN/DF	RMSEA
Default model	0.998	1.634	0.028

Table 7- Model Fit- CFA Colombia

About the model fit, the following tests were checked: The $\boldsymbol{\chi^2}$ of the default model was 6.5346 and the normalized **CMNI/DF** of 1.634, which is less than 3 as recommended in (Hair *et al.*, 2014). The **CFI** was way above the threshold of 0.9 at .998 indicating good of fitness; the **RMSEA** interval is under 0.08 with 0.028(estimate) also indicating a reasonably good fit. Summarily, all the tests indicate a good fit of the model.

Next, we conducted validity and reliability checks. The loadings were analyzed to assert the convergent validity and therefore supported the construct validity are (see Table 8). All the standardized regression weights were above 0.7, and AVE above 0.5. Reliability was also achieved as CR for both constructs are above a minimum of 0.7.

Validity- CFA Colombia						
Constructs	variables	S.R.W.	S.E	P-value (<0.01)	CR	AVE (Average Variance Extracted)
Financial Performance	RecInov	0.742		-	0.746	0.595
	ExpInov	0.800	0.268	***		
Diversity	Diversparc	0.979		-	0.866	0.687
	DiversFunc	0.750	0.030	***		
	DiversGeo	0.735	0.036	***		

Table 8- Model Fit Validity - CFA Colombia

***- 0.05 p-value (2-tail)

The next step was to check the discriminant validity (Table 9). The Square correlation between constructs was less than the AVE of each construct, therefore indicating that each construct is unique. For nomological validity, the covariance between the construct was significant but low, as expected based on the literature(Macedo-Soares, Paula e Mendonça, 2017).

Discriminant and Nomological Validity			
	AVE	Squared Correlation	Covariances
Diversity	0.595	0.054	0.204 **
Financial Performance	0.687	0.054	0.204 **

Table 9 -Discriminant and Nomological validity

Once checked the validity of the constructs and dealt with the exploratory stage of the analysis, a critical step of specifying the measurement model was made. The following SEM (Figure XIX) was run to check the hypothesis stated in the previous chapters. The first stage was to analyze the model fit of the model. In Table 10, it is possible to see that the model had a good fit.

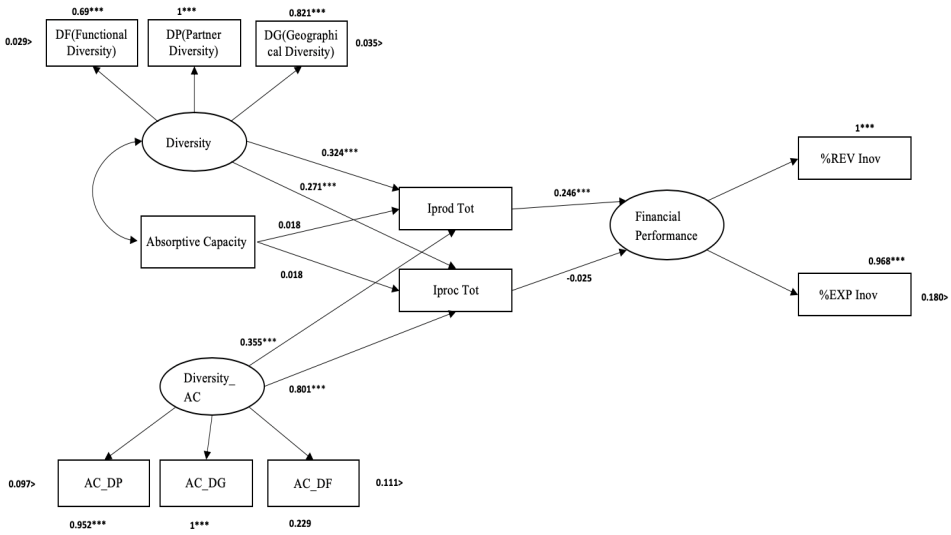

Figure 9- Structural Equation Modeling - Colombia

Chi-Square			
	Chi-square	Degrees of freedom	Probability Level
Result(default model)	146.031	35	0.000
Fit measures			
Model	CFI	CMIN/DF	RMSEA
Default model	0.967	4.172	0.063

Table 10 - Model Fit - SEM Colombia

The χ^2 of the default model was significant and the normalized **CMNI/DF** of 4.172 which is above 3 but less than 5 indicating a reasonable fit (Hair *et al.*, 2014); The **CFI** at 0.967 and the **RMSEA** interval under 0.063 also support the fit of the model. The second stage was to check the maximum likelihood estimates of our model thus asserting the hypothesis of our model(Table 11).

Estimates – Structural Equations Modelling Colombia

Relationships	**S.R.W.**	**S.E.**	**P (<0.01)**	**Hypotheses Test**
Divers → ZiprodTot	0.324	0.040	***	H1a: Supported

Divers → ZiprocTot	0.271	0.040	***	H1b: Supported
Divers_AC → ZiprodTot	0.355	0.286	***	H2a: Supported
Divers_AC → ZiprocTot	0.801	1.047	***	H2b: Supported
AC → ZiprodTot	0.018	0.051	0.580	H3a: Rejected
AC → ZiprocTot	0.018	0.052	0.592	H3b: Rejected
ZiprodTot → Fin Perf	0.246	0.026	***	H4a: Supported
ZiprocTot → Fin Perf	-0.025	0.025	0.533	H4b: Rejected

Table 11- Estimates - SEM Colombia

Examining the standardize regression weights and the p-values are possible to analysis each hypothesis:

I)Hypothesis 1a and 1b were supported, indicating a positive relationship between Diversity and Product and Process Innovation respectively.

II)Hypotheses 2a and 2b were also supported, indicating the moderation role of AC on the relationship between diversity and Innovation performance.

III)Hypotheses 3a and 3b were rejected, implying that no. the direct relationship between AC and Innovation performance can be supported.

IV)Hypothesis 4a was supported, indicating the product innovation impact on financial performance; and Hypothesis 4b was rejected, revealing that the impact of process innovation was not supported.

There are considerations of these results in the next chapter and further discussion on how it relates to the literature review introduced in the second chapter.

5. Discussion

The results of previous studies were replicated in this research in the context of Colombian manufacturing firms. In general, the results of this work complements several ones that investigated the relationship between innovation and performance. Amidst a different regional context, the role of diversity of alliance portfolio diversity was found to be relevant indirectly affecting both product and process innovation and indirectly financial performance.

To investigate the role of diversity on innovation performance (IP), there is a first assessment on the first two relations: (1) Diversity of Alliance Portfolio (Divers) on total product innovation (ZIProdTot) and (2) Diversity of Alliance Portfolio (Divers) on total process innovation(ZiprocTot), each analyzed separately. The standard estimates were positive and significant, consequently supporting the Hypotheses 1a and 1b. The relationship of Product Innovation and Diversity supports the one observed in (Faems *et al.*, 2010). Further, the Alliances portfolio serves as sources of external knowledge that positively impact innovation and diversity, one of its attributes, is demonstrated to affect this relationship (Macedo-Soares, Barboza e Paula, 2016).

The influence of diversity can be explained in different ways as it serves to expand the breadth of perspective, access to cognitive resources, access to various knowledge resources and new capabilities that were not available to the firm at first place (Duysters *et al.*, 2012; Eisenhardt e Ozcan, 2009; Goerzen e Beamish, 2005).

On the other hand, the fact that diversity was found to impact the innovation performance was contrary to the conclusion found in (Macedo-Soares, Paula and Mendonça, 2017) that used the introduction of radical and incremental Innovation instead as proxies for innovation performance. These authors

found that, even though diversity had a direct negative impact on IP, better levels of AC transform this positive relationship in a positive influence, boosting a firm's innovation performance. One of the reasons behind these observations, is the positive effects of diversity are usually observed only to a certain point, as the costs of coordination and management of the different alliances arise (Duysters *et al.*, 2012; Goerzen e Beamish, 2005; Jiang, Tao e Santoro, 2010). AC, in its turn, may change this optimal point to a higher level of diversity. Therefore, the fact that diversity on alliances portfolio affected the product and process innovation in Colombia and the behavior in the model proposed in (Macedo-Soares, Paula e Mendonça, 2017), both support the literature.

The effect on the innovation outcomes through diversity or any other external knowledge source is usually associated with the levels of AC of the firms involved in strategic alliances (Macedo Soares, Silva Barboza e Oliveira Paula, de, 2016; Paula e Silva, 2018a). Each firm approaches differently the multiple alliances, and the amount of internal research can help each on to properly recognize opportunities from alliances portfolio and other external sources of data. In the interest of checking this moderation role of AC, the hypothesis 2a and 2b were investigated. Both of them were supported, with the two relationships (product and process innovation) positive and significant. In Colombia, the fact that the moderation role of AC is positive indicates that high levels of AC boost the intensity in which diversity of the alliance portfolio affects both product and process innovation. This empirical observation represents a good contribution to the role perceived for AC on the innovation process, agreeing with findings of (Carree, Lokshin e Alvarez Alvarez, 2019).

In the case of the direct impact of AC on innovation, none of the hypotheses were supported (3a and 3b), indicated by non-significants estimations on the relationship between AC and both proxies of innovation performance. This might be related to the lower levels of AC of firms from latecomer countries such as Colombia, and lower level of technology and knowledge base, not enough to produce important results on innovation outcomes (Macedo-

Soares, Paula e Mendonça, 2017; Paula e Silva, 2018a). Similar results were found by (Paula e Silva, 2017) whose findings showed that internal R&D did not affect the innovation output of low-tech Italian manufacturing firms. This article suggested that when firms were in a low technology context, investing in internal research could be a profit drainer.

Besides, investing only in internal R&D may not guarantee better innovation performance, as it is necessary to balance internal and external R&D (Paula e Silva, 2018b). This result is consistent with the idea of complementarity between internal and external R&D introduced by Cassiman and Veugelers (2006), where the output of basic R&D is influenced by the level of external sources like using universities and research centers to acquire new information.

According to literature (e.g., Arora e Gambardella, 1994; Escribano, Fosfuri e Tribó, 2009), AC impacts external knowledge in assessing external flows and exploiting information. This idea can help explain the moderation aspect seen in Colombia where, despite affecting the impact of diversity of alliance portfolio, did not find a direct impact on innovation. Despite the rejection of the hypotheses of a positive relationship between the AC (and in its turn, internal R&D) and IP, there is still a consideration to be made on the relationship due to the construction of AC in this study. The quality of training and education of personnel is notably known to be lower in developing than in developed countries, which reflects on low levels of AC even in case of higher investments on R&D. So, the way the AC index was calculated could have impacted the results.

Regarding the impact of innovation on financial performance, only a positive influence of product innovation impact was significant (4a). That is because all variables used to reflect financial performance are related to the revenue (% of innovation in sales and export sales). While product innovation rapidly affects sales and total revenues, process innovation is supposed to affect more intensely the costs, thus impacting profits instead of directly affecting the revenue in the short term. Any impact through process innovation on sales

needs some time for firms to better price their products/services. This research only did a cross-sectional study, without any time-lag between innovation and financial performance proxies. So only the short-term impact was observable, explaining why only product innovation impacts financial performance.

The relationship between product innovation and financial performance has been supported by previous empirical studies. Faems *et al.* (2010) argued that when firms can introduce a product innovation, they usually gain market share due to more value being added to the consumers. This argument supports that innovations impact on sales and total revenues.

On the other hand, process innovation is related to increased productivity (Huergo e Jaumandreu, 2004) and lower costs (Hatch e Mowery, 1998), both impacting sales at a slower pace. Besides, the distinction between the level of process and product innovation observed in Colombia is supported by (Utterback e Abernathy, 1975) who advocated that the type of innovation sought depends on the level of maturation of the business.

This present work also speculates that the low number of successful process Innovations in comparison to the product innovation, seen at the descriptive part of the analysis, also impacted the estimation. The higher number of withdrawal on process innovation might indicate a preference for rapid returns.

6.Conclusion

6.1 Summary of the study

In a world where innovation has been sought by several companies that use it as a way of differentiation to gain competitive advantage. The study of the phenomena of innovation within firms has been subjected to multiple studies, and lately, the open innovation paradigm has been forcing firms to approach this endeavor in novel ways. Notably, the impact of external sources of knowledge became an essential aspect of developing innovation.

The aim of this study was to identify how the diversity of alliances portfolio impacts innovation and how the latter impacts financial performance. The country chosen to be studied was Colombia because of the easy access of data and for its Latin American, latecomer country context. The study investigated manufacturing firms from Colombia to answer the proposed research questions The questions were based on a literature review of the innovation field, which led to a proposed model composed of the constructs diversity of alliances portfolio, absorptive capacity, innovation performance, and financial performance: whether Diversity on Alliance portfolio impacts the innovation and financial performance of firm; and does Absorptive capacity moderateS the relation between diversity of portfolios and innovation performance?

The study proposed eight hypotheses (see section 2.7) that were tested by structural equation modeling (SEM). The data used was collected from the 8th national innovation survey of Colombia (DANE, 2020), corresponding to the years 2015 and 2016. Only firms that intended to develop innovations were used, resulting in a sample of 807 manufacturing firms.

The SEM analysis found interesting results. Most hypotheses based on the literature review were confirmed: the positive impacts of the diversity on both

product and process innovation; the moderation of AC on the relationship between the influence of the diversity on both types of innovation; and the impact of product innovation on financial performance. The results are in line with the AC and innovation management literature.

However, three hypotheses were rejected: AC did not directly affect any of the measured types of innovation, and the relationship between a process innovation and financial performance was not significant.

The findings are mostly according to the literature and the hypotheses rejected can also be explained based on previous findings. The Diversity of Alliances portfolio's role in Innovation performance was observed in addition to the moderation role of AC. Despite the majority of proposed relations been supported, it is important to emphasize this study has only focused on Colombian Firms.

This work concludes that the same relationships between AC, Diversity of Portfolio Alliances, Innovation Performance, and Financial performance seen in Development countries are also replicated in Colombia. In such a manner, This author expects that other Latin American and development countries can experience the same behavior.

6.2 Theoretical Contributions

This study has multiple theoretical contributions. Firstly, it highlights the importance of external sources outside the firm's boundaries to fuel innovation. Specifically, it highlights the importance of the diversity of the alliance portfolio as a source of knowledge. Thereby, the work contributes to the open innovation theory (Chesbrough, 2003), the literature on alliance portfolio literature (e.g., Carvalho *et al.*, 2017), and the absorptive capacity theory (Cohen e Levinthal, 1990).

Another significant contribution is the proposal of a new construct for the diversity of alliance portfolio, a novel configuration compared to the models that inspired this dissertation (see section 2.6), to measure the impact of external R&D in innovation performance. It revises the proposed concept of diversity to test it on product and process innovation and financial performance. The study also replicates relationships observed in developed countries in a latecomer country, helping consolidate the mainstream theories in a different context.

This work was successful in achieving its primary and secondary goals. The impact of the diversity on the product and process innovation phenomena was proposed by the literature review and later studied through an empirical test. The moderation of AC was also observed in the impact of diversity on two types of Innovation. The improvement of financial outcomes through effective innovation activities was also supported. These findings provide a better understanding of how manufacturing firms of Colombia behave regarding their innovation landscape.

6.3 Managerial implications

As already introduced, this study can help both policymakers and managers in their R&D efforts approaches. For the ones intending to develop innovation policies, it can provide a better understanding of how to collaborate with firms within their space to develop innovation. The government might want to provide incentives to collaboration with universities and research centers, focusing on increasing both collaboration and training of firms personnel (AC). Another policy could be fiscal incentives to R&D to more businesses being comfortable investing big sums of money in inquiry explorations. The use of international chambers of commerce and other integration efforts to increase the number of partners available to local firms.

For the managers in companies with multiple partners, a better perception of how to leverage innovation performance through AC amidst increasing coordination costs can be very helpful. The findings can also stimulate those

managers who do not possess a portfolio to search for more partners once they have their internal R&D evaluated as appropriate. Firms, with the lessons brought by this study, may choose more wisely where their research resources are spent, whether by focusing on open innovation or traditional internal development.

For managers in the Colombia context, they may choose to invest in acquiring more partners. Relying only on basic research might be a warmful approach, as they might struggle in finding short-term returns in innovation. The best approach is to use their internal research alongside the knowledge outputs of different alliances.

6.4 Limitations

Despite interesting findings, this research has several limitations. Firstly, it only used one country, thus making it difficult to generalize the conclusions to other countries. It also focused on manufacturing firms, limiting its conclusions to the firms from this section. The use of only cross-sectional data also made any casualty assertation impossible, as it does not treat some endogeneity sources, such as simultaneity and reverse causality.

Also related to the survey (Dane, 2020), the questionnaire had some subjective items that could lead to some respondent bias. The study also focused only on manufacturing firms where only respondents companies who answered all the survey's questions were used in the analysis. The use of a non-probabilistic sample(no random sampling) makes any generalization in the population, impossible.

Another important limitation concerns the way financial performance was built, as it only used the participation of innovation in sales and exportation. Therefore any conclusion on the impact of profits, ROI of innovation (Return of Investments) and on the evaluation of firms cannot be made.

Other factors in alliance portfolios that are supposed to affect the innovation performance were not considered in this research, for instance, centrality, density, structural holes, and neither other capabilities such as alliances management and relational ones.

6.5 Recommendations for Future research

This research left several research venues for scholars to explore in the future. Regarding the limitations presented in the last section, this present research only cross-sectional data. However, to better access the financial impacts of innovation, it is recommended that future research address the behavior of the variables through time. A presence of a time-lag between the constructs can provide better observation of the impacts of innovation and a possibility to investigate causality prepositions.

Related to the financial performance construct, future research might want to expand the research not only on sales but also other types of proxies, such as profits, revenue growth, the return of investment, etc. Regarding innovation performance, the investigation of other impacts of innovation, such as increased productivity, cost reduction, development of new markets, and environmental impact that could also represent this construct.

Also on the operationalization of the constructs, other variables like past research might be used to formate the AC, leading to new observations. Regarding the Colombia context, following research might investigate if the increasing number of multinational technology firms of the last years(Trivino, 2019) like Xiaomi and services company Rappi may lead to different results of the impact of AC in the country.

Another recommendation is to compare multiple countries as it could help to understand whether the different levels of AC and its impacts vary among them.There is a great availability of countries to extend the research; many use innovation surveys similar to EDIT-Dane based on Oslo Manual (e.g., Chile, Mexico, Brazil, Canada, European countries).

Lastly, this analysis neither differentiates the activity (industrial sector) nor the size of the firms. Another suggestion for the next research is to introduce control variables representing these characteristics. One example was made in Paula and Silva (2017), which separated their analysis in low- and high-tech companies. Similar distinctions based on other characteristics could be fruitful. Another possibility is to test the same model and hypotheses for different sectors, as only the manufacturing sector was used on this first analysis.

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