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Fabio de Oliveira Paula

The impact of strategic alliances and internal knowledge sources on the manufacturing firms' innovation and on their financial performance: A comparison between Brazil and Europe

Tese de Doutorado

Thesis presented to the Programa de Pós-Graduação em Administração de Empresas da PUC-Rio, as partial fulfilment of the requirements for the degree of Doutor.

Advisor: Prof. Jorge Ferreira da Silva

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Abstract

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The innovation phenomenon and how it contributes to the firms' performance is contingent on several variables, such as the firm's characteristics, its strategies, the industry and the environment. Brazil is not recognized as having a friendly environment for innovation, in contrast with most of the European countries, and this issue may be one of the reasons why the country is stuck in its economic development. Considering all mentioned above, this dissertation aims to contribute by exploring the relationships among internal and external R&D, innovation performance and financial performance in the Brazilian and in some European countries' manufacturing firms and compare both realities to learn lessons about how Brazilian firms may evolve in their innovation and financial performance. The strategy to achieve this goal was to propose a theoretical model and some hypotheses based on an extensive literature review of the innovation management and strategy fields and test them through structural equation modeling (SEM), using Bayesian estimation. In order to test the model in the Brazilian context, a sample of 2,810 manufacturing firms that conducted innovation activities from 2009 to 2011 of the Brazilian innovation survey PINTEC 2011 was used. For the European context, the sample had 2,745 manufacturing firms of 14 countries (Bulgaria, Czech Republic, Cyprus, Spain, Croatia, Portugal, Hungary, Slovenia, Norway, Lithuania, Romania, Italy, Slovakia and Estonia) of the Community Innovation Survey (CIS) 2010, which considered the years of 2008 to 2010. In the case of Brazil, a positive direct relationship between strategic alliances and innovation performance was detected. Internal R&D, on the other hand, did not influence innovation performance directly, however, it positively moderated the relationship between strategic

alliances and innovation, which is consistent with the absorptive capacity theory. Contrary to the theory, innovation performance had a negative influence on the future financial performance. This negative relationship may have been caused by the two-years lag between the proxies of the two constructs of the model, that did not identify an increasing in revenues achieved by the new products and services, but captured the negative effect of the redirection of resources from marketing and sales to innovation activities, such as internal R&D, and of the managerial costs of the strategic alliances. For the selected European countries, the empirical analysis detected a positive relationship between internal and external R&D (from strategic alliances) and innovation performance separately. Contrary to the expectations, it did not find a moderation of internal R&D on the relationship between strategic alliances and innovation performance. This was probably caused by the low absorptive capacity of the firms in the European countries studied compared to the most innovative countries in Europe and in the world. Innovation performance did not influence financial performance. This may have been caused by the absence of a time-lag between the measurement of the proxies of these two constructs, which did not to allow to identify an increasing in revenues from new products and services, that takes some time to be perceived. All the results of both models suggested that, if the main goal is an immediate improvement in the innovation performance levels, manufacturing firms should focus on either internal or external R&D. However, if the main goal is the long-term, beginning to strengthen their internal R&D is effective to improve the firms' absorptive capacity while achieving a satisfactory innovation outcome. This strategy will allow them to adopt more complex strategies, balancing internal and external R&D, effectively in the future, when the absorptive capacity level becomes high.

Keywords

Innovation Performance; Internal R&D; External R&D; Absorptive Capacity; Strategic Alliances; Financial Performance; Manufacturing Firms; Structural Equation Modelling (SEM); Bayesian Estimation; Brazil; Europe.

Resumo

Paula, Fábio de Oliveira; Silva, Jorge Ferreira da (Orientador). **O impacto das alianças estratégicas e das fontes de conhecimento internas na inovação e no desempenho financeiro das firmas de manufatura: Uma comparação entre Brasil e Europa.** Rio de Janeiro, 2017. 213 p. Tese de Doutorado – Departamento de Administração, Pontifícia Universidade Católica do Rio de Janeiro.

O fenômeno da inovação e a forma como ele contribui para o desempenho das firmas depende de várias variáveis, como as características da firma, as suas estratégias, a indústria e o ambiente. O Brasil não é reconhecido como tendo um ambiente amigável para a inovação, ao contrário da maioria dos países europeus, e isto pode ser uma das razões pelas quais o país está travado em seu desenvolvimento econômico. Considerando o que foi mencionado acima, esta tese tem como objetivo contribuir explorando a relação entre P&D interno e externo, desempenho de inovação e desempenho financeiro nas firmas de manufatura brasileiras e de alguns países europeus e comparar as duas realidades para tirar lições sobre como as firmas brasileiras podem evoluir no seu desempenho de inovação e no seu desempenho financeiro. A estratégia para atingir esse objetivo foi propor um modelo teórico e algumas hipóteses baseadas em uma extensa revisão bibliográfica dos campos de gestão de inovação e estratégia e testá-los através de modelagem de equações estruturais (SEM), utilizando a estimativa bayesiana. Para testar o modelo no contexto brasileiro, utilizou-se uma amostra de 2.810 firmas de manufatura que realizaram atividades de inovação entre 2009 e 2011 da pesquisa de inovação brasileira PINTEC 2011. Para o contexto europeu, tomou-se uma amostra de 2.745 firmas de manufatura de 14 países (Bulgária, República Checa, Chipre, Espanha, Croácia, Portugal, Hungria, Eslovênia, Noruega, Lituânia, Romênia, Itália, Eslováquia e Estônia) da Pesquisa de Inovação da Comunidade (CIS) 2010, que considerou os anos de 2008 a 2010. No caso do Brasil, uma relação positiva direta entre alianças estratégicas e desempenho de inovação foi detectada. O P&D interno, por outro lado, não influenciou diretamente o desempenho da inovação, no entanto, moderou positivazmente a relação entre alianças estratégicas e inovação, o que é

consistente com a teoria da capacidade absortiva. Ao contrário da teoria, o desempenho de inovação teve uma influência negativa no desempenho financeiro futuro. Esta relação negativa pode ter sido causada pelo atraso de dois anos entre as *proxies* desses dois construtos do modelo, que não permitiu identificar um aumento nas receitas obtidas pelos novos produtos e serviços, mas permitiu capturar o efeito negativo do redirecionamento de recursos do marketing e vendas para atividades de inovação, como P&D interno, e dos custos gerenciais das alianças estratégicas. Para os países europeus, a análise empírica detectou uma relação positiva entre o P&D interno e externo (de alianças estratégicas) e o desempenho de inovação separadamente. Contrariamente às expectativas, não se encontrou uma moderação do P&D interno na relação entre as alianças estratégicas e o desempenho de inovação. Isso provavelmente foi provocado pela baixa capacidade absortiva das firmas nos países europeus estudados em comparação com os países mais inovadores da Europa e mundialmente. O desempenho de inovação não influenciou o desempenho financeiro. Isso pode ter sido causado pela ausência de um intervalo de tempo entre a medida das *proxies* desses dois construtos, o que não permitiu identificar um aumento nas receitas de novos produtos e serviços, que leva algum tempo para ser percebido. Os resultados de ambos os modelos sugeriram que, se o principal objetivo é uma melhoria imediata nos níveis de desempenho da inovação, as firmas de manufatura devem se concentrar em P&D interno ou externo. No entanto, se o objetivo principal é o longo prazo, começar por fortalecer o P&D interno é mais efetivo para melhorar a capacidade absortiva das firmas e ao mesmo tempo alcançar um desempenho de inovação satisfatório. Esta estratégia permitirá que elas adotem estratégias mais complexas, equilibrando o P&D interno e externo, de forma efetiva no futuro, quando o nível de capacidade absortiva se tornar alto.

Palavras-chave

Desempenho de inovação; P&D interno; P&D externo; Capacidade absortiva; Alianças estratégicas; Desempenho financeiro; Empresas de manufatura; Modelagem de equações estruturais (SEM); Estimativa bayesiana; Brasil; Europa.

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List of abbreviations

AC	Absorptive Capacity
AVE	Average Variance Extracted
BEEPS	Business Environment and Enterprise Performance Survey
CFA	Confirmatory Factor Analysis
CIS	Community Innovation Survey
CNAE	National Classification of Economic Activities
CNPJ	Brazilian National Register of Legal Entity
CR	Composite Reliability
EFA	Exploratory Factor Analysis
FINEP	Brazilian Funding Agency of Studies and Projects
FP	Financial Performance
GII	Global Innovation Index
IBGE	Brazilian Agency of Geography and Statistics
IP	Innovation Performance
ISTAT	Italian National Institute of Statistics
M&A	Merges and Acquisitions
MLE	Maximum Likelihood Estimate
NACE	National Classification of Economic Activities
NSI	National System of Innovation
OECD	Organization for Economic Co-operation and Development
PCA	Principal Component Analysis
PIA	Brazilian Annual Industry Survey
PINTEC	Brazilian Innovation Survey
RBV	Resource-Based View
R&D	Research and Development
SAR	Restricted Data Access Room
SEM	Structural Equation Modeling
WoS	Web of Science

Lista de abreviaturas

AC	Capacidade Absortiva
AVE	Variância Média Extraída
BEEPS	Pesquisa do Ambiente de Negócios e Desempenho das Firmas
CFA	Análise de Fator Confirmatória
CIS	Pesquisa de Inovação da Comunidade
CNAE	Classificação Nacional de Atividade Econômica
CNPJ	Cadastro Nacional de Pessoa Jurídica
CR	Confiabilidade Composta
EFA	Análise de Fator Exploratória
FINEP	Financiadora de Estudos e Projetos
FP	Desempenho Financeiro
GII	Índice Global de Inovação
IBGE	Instituto Brasileiro de Geografia e Estatística
IP	Desempenho de Inovação
ISTAT	Instituto Nacional Italiano de Estatística
M&A	Fusões e Aquisições
MLE	Maximum Likelihood Estimation
NACE	Classificação Nacional de Atividade Econômica
NSI	Sistema Nacional de Inovação
OECD	Organização para Cooperação e Desenvolvimento Econômico
PCA	Análise dos Componentes Principais
PIA	Pesquisa Industrial Anual
PINTEC	Pesquisa de Inovação
RBV	Visão Baseada em Recursos
R&D	Pesquisa e Desenvolvimento
SAR	Sala de Acesso a Dados Restritos
SEM	Modelagem de Equações Estruturais
WoS	Web of Science

1
Introduction

> *Solve unsolved problems innovatively* – 3M past mission statement (COLLINS; PORRAS, 1996, p. 69)

It is commonly accepted that innovation is important for the firms to help them reach their goals, but it is not exactly a goal itself. It is also a popular belief that innovative companies are better than the ones that are not innovative. 3M seemed to have realized that fact and smartly used this belief as a marketing tool in a past mission statement. However, innovation development can help firms to achieve better performance in many other ways besides as a marketing tool.

Several authors consider the capacity to innovate as a very important capability to improve firms' performance and increase chances of survival in an environment increasingly competitive and full of uncertainties. Since Schumpeter, considered the precursor of the economic theory of innovation, whom introduced in the 1940s the concept of creative destruction (SCHUMPETER, 2013), by which the creation of something new destroys the current rules of an industry and deploys new ones, innovation has been considered a panacea by academics and professionals.

Nowadays, innovation has been considered even more important. Organizations of remarkable success are recognized as having, as one of their more highlighted characteristics, the ability to innovate. An example of this fact was illustrated when Bill Gates, founder of Microsoft, once said, "We always say to ourselves, we have to innovate. We need to be the first to overcome us." (GATES, 2007).

Because of the complexity and diversity of technologies, it has become very hard for organizations in the twenty-first century to work isolated. Thus, in addition to the efforts to develop innovations internally, firms increasingly seek to develop partnerships to help them to innovate more effectively, which has shown

positive results regarding to innovation performance in several cases (BELUSSI; SAMMARRA; SEDITA, 2010; FAEMS; DE VISSER; ANDRIES; VAN LOOY, 2010; FAEMS; VAN LOOY; DEBACKERE, 2005; NIETO; SANTAMARÍA, 2007). Due to the increasing importance of innovation for the firms, the Brazilian newspaper Valor Econômico, in partnership with the consulting firm Strategy&, developed a ranking of innovative Brazilian firms called *Inovação Brasil* (STRATEGY&, 2017), which, in 2017, elected Embraer as the most innovative Brazilian firm.

Some firms achieve more success than others in their efforts to innovate, both internally and through alliances. Such success is evidenced in the literature by several authors who found a positive relationship between innovation performance and financial performance (CHENG; HUIZINGH, 2014; DECAROLIS; DEEDS, 1999; FAEMS et al., 2005). Forbes magazine, in its 2016 ranking of the world's most innovative companies (FORBES, 2016), indicated the American firm Tesla Motors in the first place, followed by the also Americans Salesforce.com and Regeneron Pharmaceuticals.

Another relevant factor for the success of innovation is the environment in which the company operates, starting by the country. Brazil is at the 69th position in the 2016 ranking of the most innovative countries of the Global Innovation Index - GII (DUTTA; LAVIN; WUNSH-VINCENT, 2016), having gained one position over the previous year research. The GII ranks countries according to an index that mixes several indicators measuring innovation inputs (e.g. institutions, human resources and research) and innovation outputs (e.g. knowledge and technology outputs). Figure 1 shows all the indicators that compose the index. In contrast, European countries dominate the top positions of the list, with four from the top five countries of the ranking, and 15 countries among the 25 most innovative (see Figure 2). Besides the not very encouraging position when it comes to turn the innovative capacity into results for companies, Brazil is not in a good position even in comparison with its neighbors of South America (INFOMONEY, 2016). However, country issues are not the only reasons why Brazilian firms do not have the same innovative potential as firms from abroad. Cases of Brazilian firms that reach a world-leading innovative level in their

industries, such as the previously cited Embraer, in the aviation industry (FIGUEIREDO; SILVEIRA; SBRAGIA, 2008), and some firms in the pulp-and-paper industry (FIGUEIREDO, 2016) illustrate it. Firms' strategies, resources and capabilities may be among the other causes. The Science Technology and Industry Outlook 2008 (OECD, 2008), showed that Brazilian firms are not among the most intensive in investing in internal R&D among the world's countries' companies (see Figure 3), fact that also may influence their comparative innovation performance.

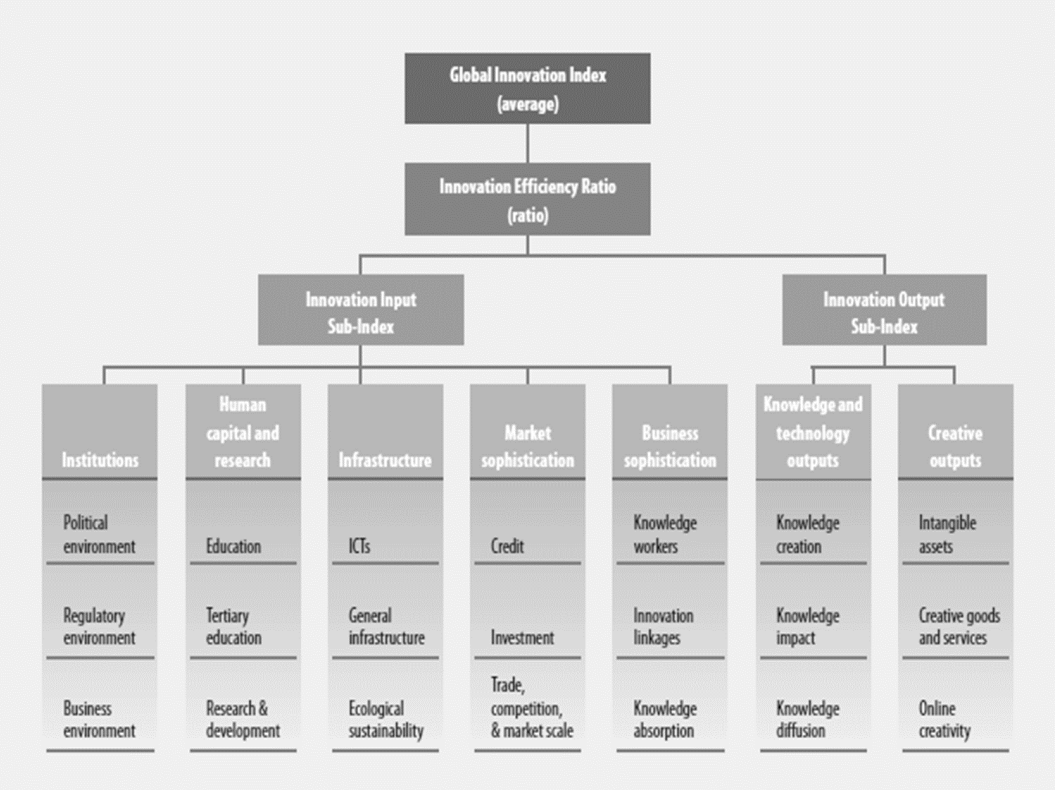


Figure 1 - Global Innovation Index indicators (DUTTA et al., 2016)

Country/Economy	Score (0–100)	Rank
Switzerland	66.28	1
Sweden	63.57	2
United Kingdom	61.93	3
United States of America	61.40	4
Finland	59.90	5
Singapore	59.16	6
Ireland	59.03	7
Denmark	58.45	8
Netherlands	58.29	9
Germany	57.94	10
Korea, Rep.	57.15	11
Luxembourg	57.11	12
Iceland	55.99	13
Hong Kong (China)	55.69	14
Canada	54.71	15
Japan	54.52	16
New Zealand	54.23	17
France	54.04	18
Australia	53.07	19
Austria	52.65	20
Israel	52.28	21
Norway	52.01	22
Belgium	51.97	23
Estonia	51.73	24
China	50.57	25

Country/Economy	Score (0–100)	Rank
Serbia	33.75	65
India	33.61	66
Kuwait	33.61	67
Panama	33.49	68
Brazil	33.19	69
Lebanon	32.70	70
Peru	32.51	71

Figure 2 - GII - Brazil x 25 first nations (DUTTA et al., 2016)

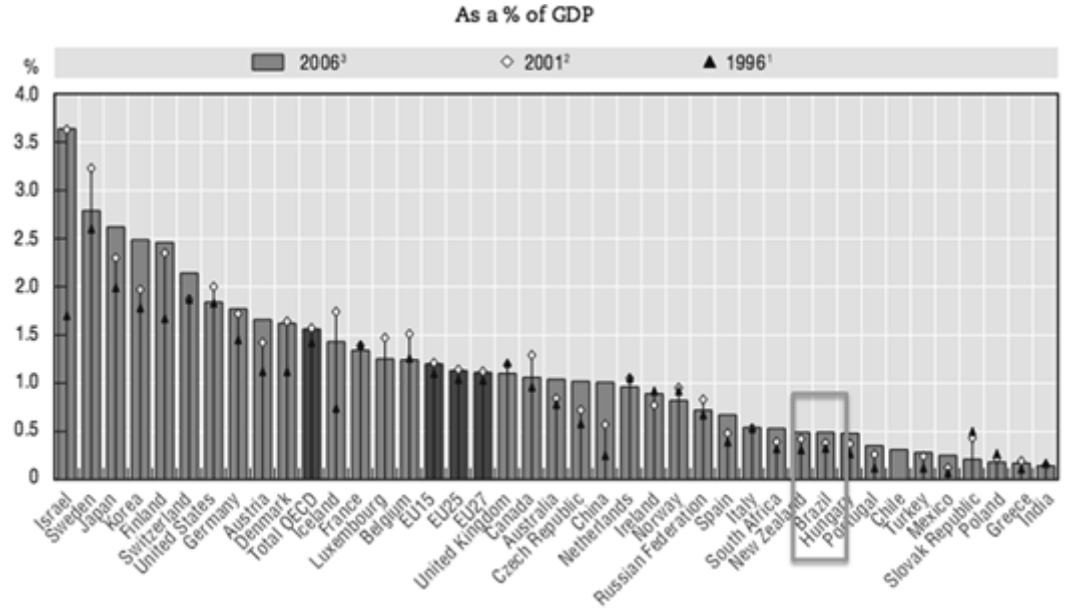


Figure 3 – Firm's R&D investments by country (OECD, 2008)

Considering these facts, it is relevant to explore the similarities and differences in the innovation processes of firms from Brazil and from countries considered more innovative, which includes the relationships among the innovation antecedents (e.g. firms' knowledge and innovation capabilities), the firms' innovation strategy (which includes the mix of internal R&D and strategic

alliances that provides R&D inputs), innovation performance and financial performance. This may help Brazilian firms to improve its innovation performance and to learn more about the conditions under which the innovation affects positively its financial performance. Additionally, it may help the Brazilian government to implement more effective policies to encourage innovation. To achieve this goal, this study proposes to compare firms from Brazil and from some selected European countries.

The type of innovation influences all the relationships listed before. According to the Organization for Economic Co-operation and Development - OECD, innovation can be classified according to the following types: i) product; ii) process; iii) marketing; and iv) organization (OECD, 2005). This study focuses on the first two types. This study also focuses only on manufacturing firms, leaving the study of other industries as a suggestion for future studies. Thereby, this dissertation proposes the following research questions:

Q1 - How do internal knowledge sources and strategic alliances influence product and process innovation performance in manufacturing firms?

Q2 - Does innovation performance have a positive impact on these firms' financial performance?

Q3 - What is the influence of the environment on these relationships in the context of Brazil and of some selected European countries?

1.1. Main research goal and secondary goals

The aim of this study is to test the research questions using a proposed model. The model operationalizes the constructs strategic alliances, innovation performance, and financial performance through proxies developed on the bases of an extensive literature review and with secondary data from Brazilian and from some selected European countries' manufacturing companies. Using statistical methods, the main goal is to explore the relationships among these constructs and the differences of these relationships in the Brazilian and the selected European

countries' contexts. Several secondary objectives are subordinated to this main goal:

i) Determine the relationship between strategic alliances and innovation performance (especially product and process innovation), regardless of financial performance, in manufacturing firms;
ii) Determine the relationship between innovation performance (especially product and process innovation) and financial performance in manufacturing firms;
iii) Determine the importance of internal knowledge sources for innovation performance (especially product and process innovation) directly and as a moderator of the relationship between strategic alliances and innovation in manufacturing firms. The firm's absorptive capacity is supposed to be of great importance in increasing its innovation capacity through alliances;
iv) Determine the similarities and differences among the countries studied according to the manufacturing firm's choices regarding strategic alliances and internal knowledge sources and in its effects on innovation (especially product and process innovation) and financial performance. This dissertation focuses particularly on the differences among Brazil and some selected European countries.

1.2. Relevance of the study

There are important research opportunities in the field of innovation management regarding to integrating the already explored relationships between the antecedents of innovation and innovation performance with the financial performance of the firms. There is a necessity to develop more complete models that integrate the open innovation strategies regarding to the choices of internal R&D and strategic alliances and their complimentary role to promote a better innovation performance with the future financial performance. Besides, the main stream literature mainly explored the most innovative countries, such as the USA and the UK, and there is another important stream that studied catching-up countries, such as Korea and China. It is supposed to be more difficult for low innovative countries such as Brazil to catch-up quickly to the most innovative

countries, as this process consists in continuous effort and evolution and there is a long distance between these two realities. Therefore, it is an interesting research venue to compare low innovative countries with moderate innovative ones, that are only a few steps ahead in their innovative capacity. Exploring the relationships among the innovation strategies, innovation performance and financial performance of firms in moderate innovative countries may bring interesting lessons to firms of low innovative countries such as Brazil.

In order to fill these gaps, this dissertation did an extensive research to explore possibilities of innovation improvements and to understand the conditions under which the innovations generated affects positively the financial performance, focusing on aspects related to the investments in internal knowledge sources and to the formation and operationalization of strategic alliances to generate and apply innovation in Brazil and in the some selected European countries that are moderate innovators. The study of the relationship between innovation and financial performance in Brazilian firms is still underdeveloped. Only since the year 2000 has Brazil had a database of innovation activity indicators (PINTEC), and there have been few studies on the subject (e.g. BRITO; BRITO; MORGANTI, 2009; JUNIOR; LIMA; LAZARO, 2011; KATO; GOBARA; ROSSONI; CUNHA, 2008; MACHADO; CABRAL; MATOS, 2015; MACULAN, 2005; RUIZ; BHAWAN, 2010). None of the latter studies focused on the relationships among innovation performance, internal knowledge sources and strategic alliances.

The main academic contributions of this dissertation consist in integrating the concepts of internal and external R&D, innovation performance and financial performance in a theoretical model; understanding if the presence of manufacturing firms in a more innovative environment, such as the selected European countries, favors the innovation performance of these firms, even if these countries are not advanced but moderate innovators, compared to Brazil, which is a low innovator; and exploring the effect of these different contexts on the alliances, on the internal knowledge sources and on the way the innovation performance affects these firms' financial performance. The study takes a step ahead in the innovation theory studying the different impacts of alliances and

internal knowledge sources in product and process innovation to ensure better performance. The comparison between Brazil and some European countries helps researchers to understand the similarities and differences of these relationships in different contexts, which increases the validity and applicability of the theory. It also serves as a reference for future studies about innovation, alliances and performance due to the extensive bibliographic research.

For practitioners, the work has relevance because it proposes a model that helps to choose the strategies that manufacturing firm may adopt (e.g. investments in internal R&D, more efficient alliance types) to develop product and process innovations effectively and to make innovation turn into financial performance. The study may also, by comparing the results in the selected European countries and in the Brazilian context, help the Brazilian firms' managers to overcome the challenges posed by the environment by lessons learned from these European countries' companies. It may also help the Brazilian governmental agencies to formulate better innovation policies.

1.3. Delimitation of the study

The first delimitation of the study is that more constructs and variables affect innovation and financial performance than the ones considered in the proposed model. General corporate strategies and strategic alliances regarding other different activities than generating innovation, such as distribution, pricing and marketing may affect both innovation and financial performance and were not included.

Another delimitation is that the dissertation considers only Brazilian and European firms in its analysis. Many other countries could be considered in the analysis, however this two regions were the ones focused. One more delimitation is that the dissertation worked only with manufacturing firms, which is a very important industrial sector in any country's economy. The study of firms from other industries was included as opportunities for future studies in the final chapter.

Another delimitation is the time-frame. This dissertation worked with secondary data from Brazilian firms of the survey PINTEC 2011, which contemplates data about innovation activities from 2009 to 2011; and of the survey PIA-Empresas 2009 to 2013, contemplating financial performance variables of the indicated period. The data from the selected European countries' firms is of the survey CIS 2010, which contemplates data about innovation activities and financial performance from 2008 to 2010.

Finally, only product and process innovation, among the four types of innovation according the Oslo Manual, were considered. This decision was taken because, although marketing and organizational innovations can also contribute to financial performance (GUPTA; MALHOTRA; CZINKOTA; FOROUDI, 2016; TOALDO; DIDONET; LUCE, 2013), the two first types are more directly related to financial performance by improvements in revenues and decreases in costs that they may promote.

2
Theoretical References

This chapter is organized in eight parts. The first part describes the bibliographic and bibliometric research done by the author to guarantee that most of the relevant literature about innovation, strategic alliances and performance was covered. Parts two, three and four separately review the literature about each of the three main concepts that are covered by the theoretical model of this dissertation: innovation, strategic alliances and performance. Parts five through seven review the works that paved the theoretical foundation of the relationships proposed in the model. Part five covers the relationship between innovation and strategic alliances, focusing on the absorptive capacity concept. Part six studies the relationship between innovation and financial performance. And part seven reviews the effects of the environment on the constructs cited above. Finally, part eight presents the proposed model and the hypotheses that formed it. The model proposes that there are positive relationships among strategic alliances, innovation performance and financial performance of the firms and that the environment in which they operate should interfere in all the three constructs and in the relationships among them.

2.1.
Construction of the literature review

The literature review was constructed by the identification of relevant articles in the fields of Strategic Alliances, Innovation and Performance. The research was conducted on *Web of Science (WoS)* database, which includes most of the main journals with high impact factor in these fields of research. The search used keywords related to the concepts mentioned above. Only peer-reviewed articles of the period between 1997 and 2015 were considered among all types of documents available (as this bibliographic and bibliometric study was conducted in 2015, this was the most recent year. New articles from 2015, 2016 and 2017

were included later in the theoretical references). By being subjected to a rigorous process of review and approval by other researchers, articles can be considered as "certified knowledge" (RAMOS-RODRÍGUEZ; RUÍZ-NAVARRO, 2004). The following table summarizes the search parameters used:

Criteria	Values
Period	1997 – 2015
Keywords	Innovation AND Performance AND Network OR Cooperation OR Collaboration OR Partnership OR Alliance OR Coopetition
Document type	Article
Research field	Business Economic

Table 1- Parameters used in WoS search

The research returned over 2,600 articles. From that list, the abstracts were selected to be read using the following heuristic created by the author to prioritize more recent studies:

i) All articles from 2015;
ii) Articles from 2014 with at least one citation;
iii) Articles from 2005 to 2013 with an average of annual citations equal or higher than 1.3 from journals with an impact factor equal or higher than 2.5;
iv) Articles from 1997 to 2004 with an average of annual citations greater than or equal to 3.8.

The limits of citations of the groups of years (3.8, 2.5 and 1.3) were inspired by the Qualis Capes periodic evaluation of Medicine A1, A2 and B1 journals from 2009 (JUKEMURA; DINIZ, 2015). They were not inspired by the limits regarding Business journals as these limits are much lower and would bring too many articles for the selection, making the abstracts' analysis infeasible.

After reading the abstracts, 264 articles were selected to be fully read. These articles were summarized and their key information was recorded in a spreadsheet elaborated for this specific purpose in a way to allow the examination of the contribution of each of them to the construction of the theoretical model, the assumptions, the constructs and the proxies.

A bibliometric study was also conducted to identify the most influential works in the field of study of Innovation, Alliances and Performance (PAULA; CALDAS; SILVA; 2016). It consisted of: i) citation analysis – that identifies the most cited authors in a set of selected works. It considered that the most cited works have more influence in the discipline than less cited; and ii) co-citations analysis - that identifies potential similarities among pairs of articles by the frequency with which they were referenced together, enabling to group articles into clusters, each one representing a knowledge area. These complementary analyses were conducted only with the articles from 1997 to 2014 because at the time of the analysis the year of 2015 was incomplete. The 50 most cited articles of the citation analysis, independent of their year of publication, were added to the list of 264 articles previously selected to be read and are listed in Table 2.

Additionally, the co-citation analysis identified the most relevant themes that formed the theoretical framework of the field of study. They are Innovation (G1), Strategic Alliances (G2), Learning / Knowledge (G3) and Resource-based View (G4) (PAULA et al., 2016). Figure 4 shows the intellectual map formed by the co-citation analysis with the four groups and the 20 most cited articles of the citation analysis.

	Articles		1997 to 2014 *n* = 2.410
1	Cohen & Levinthal, 1990	682	28,3%
2	Powell, Koput & Doerr-Smith; 1996	458	19,0%
3	Burt; 1992	344	14,3%
4	Barney; 1991	313	13,0%
5	March; 1991	289	12,0%
6	Dyer & Singh; 1998	286	11,9%
7	Ahuja; 2000	281	11,7%
8	Kogut & Zander; 1992	276	11,5%
9	Uzzi; 1997	260	10,8%
10	Winter & Nelson; 1982	252	10,5%
11	Granovetter; 1973	252	10,5%
12	Chesbrough; 2003	237	9,8%
13	Teece, Pisano & Shuen; 1997	234	9,7%
14	Hansen; 1999	225	9,3%
15	Lane & Lubatkin; 1998	220	9,1%
16	Teece; 1986	218	9,0%
17	Grant; 1996	213	8,8%
18	Nahapiet & Goshal; 1998	210	8,7%
19	Laursen & Salter; 2006	205	8,5%
20	Granovetter; 1985	204	8,5%
21	Zahra & George; 2002	202	8,4%
22	Baum, Calabrese & Silverman; 2000	200	8,3%
23	Mowery, Oxley & Silverman; 1996	194	8,0%
24	Eisenhardt; 1989	193	8,0%
25	Nonaka; 1995	190	7,9%
26	Tsai; 2001	188	7,8%
27	Fornell & Larcker; 1981	179	7,4%
28	Nonaka; 1994	172	7,1%
29	Szulanski; 1996	169	7,0%
30	Gulati; 1998	168	7,0%
31	Podsakoff; 2003	168	7,0%
32	von Hippel; 1988	168	7,0%
33	Uzzi; 1996	166	6,9%
34	Hamel; 1991	160	6,6%
35	Tsai & Goshal; 1998	156	6,5%
36	Hagedoorn; 1993	153	6,3%
37	Stuart; 2000	152	6,3%
38	Henderson & Clark; 1990	151	6,3%
39	Aiken, West & Reno; 1991	145	6,0%
40	Armstrong & Overton; 1977	141	5,9%
41	Podsakoff & Organ; 1986	141	5,9%
42	Cohen & Levinthal; 1989	137	5,7%
43	Gulati, Nohria & Zaheer; 2000	136	5,6%
44	Eisenhardt & Martin; 2000	134	5,6%
45	Levinthal & March; 1993	134	5,6%
46	Rowley, Behrens & Krackhardt; 2000	134	5,6%
47	Dyer & Nobeoka; 2000	131	5,4%
48	Kale, Singh & Perlmutter; 2000	131	5,4%
49	Wernerfelt; 1984	128	5,3%
50	Penrose; 1959	127	5,3%

Table 2 - 50 most cited articles of the citation analysis (PAULA et al.; 2016)

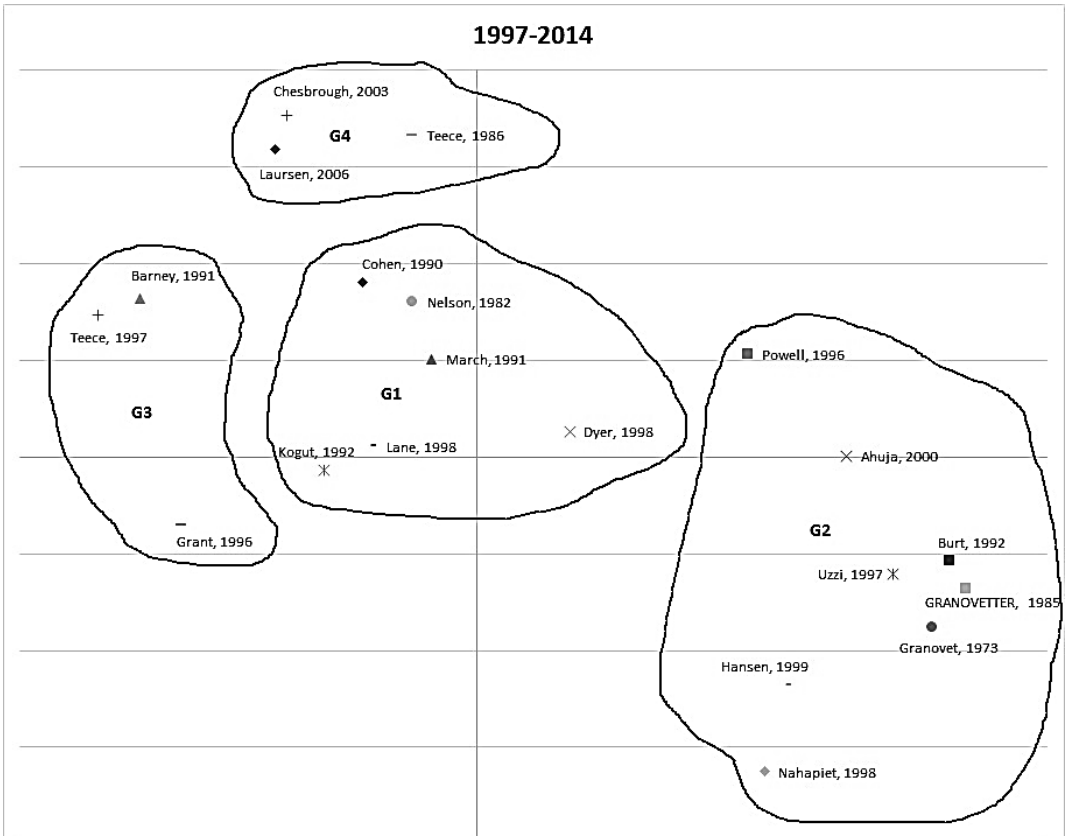


Figure 4 - Intellectual map (PAULA et al., 2016)

2.2. Innovation

After Schumpeter, several authors studied the innovation phenomenon from various facets (e.g. BOWER; CHRISTENSEN, 1996; 2013; LUNDVALL, 2007; TIDD; BESSANT; PAVITT, 2013) Most authors agree that innovation should not be a company's final goal. Innovation should be a strategy used when it presents strategic fit, or in other words, when it is a coherent and consistent strategy considering all the strategically significant factors (HOFER; SCHENDEL, 1978), allowing to leverage the strengths and minimize the weaknesses of the organization, to seize opportunities and to mitigate the macro-environmental threats (BARNEY, 2011).

The academy proposes diverse definitions for innovation. All the definitions agree with the concept that innovation is not only the generation of good new ideas, but also the process of making them evolve to reach practical usage (TIDD et al., 2013). DeCarolis et al. (2009) defined innovation as a result of the development of internal knowledge or acquisition of external knowledge, and its

application. For Fagerberg, Mowery and Nelson (2009), there is an important distinction between invention and innovation. While invention is the creation of an idea of a product or a process, innovation is putting the idea into practice. Many times, invention and innovation occur in an immediate sequence, but, in some occasions, they happen with a considerable time-lag between them.

According to the Frascati Manual (OECD, 2002), "innovation is the process that includes the technical activities, design, development, management and results in the commercialization of new (or improved) products, or the first use of new (or improved) processes" (OECD, 2002). Freeman and Soete defined innovation as "all technical, commercial, project, manufacturing, and management activities that are evolved in marketing a new (or better) product or in the first commercial use of a new (or better) process or equipment." (FREEMAN; SOETE, 1997). These definitions also differentiate innovation from invention. They make it clear that invention is only one activity of the innovation process.

The study of innovation is strongly justified. Several authors presented various reasons for a company to invest in innovation. For Tidd et al. (2013), innovation is a central strategy for firm's survival and growth and is associated with success. Since the 80s, the growing instability of the competitive environment, with shorter product technology life cycles, has forced firms to adopt an innovation strategy to increase its technological base (NIJSSEN; VAN REEKUM; HULSHOFF, 2001). Innovative firms usually succeed and grow more than non-innovative ones, gain more market-share and profit more (STATISTICS CANADA, 2006 apud TIDD et al., 2013). Porter (1990) affirmed that firms obtain competitive advantages through innovative actions. Lee and Grewal (2004) said that firms should adopt and assimilate new technologies to build and sustain competitive advantage.

Innovation and competitive success are closely linked in all types of industries, from high-tech industries to industries that demands low technology (TIDD et al., 2013). Many authors studied empirically the effects of innovation on the company's financial performance (CHENG; HUIZINGH, 2014; DECAROLIS; DEEDS, 1999; FAEMS el at., 2005) and attested its importance as

a strategy that helps to improve the firm's performance as well as to increase the chances of survival in today's uncertainty (TEECE, 2007) of various industries and business environments.

2.2.1. Classifications of innovation

The literature and governmental organizations classify innovation in diverse ways. This Section describes some of the most used by the academy and the ones considered in the analysis' part of this dissertation.

Mainly focusing its goals, Schumpeter (2013) classified innovation according to five types: i) introduction of new products; ii) introduction of new production methods; iii) new markets; iv) development of new sources of raw materials and other inputs; and v) creation of a new industrial organization, either by creating a monopoly or by fragmentation of a monopoly.

Due to the increasing importance of innovation, especially in turbulent environments where uncertainty is growing (EMERY; TRIST, 1965), the OEDC (Organization for Economic Co-operation and Development), an organization founded in 1961 and composed of 34 countries, created the Oslo Manual in order to conceptualize innovation and unify the way to collect data about the phenomenon by researchers and countries throughout the world (OECD, 2005). The Oslo Manual proposed a classification focused on the objectives of innovation, similarly to Schumpeter. The institution classified innovation according to the following types: i) product innovation; ii) process innovation; iii) marketing innovation; and iv) organizational innovation. This study focuses on product and process innovation. Below are found the definitions of these two types of innovation according to the Oslo Manual:

> *A **product innovation** is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics.* (OECD, 2005, p.49)

> *A **process innovation** is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.* (OECD, 2005, p.50)

Other important proposed classifications describe the intensity level of technological change of the innovation or its potential intensity to provoke changes in the market. Dewar and Dutton (1986), among other authors, categorized innovation as incremental, when it is introduced into the product, process, etc. steadily and gradually, without radical changes. Radical innovation, on the other hand, involves revolutionary changes in the technology. It happens when there is a paradigm change and when it promotes, through a technological evolution, the creation of a new set of attributes that enables the entry into new markets, acquiring new customers and creating new applications. Radical and incremental innovation present different levels of risks and costs, with the first type presenting much higher levels of both. The choice of which type the firm will pursue or if it will adopt both types is an important strategic choice.

Similarly, Christensen (2013) categorized innovation as sustained or disruptive. Sustained innovations promote improvements in attributes of the product or service that clients value without changing this product or service. In contrast, disruptive innovations promote, through technological evolution, the creation of a new set of attributes not initially valued by existing customers, but that are valuable for new customers. It is easy to perceive the similarity between incremental and sustained innovation, and between radical and disruptive innovation. However, they are not synonyms because a disruptive innovation mandatorily promotes a discontinuity in the market. This kind of discontinuity can only be generated by a radical innovation, and not by incremental ones, however not all radical innovations are disruptive. A characteristic of a disruptive innovation is that it provokes the creative destruction, as when time passes, the disruptive innovation will overcome the old technology in its performance and will take the old technology out of the market. Figure 5 show how the disruption occurs. The S-curve on the left represents the performance of the current market-leader product over time and on the right, the S-curve of the disruptive innovation. The innovation starts with a much worse performance but, in a point of time, the

performance of the market-leader stabilizes while the disruptive product overcomes it, taking the old product out of the market.

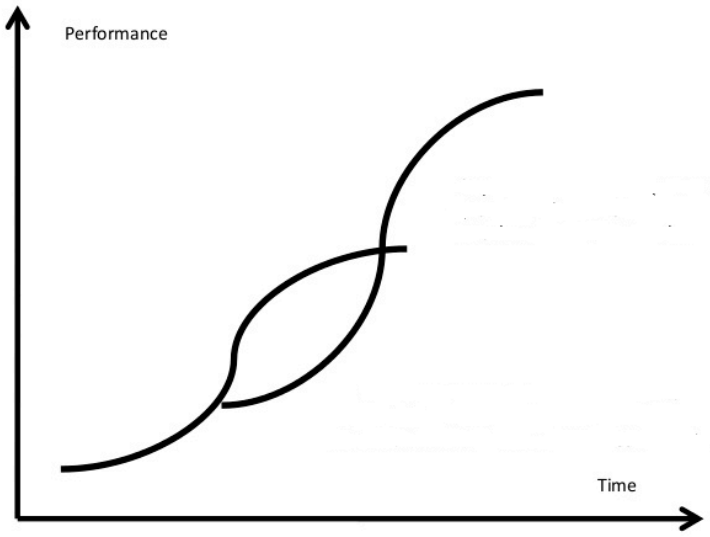


Figure 5 - Disruptive technology curve

Henderson and Clark (1990) proposed a typology to classify innovation according to two dimensions. The first dimension is innovation regarding the "basic knowledge underlying the components" of the product (core concepts) and the second dimension concerns "the way in which the components of a product are linked together". The junction of these dimensions led to four categories (Figure 6): i) incremental innovation - when both dimensions do not suffer strong modifications; ii) modular innovation - when the connections among components remain unchanged but the components are modified separately; iii) architectural innovation - when the connections among components are changed but the components (separately) remain unchanged; and iv) radical innovation - when both dimensions are changed significantly.

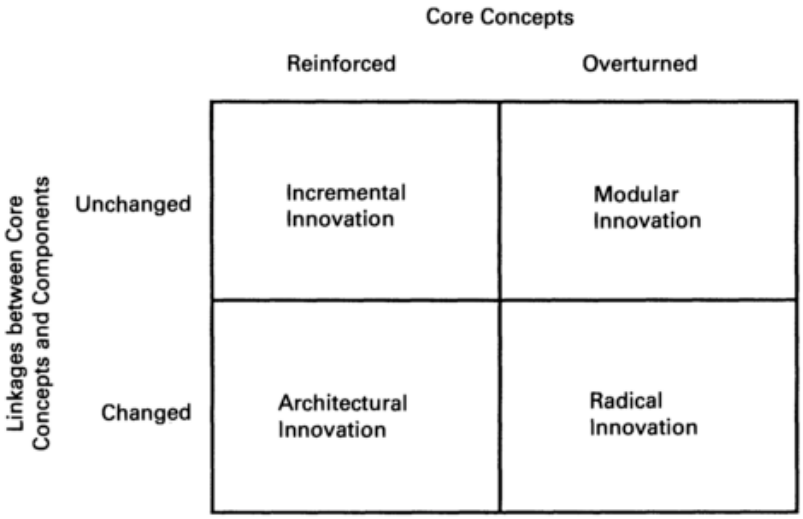


Figure 6 - Henderson and Clark's framework (1990)

Afuah and Bahram (1995) suggested that innovation may be classified differently depending on the stakeholder's point of view. An architectural innovation for the manufacturer may be radical for the customer. On the other hand, a modular innovation for manufacturers and suppliers may not be recognized as an innovation by the final users of the product. Therefore, they proposed the concept of the hypercube of innovation, that adds the value chain as a new dimension in the classification of Henderson and Clark. The other classifications mentioned previously in this text can also be interpreted differently depending on which stakeholder in the value chain is analyzed.

Consistent with the previous classification, Garcia and Calantone (2002) proposed a ranking of product innovativeness, based on diverse classifications proposed by the academia that were analyzed by them. Product innovativeness is the degree of novelty of an innovation. The innovativeness intensity goes from *new to the world*, passing by *new to the industry*, *new to the customer* and *new to the firm*. The authors realized that the literature presents several dimensions for this construct, so the classification also comprehends levels concerning the nature of innovation, such as *new process*, *new service*, *new product*, *new product line* and many others. In addition, the same article also defines firm innovativeness as the propensity of the firm to innovate and develop new products or adopt innovations, considering the different perspectives of innovation.

In the early 2000s, Chesbrough, perceiving that innovation in American firms was occurring in a strongly closed way, proposed the concept of Open Innovation, that considers "the use of internal and external flows of knowledge to accelerate internal innovation and expand markets for external use of the innovation, respectively." (CHESBROUGH, 2003). This concept claims that it is possible to develop and expand markets for an innovation through external paths, ideas or resources, in addition to paths internal to the firm. Following this concept, the adoption of strategic alliances for innovation can be considered. This topic will be better developed in Section 2.5 of the literature review.

2.2.2. Innovation process and strategy

Innovation is central for firms nowadays. It has an important role in firm's renovation, as well as in its survival and growth. Previously, innovation was defined as a process, which makes sense as the generation of innovation consists of several sequential steps or activities. There is no rule-of-thumb on how to succeed in it, however, it does not occur by chance. The innovation process is contingent on the economic sector, on the field of knowledge, on the firm's characteristics and many other aspects. Therefore, its essential to recognize the nature of the innovation process and its environment to be able to analyze it and take the right decisions to improve innovation performance. The innovation process has several stimuli, external or internal. After these have been initiated, the firms need to choose the strategies to execute the innovation process so as to achieve some specific results. The innovation stimuli and the firm's strategies will be addressed in this Section and the expected results, also called innovation performance, will be addressed in Section 2.2.3. According to Tidd et al. (2013, p. 224), some stimuli for the companies to start an innovation process are:

i) system shocks – events that change the world and force firms' change;
ii) accidents – unexpected events that indicate new directions;
iii) observation – imitation or extension of things that already exist;
iv) recombining innovation – application of valid ideas in a different context;
v) regulations – new rules that pull innovation in some direction;

vi) advertising – discovery and amplification of talent necessities;
vii) inspiration – when people have special visions, as Newton had when the apple felt in his head;
viii) knowledge stimuli – opportunities creation by the science frontier;
ix) design – that the authors consider as the main driver of innovation;
x) necessity – that can demand invention and innovation;
xi) users – they can help innovation development by their necessities;
xii) exploration – future scenarios and new possibility analysis.

When the firm engages in the innovation process, it must choose the strategies to execute it. To do so, it must recognize the characteristics of the innovation activities that are, according to Dosi (1988): i) innovation has a degree of uncertainty; ii) reliance of major new technological opportunities on advances in scientific knowledge; iii) formal research activities integrated in manufacturing firms; iv) innovation and improvements originated by 'learning-by-doing' and 'learning-by-using'; and v) technical change as a cumulative activity.

Innovation activities, although faced by uncertainty and contingencies, have some sort of pattern in the way they are divided and sequenced. Pavitt (2005) considered that innovation sub-processes have the following sequence: i) the production of technological knowledge; ii) the translation of knowledge into working artifacts; and iii) responding to an influencing marketing demand. This sequence of overlapping sub-processes receives inputs from the environment (existing scientific knowledge, money, people to work on them, firm's strategies, etc.) and produce results (innovations to the market). In a similar way, Tidd et al. (2013) modeled the innovation process as the sequence of the following sub-processes: i) search of opportunities of innovation; ii) selection of the opportunities found; iii) implementation of the selected ideas; and iv) value-capture of the innovation (by selling it in the market or applying it in an internal process).

For Dosi (1988), innovative activities concern the search, the discovery, the experimentation, the development, the imitation, and the adoption of new products, new production processes, and new organizational set-ups. Some of

these activities can replace each other in the process, as for example development and imitation, but others, like adoption, always occur. The innovation activities executed may indicate the degree or stage of development of the innovation process that the firm is carrying out. Figueiredo (2009) proposed a spectrum of innovation activities (as part of the innovation process) as a continuum in the degree of innovation novelty and complexity, from the less to the most novel and complex: i) duplicative imitation; ii) creative imitation; iii) small and medium adaptations and modifications; iv) robust adaptations and modifications through engineering; v) design and development not new for the country, through engineering and R&D; vi) design and development not new for the world, through engineering and R&D; vii) original design and development, through open engineering and R&D; and viii) discovery of radically new knowledge to support new design and development activities through sophisticated R&D efforts. Figure 7 presents a simplified view of this spectrum highlighting the specific activities and not considering the specific results in the degree of novelty (original, new to the country, etc.). This classification of activities is important because it facilitates the creation of measurable proxies that represent the innovation efforts.

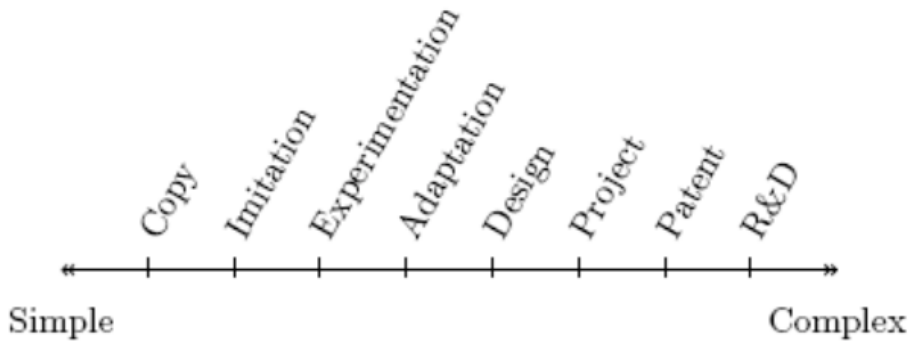


Figure 7 - Innovation activities spectrum (FIGUEIREDO, 2009)

During the innovation process, the contingent form and the uncertainty provoke a considerable variety of strategic choices. The first strategic choice considered in this text is the degree to which the firm will invest in innovation. There are some evidences of a firm's pro-innovation strategic approach: level of spending on R&D; number of engineers, scientists and other technical employees; the degree of emphasis in terms of resource allocation in new product

development; frequency or speed of introduction of new products on the market; etc. (LI; ATUAHENE-GIMA, 2001) However these evidences do not guarantee by themselves a satisfactory innovation performance.

According to Sundbo (2001), innovation theory is based on three basic theories that describe the determinants of the strategic choices of firms when faced with the innovation process:

i) Entrepreneur theory - the main determinant of innovation is the entrepreneur's psychology. The innovations are generally operationalized by the creation of new enterprises;
ii) Technology-economic theory - innovations are basically technological, and developed by technicians and R&D activities;
iii) Strategic innovation theory – guided by the firm's strategy and driven by top management, innovation is a process that involves the whole company. The strategy is the guideline for the process.

All these three theories may be valid depending on the context. This dissertation builds its hypotheses based more on the technology-economic theory and on the strategic innovation theory, although it does not ignore the importance of the entrepreneur as conductor of innovation. Therefore, this work considers innovation as a strategy defined by top management, in accordance with the third theory; furthermore, the focus is on product and process innovation, that are mainly generated by internal R&D or external R&D in the context of strategic alliances and knowledge acquisitions, in accordance with the second theory. This view is also in accordance with Du, Leten, and Vanhaverbeke (2014), for whom innovation activities in firms are usually conducted as R&D projects, that are, together with project management, at the heart of corporate innovation strategies.

Considering Tidd's four innovation sub-processes, the literature on innovation describes how some strategic choices influence the sub-processes 1 (search), 2 (selection) and 3 (implementation). Some of these strategic choices are: i) radical versus incremental innovation; ii) learning-by-doing versus creative destruction; iii) exploration versus exploitation; iv) flexibility versus a well-defined objective (FAEMS et al., 2005); and v) mainly internal versus open

innovation (CHENG; HUIZINGH, 2014; DU et al., 2014LAURSEN; SALTER, 2006).

The choice in investing in incremental or radical innovation (DEWAR; DUTTON, 1986) may cause a high impact on the competitive success of the firms. Many established leading companies choose to focus only on incremental innovation leaving aside efforts to develop radical innovation. They may end up missing new opportunities, and are usually being overcome by new entrant firms that created a completely new product that proved to be more valuable than the market leader's one, stealing its customers. Often, the attempt to introduce radical innovation is the only possible strategy for a new entrant firm when the market is already established and high entry barriers exist. However, incremental product innovation is necessary to develop the characteristics of a product that was created by a radical innovation so as to increase its market. Similarly, incremental process innovation is necessary to adjust the production process to lower production costs (UTTERBACK; ABERNATHY, 1975).

The way firms generate innovation is also an important dimension of their strategy. Learning-by-doing (ARROW, 1962) is the process to derive innovation through a trial and error dynamics, in continuous improvement (BOGERS, 2009). On the other hand, creative destruction is the concept of making an old technology obsolete by creating a new superior one (SCHUMPETER, 1961). This process may be linked to the previous strategies as learning-by-doing may favor the creation of incremental or sustained innovation and creative destruction is mainly a form to generate radical and disruptive innovations.

According to March (1991), exploration of new possibilities occurs by "search, variation, risk taking, experimentation, play, flexibility, discovery, innovation" (MARCH, 1991). Exploitation of already developed successes is "refinement, choice, production, efficiency, selection, implementation, execution" (MARCH, 1991). Exploration, as being the discovery of new technologies that were not previously known, are related to basic R&D investments. Exploitation is more related to the discovery of new applications of already known technologies, and is more linked to applied research. Both are usually necessary for firms to

succeed in their efforts to develop innovation. The choice of the degree of exploration and exploitation is a strategic choice that is also very important for the innovation process. A firm should balance both types because exploitation usually has better financial return in the short term, however, the absence of exploration can compromise firm survival in the long term (BELDERBOS; FAEMS; LETEN; VAN LOOY, 2010; MARCH, 1991).

Another important choice for the innovating firm is between flexibility to invest in an innovation development when an opportunity appears (GHEMAWAT, 1991) versus having a well-defined objective and investing only in innovations that are linked to this goal. Flexibility regards having organizational processes that enable the firm to adapt to changes in the market and redirect resources to new opportunities, even if the market for that particular opportunity in not developed to a level that brings high revenues. This flexibility allows the firm to develop innovation and keep them as options opened and, if the market for that innovation develops, the organization will be well-positioned. However, the cost is high as some innovations will not become a market success. Innovating following a well-defined objective helps to maintain focus, and lower R&D costs. However, it increases the risk that a competitor more flexible introduce disruptive innovations that promote a market change and take the firm out of the market.

Furthermore, firms can choose the sources of knowledge/resources that are inputs for the innovation process. Chesbrough's (2003) concept open innovation, that was mentioned in Section 2.2.2 proposes that it is possible to innovate using internal and external ideas and resources, or a mix of both. The aggregation of external possibilities collaborates with the performance, as many subsequent studies illustrated (CHENG; HUIZINGH, 2014; DU et al., 2014; MARTINEZ et al., 2014; RANDHAWA; WILDEN; HOHBERGER, 2016). The complementarity of internal and external sources of knowledge in the innovation process is represented in Figure 8, which shows that research projects inside the firm's boundaries and knowledge outside them (both represented by circles) combine to advance the development innovation and to pave their paths to market. Open innovation can be addressed through strategic alliances, that will be the focus of

Section 2.3. The way open innovation and strategic alliances affect innovation performance will be addressed in Section 2.5.

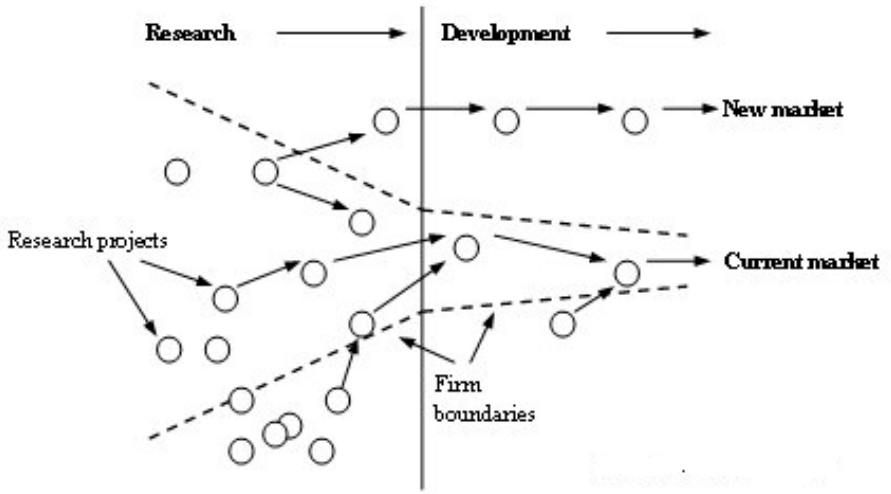


Figure 8 - Open innovation (CHESBROUGH, 2003)

A strategic choice that affects the fourth sub-process (value capture) described by Tidd et al. (2013) is the appropriability regime. The appropriability regime is the choice of a set of appropriability mechanisms, which are tools that the company uses to protect innovation from imitation and ensure that it will earn an appropriate share of the rent generated by it (COHEN; WALSH, 2001). The appropriability mechanisms can generate better rents by minimizing the risks of evasion of rents for imitators, suppliers, clients, etc. (TEECE, 1986). The appropriability regime is even more important when strategic alliances are used to develop innovation, because the partnership raises misappropriation risks. The higher the risk of misappropriation, the more hierarchical is the alliance governance (GULATI; SINGH, 1998) and higher the coordination costs.

According to Hurmelinna-Laukkanen and Puumalainen (2007), there are five types of appropriability mechanisms that can compound the firm's appropriability regime: i) nature of knowledge – if it is codified or tacit; ii) institutional protection - IPRs (intellectual property regimes), contracts and labor legislation; iii) human resources management – communication, (im)mobility; iv) practical/technical means – passwords, secrecy, access restriction etc.; and v) lead time – speed of market entry, continuous development, etc. Different mechanisms are more appropriate depending on several dimensions, such as the industry, the

country, the technological complexity and on how coupled are the organizations involved (ALNUAIMI; GEORGE, 2016; HALL; SENA, 2017; LAURSEN; SALTER, 2014). Alnuaimi and George (2016), in a study of patent citations in the US semiconductor industry, found that moderate technological complexity is positively related with the appropriability. If the main risk to be mitigated is imitation, tightly-coupled organizations are better, but if the issues are other, loosely-coupled firms are superior as they maximize successful exchange of technology. Analyzing the type of appropriability regime, many studies found that patents and secrecy are substitutes (FRIEDMAN; LANDES; POSNER, 1991). Hall and Sena (2017) found that informal mechanisms of appropriability are usually preferred, instead of patents. Laursen and Salter (2005) empirically found that the most used mechanism in UK firms is the first mover advantage. This type of mechanisms based on lead-time were also found effective in Finland (HURMELINNA-LAUKKANEN; PUUMALAINEN; 2007). On the other hand, Amara, Landry, and Traore (2008) found that patents and secrecy are complementary in knowledge intensive industries.

A different perspective of the innovation process is the relationship between the product lifecycle and the rate of product and process innovation. Utterback and Abernathy (1975) introduced a model to explain the innovation trajectory of a product in three stages, as shown in see in the upper part of Figure 9: i) fluid, ii) transition, and iii) specific. This is a sequence model in which each stage represents a phase in the product life-cycle (emergence, consolidation and maturity). In the emergence phase, or fluid, most investments in product innovation are made for the emergence of radical innovation. In the second phase, consolidation or transition, the dominant product design is achieved and high investments in mass-production methods and to lower costs are made, therefore, the degree of process innovation investments is bigger. In the maturity phase, the investments in innovation shifts to incremental innovation as production processes become more automated, integrated, systematized and rigid, with a high degree of product standardization. The incremental innovation is used to extend the product's life in the market.

This model suffered several critics as it would not be appropriate for developing countries, where the firms are not technologically developed and are still in a process of catching-up, of reducing the differences in their level of technological capabilities compared to firms in developed countries. The firms from these developing countries do not have the money to invest in expensive R&D to develop radical innovation. According to Kim (1997), technological development in these countries occurs in a different way. During the early stage of firms' development, they usually acquire mature foreign technologies (in the specific or maturity stage of the Utterback-Abernathy model), developing production capabilities and starting by developing copied products. During this process, they assimilate the capabilities and, after this assimilation, they start making improvements in the products. This process is called the acquiring-assimilation-improving three-stages model. As shown in lower part of Figure 9, a firm in a developing country may enter in this acquiring-assimilation-improving process by acquiring technologies in the consolidation or maturity phases of Utterback-Abernathy's model and, by the accumulation of knowledge over several cycles, catch-up and start generating more technologically advanced innovations. Kim (1998), Lee and Lim (2001) show some interesting cases of this process that happened in Korean firms.

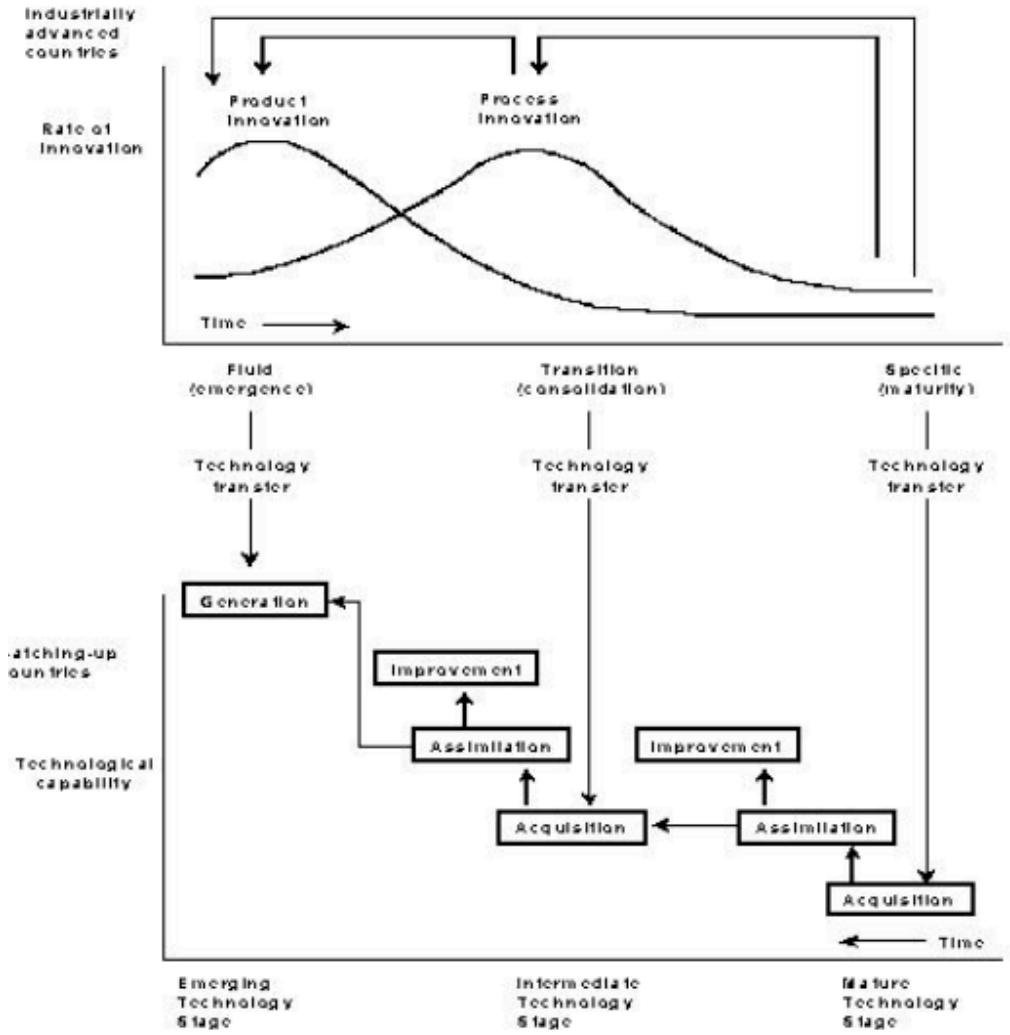


Figure 9 - Process of technological development in advanced (upper figure) and in developing countries (lower figure) (KIM, 1997)

2.2.3.
Innovation performance and factors that drive innovation

Innovation performance is a concept hard to measure. It is measured in several forms in the innovation literature, but there is no unanimity regarding a specific measurement. Some authors measure innovation performance as the revenues obtained by the firm from new products or services (CASSIMAN; VEUGELERS, 2006; LOVE et al., 2014; MULLER; VÄLIKANGAS; MERLYN, 2005). Others consider the number of patents or patent citation (AHUJA, 2000; DECAROLIS; DEEDS, 1999; HAGEDOORN; DUYSTERS, 2002; KARIM; KAUL, 2013) or the number of innovations generated, whether they were

patented or not (TSAI; GOSHAL, 1998). Cuevas Rodríguez, Cabello-Medina, and Carmona-Lavado (2014) defined scales for two dimensions of product innovation to be measured: i) technological dimension – the degree to which an innovation is technologically new; and ii) marketing dimension – the degree to which that innovation creates new markets. The most used measures of innovation performance according to the literature are listed in Table 3.

As shown in Table 3, the most used proxies of innovation performance are total or share of revenues from new products or services, number of innovations launched, number of patents and degree of innovativeness. However, alternative proxies are also used, such as patents' citations, number of prizes for innovativeness and patents' commercial value. Another way to access innovation performance is through scales that try to measure the impact of the innovation on the firm's strategies and goals. Leskovar-Spacapan and Bastic (2007) proposed a scale of innovation advantage that measures the extent of financial and marketing advantages achieved by the firm's innovations and includes the following questions: i) the innovations assisted your firm to gain an advantage over competitors by entering new markets?; ii) the innovations assisted your firm to gain an advantage over competitors by increasing market share?; iii) the innovations assisted your firm to gain the advantage over competitors by increasing customer satisfaction?; iv) the innovations assisted your firm to gain the advantage over competitors in increasing return on investment?; v) the innovations assisted your firm to gain the advantage over competitors by higher ratio profit/employee than your industry average?

Proxies	Articles
Total or share of revenues from new products or services	Berchicci (2013); Cassiman & Veugelers (2006); Du et al. (2014); Duysters & Lokshin (2011); Faems et al. (2005); Fosfuri & Tribo (2008); Frenz & Ietto-Gillies (2009); Klingebiel & Rammer (2014); Knudsen (2007); Love et al. (2014); Oerlemans, Knoben, & Pretorius (2013); Ritter & Gemunden (2003); Tsai (2009); Zeng, Xie, & Tam (2010)
Number of product innovation developed or launched	Capaldo (2007); Hall & Bagchi-Sen (2007); Lee, Park, Yoon, & Park (2010); Ordanini & Parasuraman (2011); Quintana-García & Benavides-Velasco (2004); Rothaermel & Deeds (2006); Rothaermel (2001a); Tomlinson (2010); Tsai & Ghoshal (1998); Wu (2014, 2011); Yeniyurt, Henke, & Yalcinkaya (2014); Zaheer & Bell (2005)
Product innovation developed or launched? (Yes / No)	Hoang & Rothaermel (2005); Jesús Nieto & Santamaría (2010); Vega-Jurado, Gutiérrez-Gracia, & Fernández-De-Lucio (2009)
Growth of new products introduction	Williams & Du (2014)
Time of innovation on the marketing	Capaldo (2007)
Degree of success of new products or services	Cheng & Huizingh (2014)
Number of process innovation developed or adopted	Ritter & Gemunden (2003); Hall & Bagchi-Sem (2007); Tomlinson (2010); Lee et al. (2010)
Process innovation developed or adopted? (Yes / No)	Vega-Jurado et al. (2009); Jesus Nieto & Santamaria (2010)
Number of patents	Aharonson, Baum, & Plunket (2008); Ahuja (2000); Belderbos et al. (2010); Berry (2014); Czarnitzki, Ebersberger, & Fier (2007); DeCarolis & Deeds (1999); Durand, Bruyaka, & Mangematin (2008); Hagedoorn & Duysters (2002b); Hagedoorn & Wang (2012); Hall & Bagchi-Sen (2007); Joshi & Nerkar (2011); Keil, Maula, Schildt, & Zahra (2008); Lichtenthaler (2011); Lin, Wu, Chang, Wang, & Lee (2012); Nooteboom, Vanhaverbeke, Duysters, Gilsing, & van den Oord (2007); Park, Srivastava, & Gnyawali (2014); Sampson (2007); Schilling & Phelps (2007); Schilling (2015); Stuart (2000); Tortoriello (2015)
Number of patents' citations	DeCarolis & Deeds (1999); Dushnitsky & Lenox (2005a); Fischer & Leidinger (2014); Funk (2014); Hess & Rothaermel (2011); Hsu & Lim (2014); Karim & Kaul (2013); Nieto & Santamaría (2007); Operti & Carnabuci (2014); Soh & Subramanian (2014); Yayavaram & Chen (2015)
Patents' commercial value	Fischer & Leidinger (2014)
Degree of innovativeness of the firm or of the products	Chatterji & Fabrizio (2014); Cheng & Huizingh (2014); Hemmert, Bstieler, & Okamuro (2014); Li, Eden, Hitt, & Ireland (2008); Mention (2011); Ordanini & Parasuraman (2011); Ozer & Zhang (2015); Pérez-Luño, Cabello Medina, Carmona Lavado & Cuevas Rodríguez (2011); Revilla & Fernández (2012); Wuyts, Colombo, Dutta, & Nooteboom (2005); Yami & Nemeh (2014); Zaheer & Bell (2005); Zhou, Li, Wales, Parida, & Patel (2012)
Number of prizes for innovativeness	Capaldo (2007); Soh (2010)

Scale of innovation impact	Leskovar-Spacapan & Bastic (2007); Martinez et al. (2014); Ritala, Olander, Michailova, & Husted (2015)

Table 3 - Innovation performance's measures

PINTEC survey, an innovation survey of Brazilian firms conducted by the Brazilian government agency IBGE[1] (IBGE, 2016a), which was used as a source of data in this dissertation, also proposed a scale of innovation impact based on the Oslo Manual (OECD, 2005). PINTEC's scale consists of 15 questions and indicates the impact of product or process innovation according to four dimensions. The European survey CIS (EUROPEAN COMISSION, 2016a), also used in this dissertation, has a similar scale:

i) Product dimension – the degree of quality of goods or services improvement; the degree of extension on the range of goods or services offered;
ii) Market dimension – in which degree it allowed to keep the company's participation in the market; in which degree it expanded the company's participation in the market; in which degree it allowed the firm to open new markets;
iii) Process dimension - increasing of production or service delivery capacity; increasing in the flexibility of production or service delivery; reduction of production or services' costs; reduction of labor costs; reduction of the consumption of raw materials; reduction of energy consumption; reduction of water consumption;
iv) Other impacts – reduction of the impact on the environment; in which degree it allowed to control aspects of health and safety; in which degree it helped to attend norms and regulations.

To ensure a good innovation performance measurement, it is important to understand the factors that influence innovation. Several factors, endogenous or exogenous to the firm, influence innovation performance in two different moments: the moment of the decision to invest in innovation and innovation

[1] IBGE (Instituto Brasileiro de Geografia e Estatística) - national agency in charge of statistical issues.

productivity, once the firm is investing in innovation. Both factors influence innovation performance because, even if the productivity of innovation is not high in some conditions, if there are more individual independent research efforts, innovation performance tends to be higher and, if companies are linked to partners, the individual efforts may lead to knowledge spillovers (AHUJA; LAMPERT; TANDON, 2008).

The industry lifecycle theory addresses an exogenous factor that influences the decision to innovate. According to Von Tunzelmann (1995), in the earlier stages of an industry evolution, there is an incentive for the firms to invest in product innovation. This phase is called product cycle. Various designs are created by the incumbents and new entrants until one specific design starts to stand out, becoming a standard in the market and driving the others out. At this moment, the industry starts the process cycle, in which firms seek economies of scope and cost-cutting. To achieve these goals, they need to invest in process innovation. The industry lifecycle can be applied to several industries, but it is not the only factor that drives innovation.

According to Ahuja et al. (2008), four dimensions of factors influence the firm's efforts to develop innovation and/or its innovation productivity, influencing innovation performance as a whole. The authors' work is an extension of Schumpeter's work (SCHUMPETER, 1961, 2013), that considered only firm-size and market-structure as important drivers. They proposed the following dimensions and factors:

i) Industry structure
   a. Market structure – market power may enhance investments on innovation and some arguments suggest this: market dominance provides resources and security to finance innovation activities that are risky; the threat of creative destruction may make the firm lose its position; and creation of disruptive innovation can alter market structure and strengthen the position of the innovator company;
   b. Collaboration networks – this factor is linked to the level of innovation efforts according to two arguments: the division of labor naturally leads us

to conclude that the innovation task can be divided by different firms that are specialists in some parts of it; and the social network theory provides insights that lead to the conclusion that the more links you add in a network the more value you can add as compared to that of the sum of each individual links. Innovation productivity can also be enhanced by the information and technical flow and joint problem solving that a network provides;

c. Buyer / user – some users have an intrinsic innovative characteristic, as for example the "lead-users", influencing the industry to invest in developing innovations to supply them. The recognition of the firm as innovative by the user's community is very important for competitive advantage in some industries;

d. Suppliers and complementors (NALEBLUFF; BRANDENBURGER; MAULANA, 1996) – buyers, suppliers and complementors may be motivated to invest in innovation if they are interested in developing the technology and raising investments in the development of technology. The presence of complementary assets in this type of stakeholder can also enhance innovation productivity.

ii) Firm characteristics

a. Firm size – the innovation efforts tend to be higher in larger firms because they have a bigger budget to invest in risky R&D projects, and returns of R&D are higher for larger volumes of sales. Size can also affect positively the firm's innovative production in terms of economies of scale in the R&D process that benefits big firms with larger budgets; and from the complementarities among R&D and other activities that tend to be higher in bigger companies. On the other hand, the size can have a negative effect because of the tendency of bureaucratization of the inventive activity and the lesser capacity of individual scientists to benefit from their efforts in such companies.

b. Firm scope – the diversification of the firm's activities can affect positively and negatively innovation performance. The negative influence may come from the higher investments that business diversification requires in a risky activity such as R&D. The positive influence comes from the fact that a

broad product base leads to more incentives to invest in basic research, increasing the likelihood of positive innovation outcomes and the occurrence of internal knowledge spillovers;

c. Alliances and networks – dyadic alliances can leverage innovation performance by increasing potential R&D investments, by providing economies of scale and by ensuring potential complementarity benefits. The effect can be negative if the innovation activities carried out in the scope of the alliance fragment company's research efforts and make it lose its focus. Moreover, there is an increase in managerial expenses because of opportunism threats. The effects of alliance networks on innovation performance will be discussed deeply in Section 2.5;

d. Performance - performance below expectations can make firms decline innovation efforts because of the necessity of cutting costs. On the other hand, some decision makers may assume more risks when facing losses, which can provoke an increase in the investments in R&D. In some cases, not investing in innovation is the cause of profits' decline and boosting investments becomes necessary.

iii) Intra-organizational attributes

a. Organizational structure and processes – organizational structure influences the flow of information inside the company, being determinant on innovation efforts and productivity. Firm processes are influential on innovation productivity and the most influential are: role of social ties among firm personnel, environmental scanning processes and innovation management practices;

b. Governance, compensation and incentive structures – the tendency to take risks by the managers is strongly influenced by this factor. Because, according to agency theory (JENSEN; MECKING, 1976; EISENHARDT, 1989), the interests of stockholders and managers are different, the incentives are a way for stockholders to minimize this difference;

c. Manager's background – individual characteristics and the composition of top management are relevant for innovation. Some characteristics, as age and previous experience in innovative firms are positive related to innovation as well as the top management's heterogeneity;

d. Organizational search processes – search and learning processes make innovation emerge. The efficiency of these processes has a considerable influence on innovation productivity.

iv) Institutional influence

a. Science - the progress of science and technology associated to the industry influence the efforts on R&D. The necessity of investments to acquire the necessary knowledge when the technology evolves increase firms' costs. Science also increases innovation productivity as it identifies the paths to succeed in innovation development;

b. Appropriability conditions – appropriability mechanisms are strategies, but the ones that are available depend on the appropriability conditions of the environment. They may influence positively innovation efforts, if the mechanisms available are appropriate for guaranteeing that the firms can avoid opportunism and an expected return on their innovations.

Other authors also proposed frameworks for identifying the factors that influence innovation. Bell and Figueiredo (2012) proposed the following types of factors: i) firm-specific factors – as for example age, size, ownership and market orientation; ii) industry-level factors – specific characteristics of the industry in which the firm competes that influence innovation performance; iii) economy-wide incentives – macroeconomic incentives, incentives from competition and incentives from factor markets; and iv) economy-wide institutions – universities and research institutes, government, national system of innovation, etc.

2.2.4. A learning perspective of innovation

To achieve good innovation performance, a firm should accumulate knowledge on how to conduct innovation activities through learning, called in this dissertation innovation capabilities. The nature of innovation capabilities is accumulative as the accumulation of knowledge through learning builds an "organizational memory" (NELSON; WINTER, 2009) that may lead firms increasingly to achieve a superior innovation performance. The phenomenon of accumulating innovative capability by a firm has two dimensions (BELL;

FIGUEIREDO, 2012): i) the technological dimension; and ii) the organizational dimension.

Where the technological dimension is concerned, firms acquire knowledge on how to do things. This includes the set of techniques, skills, methods and processes used in the production of goods or services that are centered on human resources, R&D, skills and knowledge bases. The accumulation of the technology capabilities is necessary but not sufficient to handle innovation activities with success. An imitator firm may have only technological capabilities but it may not be able to evolve from a simple imitator to an innovator that promotes adaptations or changes in the products or services. The technological dimension has the following levels, considering the degree of development achieved by the firm:

i) World-leading – firms that are at the world technological frontier, producing the most innovative products and services and using the most innovative organizational processes. These firms are recognized as having the most developed R&D and conduct cutting-edge design, research and development;
ii) Advanced – firms catching up with the international technological frontier. Firms at this level conduct various types of design, research and development close to the upper level, but still at a slower pace than the world-leading companies;
iii) Incremental / intermediate – firms that conduct relatively complex incremental modifications in products, services or processes. Professionals, such as specialized engineers and technicians, are mainly allocated in activities such as duplication, creative imitation and large-scale production systems;
iv) Basic – firms that make minor adaptations and improvements. Those firms usually have their specialized personnel informally allocated in conducting technical evolutions in products, services and processes. These professionals have limited time to dedicate to innovation and are not able to conduct high-impact technological changes.

The organizational dimension is centered on different formats of organizational structures that influence innovation performance. The different organizational formats may prioritize i) specialization / differentiation, ii) integration / coordination or iii) orchestration. Organizational formats that focus on specialization / differentiation allow a lower level of innovation capability development, and may evolve to a higher level with focus on integration / coordination and even more with focus on orchestration. Figure 10 shows the curve of innovation capability accumulation, which is formed by a constant improvement in both dimensions' levels. The transition phase happens when the firms is in the average level in both dimensions and it catches-up with the evolution of the technological dimension to world-leading, conjointly with the evolution of the organizational dimension to orchestration.

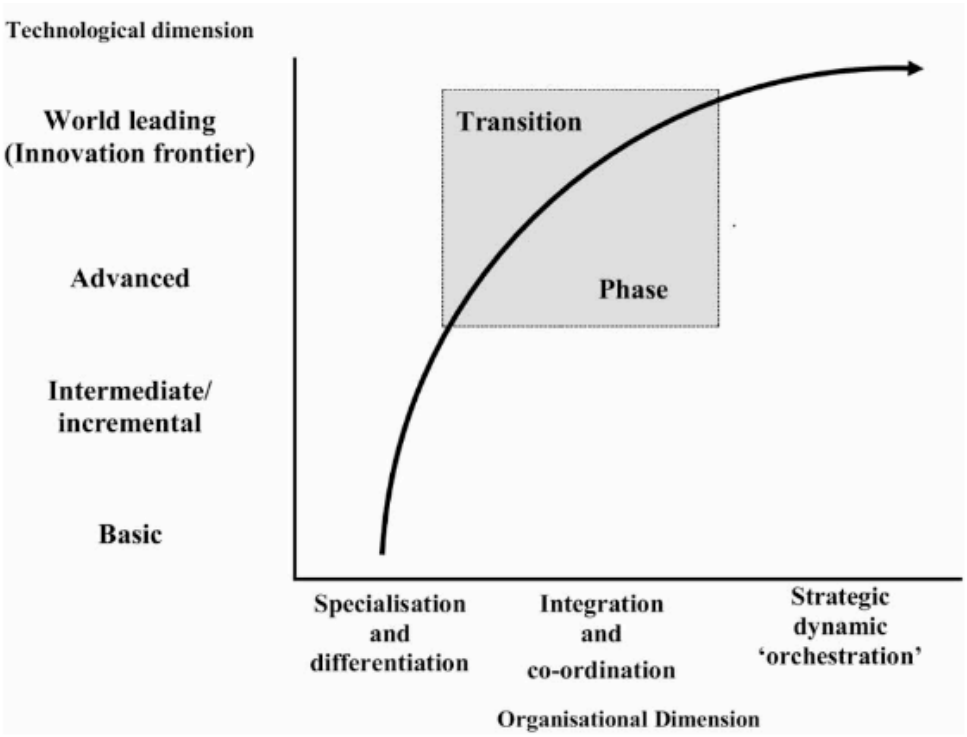


Figure 10 - Innovation capability accumulation (BELL; FIGUEIREDO, 2012)

Knowledge is a resource that is not perfectly tradable on the market and, for that reason, may be a source of sustained competitive advantage for the firm. This resource view of knowledge is consistent with the resource-based view of the firm – RBV (BARNEY, 1991; PETERAF, 1993; WERNERFELT, 1984; 2013). The main aspects of knowledge that are relevant for value creation according to Grant

(1996), author that introduced the knowledge-based view of the firm, are: i) transferability; ii) capacity of aggregation; iii) appropriability; iii) specialization in knowledge acquisition; and iv) knowledge requirements of production.

The acquisition of knowledge is a complex process. Nahapiet and Ghoshal (1998) argued that knowledge can be achieved thorough learning among members inside the firm or by bringing knowledge from people outside the firm. Therefore, a simplified view consists of two types of knowledge sources: internal and external knowledge. Tables 4 and 5 present a classification of knowledge / innovation sources based on the UK Innovation Survey of 2011 (TIDD et al., 2013) and their proportion by firm's size and industry type. These tables illustrate that internal sources of knowledge and knowledge from clients are the most frequent sources used in the learning process to induce innovation in the whole spectrum of sizes and sectors. However, different proportions can be found, which illustrates the fact that the innovation process is contingent on some characteristics of the firm and of the environment.

Sources of Innovation	10 to 250 employees	More than 250 employees	All (more than 10 employees)
Internal			
Inside the business group	39	52	39
External			
Market			
Equipment suppliers	18	23	19
Clients	39	50	39
Competitors	14	18	15
Consultants, commercial labs or private R&D institutes	4	7	4
Institutional			
Universities and other educational institutes	3	2	3
Public and private research institutes	2	4	2
Other sources			
Sectorial technical patterns	8	15	8
Conferences, fairs and expositions	5	5	5
Scientific journals, technical and commercial publications	8	15	8
Professional associations	6	8	6

Table 4 - Innovation sources' proportion by firm size (UK Innovation Survey, 2011 apud Tidd et al., 2013)

Sources of Innovation	Primary Sector	Engineering-based manufacturing	Other manufacturing	Construction	Retail & distribution	Knowledge intensive services	Other services
Internal		53	45	25	36	54	34
Inside the business group	46	53	45	25	36	54	34
External							
Market							
Equipment suppliers	19	24	24	15	21	18	14
Clients	39	54	43	29	34	54	36
Competitors	12	20	13	11	15	19	13
Consultants, commercial labs or private R&D institutes	4	8	5	4	3	6	4
Institutional							
Universities and other educational institutes	..	3	4	..	1	4	1
Public and private research institutes	..	3	2	..	1	3	2
Other sources							
Sectorial technical patterns	..	8	5	3	7	6	3
Conferences, fairs and expositions	5	5	4	7	6	8	7
Scientific journals, technical and commercial publications	13	12	7	11	6	13	6
Professional associations	..	2	2	3	3	3	2

Table 5 - Innovation sources' proportion by broad sector (UK Innovation Survey, 2011 apud Tidd et al., 2013)

Internal sources of knowledge come mainly from R&D developed inside the boundaries of the company or inside its business group. On the other hand, external sources may be innovations acquired from other firms, merges, acquisitions and collaboration with other players in the industry, in the academia, etc. (CHESBROUGH, 2003; FAEMS et al., 2005). Many studies examined the relationship among all sources of knowledge and innovation performance. The relationship between internal R&D and innovation is positive in many of them (FAEMS et al. 2005; BELUSSI et al., 2010), however it is dependent on the firm's internal structure (ARORA; BELENZON; RIOS, 2014) and on the type of knowledge developed (PÉREZ-LUÑO et al., 2011).

The relationship between external sources and innovation performance is also highly addressed in the academia. Some studies suggested that it depends on the type of partner (BELDERBOS; CARREE; LOKSHIN, 2006; CHATTERJI; FABRIZIO, 2014; SOH; SUBRAMANIAN, 2014; VON HIPPEL, 1988), on the type of knowledge sought (PÉREZ-LUÑO et al., 2011) and on the absorptive capacity of the firm (COHEN; LEVINTHAL, 1989, 1990). According to Cohen and Levinthal (1990), absorptive capacity is defined as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends." This ability draws on both partners' knowledge bases, organizational structures and compensation policies, and the dominant logic, as it depends not only on the receptor but also on the transmitter of the knowledge (LANE; LUBATKIN, 1998).

Lichtenthaler and Lichtenthaler (2009) proposed a capability-based framework to describe which capabilities a firm must have so as to deal with knowledge in an open innovation context (see Figure 11). In this framework, the authors identify three knowledge activities and which capabilities the firm should have to deal with them internally or externally. The activities are i) knowledge exploration, ii) knowledge retention, iii) and knowledge exploitation. Knowledge exploration refers to the generation of new knowledge. Internal knowledge exploration happens when the exploration occurs inside the firm, through R&D activities. The capability necessary for internal knowledge exploration was called inventive capacity. External knowledge exploration refers to the acquisition or generation of knowledge through external sources, such as strategic alliances. The capability necessary for external knowledge exploration was called absorptive capacity. The authors' definition is different from the broader one proposed by Cohen and Levinthal (1990). It considers only the part of recognizing external knowledge. Assimilation and application of external knowledge are considered different capabilities that will be covered ahead.

Internal knowledge retention is keeping the knowledge internally generated over time inside the company. External knowledge retention is the maintenance of the knowledge embedded in the alliances or in the alliance networks. The

capabilities for both types of knowledge retention were called transformative capacity for the former and connective capacity for the latter.

Finally, knowledge exploitation is treated by the authors as the application of knowledge by firms. Internal knowledge exploitation is the application of the firms' internally developed knowledge to generate innovation in the form of new products that will be commercialized or new processes that will be applied internally. The capability for this activity is called innovative capacity. External knowledge exploitation happens when the firm applies its own knowledge in the innovation process of a partner, through licensing, joint R&D etc. The capability for external knowledge exploitation is desorptive capacity. The existence of desorptive capacity is consistent with Lane and Lubaktin's (1998) statement that the transmission of knowledge depends both on the receptor and on the transmitter.

	Knowledge exploration	**Knowledge retention**	**Knowledge exploitation**
Internal (Intrafirm)	Inventive capacity	Transformative capacity	Innovative capacity
External (Interfirm)	Absorptive capacity	Connective capacity	Desorptive capacity

Figure 11 - Capability-based framework for open innovation (LICHTENTHALER; LICHTENTHALER, 2009)

2.3. Strategic alliances

Alliances are defined by Gulati (1998) as "voluntary arrangements among organizations involving exchange, division or co-development of products, technologies or services". Strategic alliances are a "manifestation of interorganizational cooperative strategies" (VARADARAJAN; CUNNINGHAM, 1995, p. 283) and are formed to pool skills and resources for the achievement of the shared goals of the cooperating firms. These collaborative efforts have a

potential to increase overall competitiveness of the firms (CHEUNG; MYERS; MENTZER, 2011). For this reason, among others, firms are commonly motivated to form alliances, either dyadic (when the partnership happens between two firms), or in the form of a network of several partners. Gulati (1998) defined five important aspects in the study of alliances, which are the following: i) the formation of alliances; ii) the governance of the alliances; iii) the evolution of the alliances and networks; iv) the performance of the alliance; and v) performance advantages for firms entering alliances.

The first aspect, formation of alliances, starts with the motivation of firms to enter in alliances and the choice of their partners. The motives are also strongly connected with the fifth aspect of Gulati's list, performance advantages for entering alliances, because the main reason for a firm to form an alliance, as it is with the adoption of any strategy, is to achieve a better performance. Several authors proposed lists of reasons that motivate the formation of an alliance. According to Mowery, Oxley and Silverman (1996), some reasons are: i) need to share costs and risks of innovation, as well as the required capital for project's development; rapid penetration in foreign markets; ii) collaboration between customer and supplier to coordinate and formulate technical standards; and iii) coordination among rivals to gain bargaining power in the market.

Powell, Koput, and Smith-Doerr (1996) highlighted the following goals: i) share of risks; ii) gain of access to new markets and technologies; iii) acceleration of the launch of new products on the market; iv) formation of a pool of complementary skills; and v) exploitation of partners' radical innovations. In a similar way, Tsai and Ghoshal (1998) listed the following benefits associated with collaboration: i) learning; ii) reduction in transaction costs; iii) formation of a resource pool; iv) investment in specific resources of the relationship; v) substantial exchange of knowledge and learning; and vi) combination of complementarities.

For Barney (2011), the benefits of alliances, or the "economies of scope that can motivate strategic alliances" (Barney, 2011) are: i) exploiting economies of scope; ii) learning from competitors; iii) managing risk and sharing costs; iv)

facilitating tacit collusion; v) low-cost entry into new markets; vi) low-cost entry into new industries and new segments; vii) low-cost exit from industries and industry segments; and viii) managing uncertainty. Focusing on collaboration for innovation development, Tidd et al. (2013) highlighted two types of reasons to form an innovation alliance, based on the affirmative that a peripheral technology necessary for a firm is potentially a core competence of another:

i) Strategic reasons – leadership and learning. A firm recognizes that it can learn with partners in terms of new technologies and innovation processes;
ii) Tactic reasons – reduction of cost, time and risk to develop an innovation and launch it in the market.

Although the benefits are evident, collaboration also brings certain risks. Cheung et al. (2011) listed some possible risks in forming an alliance as: i) sharing of sensitive information, ii) commitment to unique and costly investments; and iii) creation of potential competitors through collaboration. Although many of the alliances are collaborative, others are opportunistic. There are several temptations to cheat in the relationship. According to Barney (2011), firms can cheat in a strategic alliance in the following ways: i) adverse selection - misrepresentation of skills, abilities, capacities and resources by one of the partners; ii) moral hazard – a partner provide to the alliance less resources and capabilities than promised; and iii) holdup – exploitation by a partner of transaction-specific investments made by the other partner.

Balancing opportunities and risks is important to decide if the firm will get into a strategic alliance. However, the propensity to enter or not is also driven other by internal and external factors. According to Varadarajan and Cunningham (1995), there are several factors that interrelate to motivate firms to form alliances or not. These factors can be grouped in three types (see Figure 12): i) firm characteristics; ii) industry characteristics; and iii) environmental characteristics. The combination of these factors is important in the analysis of the level of opportunities and risks the alliance formation presents. Firms with less resources (firm characteristics) in an industry that faces less threat of new entrants (industry characteristics) may be more inclined to ally to a supplier of some resource

without fearing the supplier will become a competitor in the future than in an industry with a higher threat of new entrants, for example.

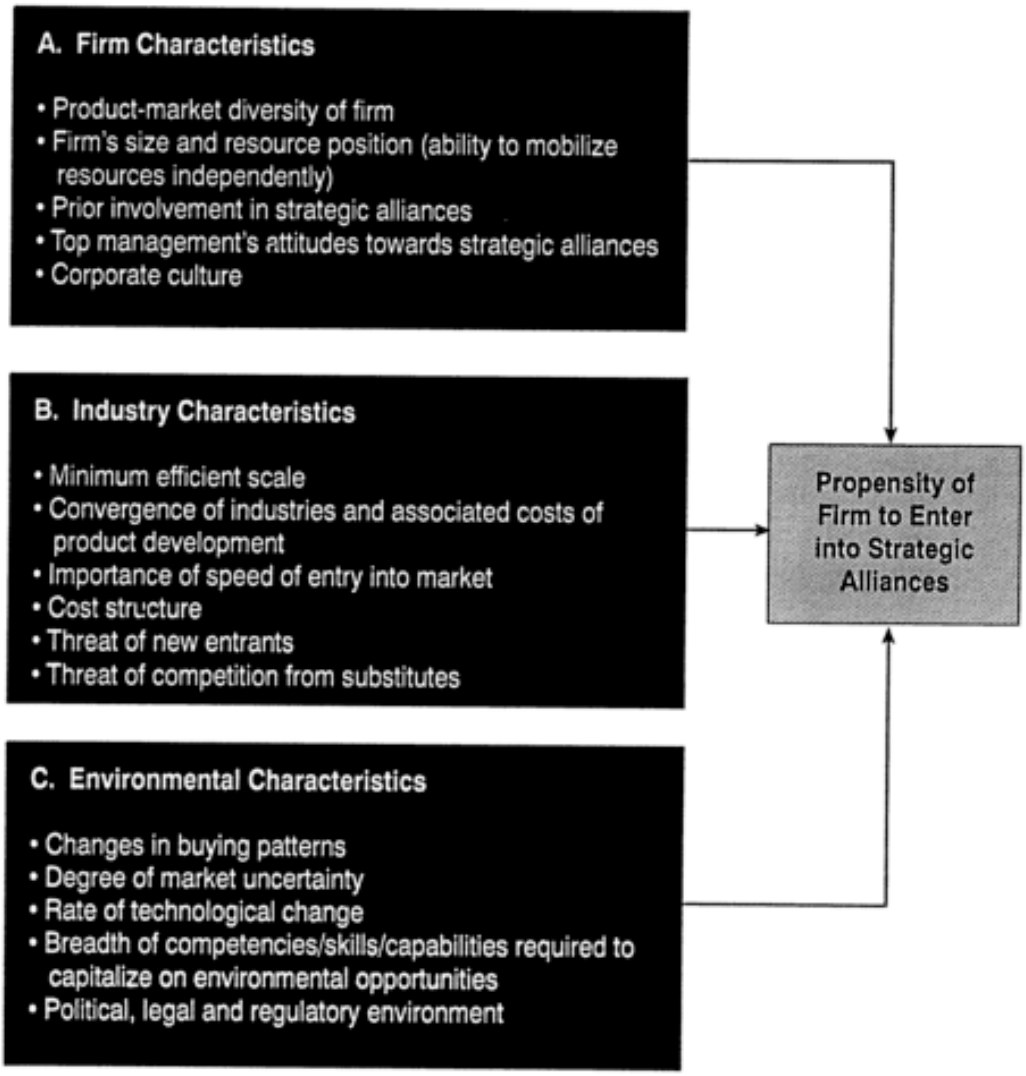


Figure 12 - Factors influencing the propensity to enter in strategic alliances (VARADARAJAN; CUNNINGHAM, 1995)

Still with respect to the formation of alliances, it is important to classify the type of alliance and the type of partner. Dyadic alliances may be of two types, in terms of partners' intentions: i) symmetric – when both partners intend to obtain the same advantages from the tie; and ii) asymmetric – when there are differences among the intentions of the two allied firms. Considering Barney's list of reasons to form an alliance, symmetric alliances usually happen when the main goal is to get economies of scale or tacit collusion; and asymmetric alliances usually occur when the goal is learning from competitors, low-cost entry into new markets or low-cost entry into new industries and new segments. When the motives are

managing uncertainties, or managing risks and sharing costs, both types may apply.

The partner's choice is also a very important decision. Uzzi (1997) classified ties in two types: i) arm-length ties – market relations, strictly economic, without reciprocity and repetition; and ii) embedded ties - special and close relationship, personal in nature, with economic effects. The first type is more frequent and less significant for the firm's success. Morgan and Hunt (1994) identified the following types of partnerships: i) buyer partnerships - with intermediate customers and ultimate customers; ii) supplier partnerships - goods suppliers and services suppliers; iii) lateral partnerships - with competitors, nonprofit organizations and government; and iv) internal partnerships - among the various business units, functional departments, and employees of the firm. This study mainly focuses on external partnerships (buyer, supplier and lateral).

This study is especially interested in R&D alliances (that may be a source of ideas, knowledge and resources to induce innovation) and in alliances that allow firms to exploit innovation (marketing, commercialization, distribution links that help to put existing innovation in the market). They are central to the concept of open innovation of Chesbrough (2003). According to OECD (2008), a firm may execute open innovation with seven types of partners: i) suppliers, ii) customers, iii) competitors, iv) consultants, v) private R&D institutes, vi) Universities and other higher education institutes, and vii) government and public research centers. The effects of the partner's type on the firm's innovation performance depends on several factors, such as industry, the type of innovation etc. This relationship will be better explored in Section 2.5.

The mitigation of risks is one of the main reasons for decisions regarding the alliance's governance structure, Gulati's second factor. Increasing the strength of the link (of the alliance) is one of the possibilities to mitigate some of the risks, however it creates other threats. The typology proposed by Contractor and Lorange (1988) considered the following spectrum of linkages, from the most intense to the less intense: i) mergers and acquisitions (M&A); ii) independent joint ventures; iii) cross equity ownership; iv) minority equity investment; v) joint

R&D, production, or marketing. vi) franchise alliances; vii) know-how or patent licensing; viii) agreements, e.g. of co-manufacturing or co-supply. Except for M&A, that forms a new organization, the other types can be considered alliances according to the definition proposed by Gulati (1998). Stronger links are usually necessary when the risk of opportunistic behavior or misappropriation of knowledge is high. However, the more intense the link, the higher are the transaction costs and the higher is the risk of "lock-in" (GULATI; NOHRIA; ZAHEER, 2000).

R&D alliances have a high failure rate due to their dual nature of competition and cooperation (XU; FENIK; SHANER, 2014). Therefore, understanding the third topic of Gulati, the evolution of the alliances and networks, is central to their success. Social and behavioral dynamics among partners influence the evolution of the relationship. Della Corte and Aria (2014) highlighted that the personal attitudes and moral approaches of the firms' leaders, their history and trust, as well as their previous experiences in alliances with other companies may help to reduce the initial distrust in inter-organizational relationships and may lead the firms to achieve a stable cooperation.

Harrigan and Newman (1990), studying joint ventures, concluded that alliance partners should have an unusual mix of propensity, power, and persistence. The propensity of the firms to ally grows with the perception of the cooperation benefits, the resources offered by the potential partner, the costs of the alliance and the alternatives to the alliance and necessity, which are related to the formation of the alliance. The bargaining power and persistence of the partners are characteristics extremely important for the evolution of the alliance. The bargaining power of each partner should be balanced to enable the formation of a win-win partnership. During the evolution of the alliance, the bargaining power must remain balanced to avoid that one partner stops gaining from the relationship and starts to make efforts to leave it. Persistence by both partners is also important, because the environment or even the partners themselves may create pressures for changes and the will to make things work is necessary to keep the partnership going. These characteristics should be joined by the definition of a

management process and of control mechanisms that guarantees the appropriate feedback to ensure that the alliance is working well.

The fourth aspect that Gulati highlighted was the performance of the alliance. Measuring alliance's performance is not an easy task. Studying the termination of an alliance is quite common for trying to understand its performance (CUI, 2013; KOGUT, 1988; LEVINTHAL; FICHMAN, 1988). Some studies tried to measure the performance dimension according to specific alliance characteristics, such as the type of alliance (ROTHAERMEL; DEEDS, 2006) and the age of firms (STUART; HOANG; HYBELS, 1999), as well as alliance network dynamics (HAGEDOORN; DUYSTERS, 2002), and network patterns (SOH, 2010) among others.

Strategic alliances forming a pool of skills and resources for the achievement of the partners' common goals may be an integrative view of the positioning school (PORTER, 1980; 1985). and the RBV. This interpretation may provide an explanation about how strategic alliances may generate superior performance. According to RBV, the pooled skills and resources of the alliance should be valuable, rare and hard to imitate in order to provide sustained competitive advantage (BARNEY, 2011). Resources and skills have value when they provide cost or differentiation advantages according to the position of the collaborating firms in the industry, which is consistent with the positioning school These advantages are sustained only if these resources are rare and barriers to imitation exist and bring a superior performance for the strategic alliance. Figure 13 (VARADARAJAN; CUNNINGHAM, 1995) shows an schematic of the above process listing several possible resources and skills that may be pooled. It is important to notice that the strategic alliance may bring sustainable competitive advantage only if the set of resources and skills may not be achieved, or may be achived only with a very high cost, by one of the partners alone or by a competitor.

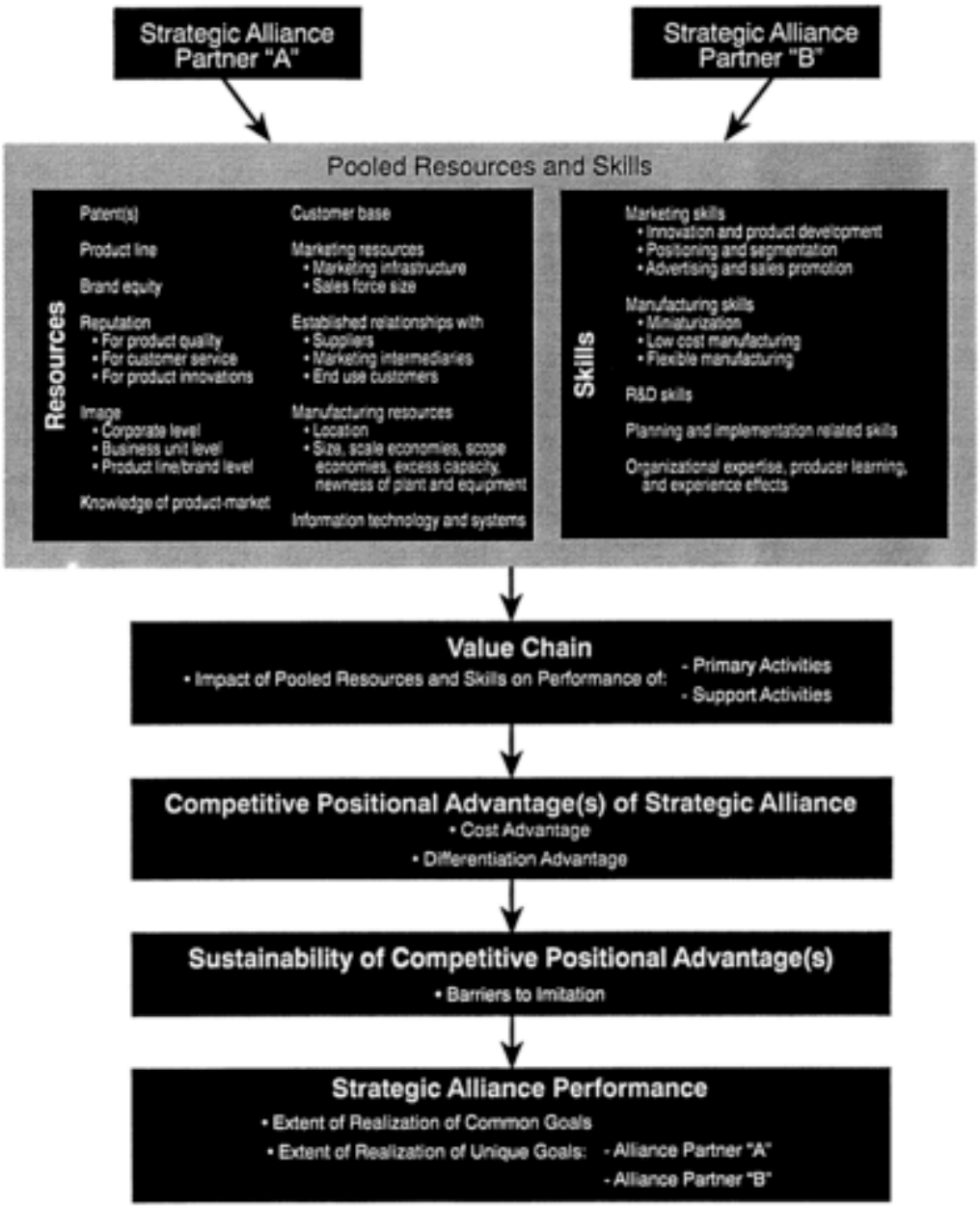


Figure 13 - Achieving superior performance in strategic alliances (VARADARAJAN; CUNNINGHAM, 1995)

2.3.1.
Alliance Portfolio

Multilateral alliances have been reported as forming from 27% to 50% of all alliances, particularly in technology-intensive firms (XU et al., 2014). Several studies indicated that firms which participate of alliance networks are more successful, being bigger, both in revenues and in number of employees; and exporting more, which indicates that they are more competitive on the

international market (AZAR; CIABUSCHI, 2016; RODIL; VENCE, SÁNCHEZ, 2014). Gulati et al. (2000) defined strategic network, as a set of alliances with other firms, whether in the same industry or not, whether domestic or international. Building on the social network theory introduced by Granovetter (1973), alliance portfolio was defined by Knoke (2001) as an egocentric network or ego-net, representing the network formed by the focal firm, its direct ties to partners and its indirect ties among partners. In an extensive research about alliance portfolios, Wassmer (2008) identified several definitions of alliance portfolios in the literature (see Table 6). Table 6 presents some definitions more consonant with the strategic network of Gulati et al. (2000), such as the ones of Bae and Gargiulo (2004) and Lavie (2007); and others more consonant with the alliance portfolio of Knoke (2001), such as the definition of Baum, Calabrese and Silverman (2000) and Rowley, Behrens and Krackhardt. (2000). The diverse theoretical lenses used in alliance portfolio research, identified by Wassmer (2008), are in Table 7, from which we can highlight the social network theory, which is the theory that bases the alliance portfolio definition of Knoke (2001), Baum et al. (2000) and Rowley et al. (2000).

Study	Alliance Portfolio Conceptualization
Bae & Gargiulo (2004)	The set of alliances in which a firm is involved
Baum et al. (2000) and Rowley et al. (2000)	A focal firm's egocentric alliance network (i.e., all direct ties with partner firms) (social network perspective)
Doz & Hamel (1998)	The set of bilateral alliances maintained by a focal firm
George et al. (2001)	A firm's portfolio of strategic agreements or relationships
Hoffmann (2005, 2007)	All alliances of a focal firm
Lavie (2007)	A firm's collection of direct alliances with partners
Lavie & Miller (in press)	A firm's collection of immediate alliance partners
Parise & Casher (2003)	A firm's network of business-partner relationships
Reuer et al. (2002)	A firm's accumulated international joint venture experience (learning perspective)
Reuer & Ragozzino (2006)	All international joint ventures of a focal firm

Table 6 - Existing definitions of alliance portfolio (WASSMER, 2008)

The academy recognizes that the network's characteristics influence its performance. Gulati et al. (2000) stated that the alliance networks where firms are inserted may be sources of strengths and weaknesses. For Wassmer (2008), the configuration of an alliance portfolio of a focal firm determines: i) the quality, quantity and diversity of information and resources it accesses; ii) the efficiency

of the net's resources access; and iii) the flexibility and stability of the position of the focal firm in the ego-net.

Theoretical Lens	Study
Social network theory	Ahuja, 2000a, 2000b; Bae & Gargiulo, 2004; Baum et al., 2000; Capaldo, 2007; Chung et al., 2000; Goerzen, 2007; Goerzen & Beamish, 2005; Gulati, 1999; Powell et al., 1996; Rowley et al., 2000; Stuart, 2000; Walker et al., 1997; Zaheer & Bell, 2005
Organizational learning in general	Anand & Khanna, 2000, Deeds & Hill, 1996; Draulans et al., 2003; George et al., 2001; Gulati, 1999; Hoang & Rothaermel, 2005; Kale et al., 2002; Lavie & Miller, in press; Powell et al., 1996; Reuer et al., 2002; Stuart, 2000
Exploration/exploitation framework	Dittrich et al., in press; Lavie & Rosenkopf, 2006; Rothaermel, 2001
Resource-based view	Ahuja, 2000a, 2000b; Chung et al., 2000; Lavie, 2006; Lorenzoni & Lipparini, 1999; Vassolo et al., 2004; Zaheer & Bell, 2005
Dynamic capabilities	Kale et al., 2002; Lorenzoni & Lipparini, 1999
Knowledge-based view	Draulans et al., 2003; Kale et al., 2002; Lorenzoni & Lipparini, 1999
Relational view	George et al., 2001
Evolutionary economics	Kale et al., 2002
Transaction cost	Goerzen, 2007; Goerzen & Beamish, 2005 economics
Other economics	Deeds & Hill, 1996
Agency theory	Reuer & Ragozzino, 2006
Contingency theory	Hoffmann, 2007
Coevolutionary perspective	Hoffmann, 2007
Contract theory	Anand & Khanna, 2000
Real options	Vassolo et al., 2004
Resource dependency theory	Bae & Gargiulo, 2004; Ozcan & Eisenhardt, in press theory

Table 7 - Theoretical lenses of alliance portfolio research (WASSMER, 2008)

From the industry level perspective, an alliance network presents three dimensions, according to Galaskiewicz and Zaheer (1999): i) network structure – the overall pattern of relationships within which the industry is embedded; ii) network composition – identity, that is represented by the intensity of attractiveness or recognition of a firm as a trade partner (ANDERSON; HÅKANSSON; JOHANSON, 1994); status; access of resources from the firm and from the partners; and iii) tie modality – the set of rules and norms that conduct the network.

Based on Wassmer and other authors, some dimensions of the portfolio configuration are: i) size dimension - number of alliances and partners; ii) structural dimension – centrality (the position the firm occupies in the network, that can be central or peripheral), breadth, density (proportion of existing ties in

all possible ties of the portfolio) and level of redundancy (a bunch of ties with the same set of partners); iii) relational dimension - tie strength of the individual alliances; and iv) individual partners' characteristics. The definition of this dimensions allows the creation of metrics to be implemented in empirical studies.

Several authors analyzed the relationship between the configuration of the alliance portfolio and performance. Ozcan and Eisenhardt (2009) concluded that portfolios with a good amount and mix of strong and weak ties, achieving diversity, have higher chances to reach a good performance. Portfolios rich of resources, with experienced partners, present the same advantage. Other configuration that favors competitive advantage is if the firm's ego-network (the portfolio of alliances of the firm and among their partners) is centrally embedded in the whole industry's network, with a lot of different partners, providing flexibility, information flow and varied resources. Regarding the individual ties, they are more effective if partners are experienced and have central position in the network.

The influence of alliance portfolios and its configurations on innovation was also investigated. Macedo-Soares, Barboza and Paula (2016), in a bibliographic study about alliance portfolios, absorptive capacity and innovation performance identified that the participation in alliance portfolios has a positive effect on innovation performance and that this relationship is influenced by the portfolios' characteristics, notably diversity (functional, geographical and institutional), but also centrality, size, partners type and so forth.

Another important structural characteristic of a portfolio is the existence of structural holes. According to Burt (1992), "a structural hole is a not redundant connection between two contacts". They usually link two separate networks. The company that bridges the hole is called the broker. Through a structural hole, the information flow is more fluid. Firms in both side of the hole access different information flows by way of the broker. Networks rich in structural holes enable access to non-connected partners and allow many different flows of information (AHUJA, 2000), as opposed to embedded networks, only with strong ties, in

which the focal firm have difficulty to access external, new information. For this reason, the presence of structural holes in a network favors innovation.

Based on the portfolio configuration, Hagedoorn and Duysters (2002) proposed a framework to classify alliance networks:

i) Efficiency-based networks - firms in this network configuration expect to have a complete and accurate information about all network connections. They understand and apply the principles of power network, which involves being very selective and efficient in the choice of partners, and bridging structural holes with as little redundancy as possible. Burt (1992) stated that network size is not as important for information transfer as the non-redundant contacts because the redundant contacts carry the same information, which is aligned with efficiency-based networks;
ii) Learning-based networks - cooperation among firms in dynamic environments helps the firm to learn different ways to operate. For this kind of network, redundancy is important. In high-tech industries, multiple links are relevant not only for information transfer, but also for joint learning about new technologies and new opportunities.

Contradicting Burt's theory, the authors empirically found a positive relationship between the existence of learning-based networks and innovation performance and a negative relationship between the existence of efficiency-based networks and innovation performance. A justification for these results is that multiple redundant ties would improve information transfer and joint learning, as previously said.

Another important aspect of alliance portfolios is their management. The firm cannot take advantage from their alliances or from the alliance portfolio of which it is part, even if the configuration of the network and the firm's position inside it is ideal, without a good management of its alliances. Wassmer (2008) identified two main aspects focused by the main stream of research about management of alliance portfolios: i) alliance capabilities and ii) approaches and tools for multiple alliances management.

Alliance capability is defined as "a firm's ability to identify partners, initiate alliances, and engage in the ongoing management and possible restructuring and termination of these alliances" (KHANNA, 1998). The main manner to build alliance capability is through experience. For Rothaermel and Deeds (2006) this is a path-dependent capability, that is built through time with repeated participation in alliances. The literature frequently finds a positive effect between alliance capabilities and alliance experience, but this effect is dependent on the firm's internal effort to maximize the learning effects of these experiences. The company should create processes to internalize the experience of the previous alliances, codify the management routines and train managers to deal with it. There is also a difference in acquiring alliance capability and acquiring alliance portfolio capability. The routines and knowledge to manage a single partnership with a firm is different from the ones to deal with big nets formed by different companies of diverse types that relates with the focal firm and other firms in the environment. The construction of single alliance capability is necessary but not enough to build the appropriate alliance portfolio capability.

Another important aspect of the management of alliance portfolios refers to the approaches and tools for alliance portfolio management. It prioritizes a holistic approach with the formalization of the process and tools that supports the managers on activities such as partner selection, guaranteeing fit between the portfolio's choice and the company's strategy; absorption of knowledge about the alliance portfolio; exploiting synergies; avoiding conflicts, among other things. Some examples of tools are portfolio analysis, alliance databases, knowledge management and alliance scorecards. One of the biggest challenges in the development of these tools and techniques is to create measures of alliance portfolio performance and success.

2.3.2. Strategical benefits of alliances and alliance portfolio according to the level of analysis

The theories of strategic alliances and networks have significant overlaps. Empirical works found different results, contingent on the context where the firms

and its ego-net are located. An interesting contribution to the theory was made by Zaheer, Gözübüyük and Milanov (2010), that proposed a framework for organizing the strategic network research based on an extensive literature review of the field. The framework considers a relationship between strategical benefits that can be sourced by alliances or alliance networks (the strategical benefits are called by the authors as theoretical mechanisms) and some network characteristics, such as the ones of the structural dimension (centrality, density, etc.), according to three level of analysis: i) dyad – the individual tie between the focal firm and a partner; ii) ego-net – the focal firm's alliance portfolio formed by their ties with partners and the ties existent between partners; and iii) whole network – interorganizational networks at the network level (PROVAN; FISH; SYDOW, 2007). The focus of the framework is on four theoretical mechanisms and their relationships with the characteristics of each level of analysis (see Table 8). The theoretical mechanisms are:

- Resource access – resources and capabilities that form the pool to which the focal firm has access. This access is enhanced at the dyad level by strong ties for tacit knowledge transfer and weak ties for explicit knowledge transfer. At the ego-net level, centrality and the existence of structural holes increase information transfer, capabilities and learning. At the level of the whole network, the existence of interorganizational networks allows an effective knowledge transfer;

- Trust – trust among partners or network participants is considered an important mechanism, as it can reduce transaction costs and lower the potential threat of opportunistic behavior. Strong ties at the dyad level, centrality and closure at the ego-net level and interorganizational networks at the level of the whole network enhances trust;

- Power / control – the power of the focal firm in relation to its partners and to the network may be enhanced by the level of power imbalance and mutual dependence at the dyad level. Structural holes may be a source of bargaining power within the ego-net and interorganizational networks may help the formation of strategic blocks at the level of the whole network;

- Signaling – this theoretical mechanism is the communication of the actors' quality to the market, that can be inferred from its relationships. This mechanism is less developed in the literature and the authors could only identify that centrality, at the ego-net level may be a source of status.

Theoretical Mechanism	Level of Analysis		
	Dyad	Ego	Network
Resource Access	Strong Ties --> Tacit Knowledge Transfer Weak Ties--> Explicit Knowledge Transfer Uzzi & Lancaster (2003) Exploitation Context --> Strong Ties Exploration Context --> Weak Ties Rowley	Degree Centrality --> Information Ahuja (2000) Shan et al. (1994) Degree Centrality --> Capabilities and Learning Powell et al. (1996) George et al. (2001) Structural Holes --> Information Burt (2004) Zaheer & Bell (2005) Structural Holes3Capabilities and Learning McEvily & Zaheer (1999)	Interorganizational Networks --> Regional Success Saxenian (1994) Interorganizational Networks --> Effective Knowledge Transfer Singh (2005) Almeida & Kogut (1999)
Trust	Strong Ties -->Trust Gulati (1995) Trust --> Performance Zaheer et al. (1998)	Closure --> Trust Ahuja (2000) Rowley et al. (2000) Centrality --> Trust Ingram & Roberts (2000)	Interorganizational Networks --> Regional Success Saxenian (1994)
Power / Control	Power Imbalance --> Tie Formation Bae & Gargiulo (2004) Mutual Dependence --> Constraint Absorption Casciaro & Piskorski (2005)	Structural Holes --> Bargaining Power Burt (1992)	Interorganizational Relationships --> Strategic Blocks Nohria & Garcia-Pont (1991)
Signaling	Future Research	Bonacich Centrality as Status Benjamin & Podolny (1999) Gulati & Higgins (2003) Jensen (2003)	Future Research

Table 8 - Framework for network research (ZAHEER et al.; 2010)

An important conclusion can be drawn from this framework. Some characteristics enhance some theoretical mechanisms while reducing others. Structural holes, for example, are opposite to closure. The existence of structural holes favors information flows and learning while lowers trust. Balancing the characteristics when establishing the alliances and the portfolios is a tough and fundamental activity for the firm. These choices are strategic and are contingent on its goals, firm and industry characteristics, the environment etc.

2.4. Performance

The definition of performance is complex and it is of fundamental importance to this study's goals. Independently from its context, every firm seeks

to achieve superior performance and all the ideas mentioned above about innovation and strategic alliances are based on the assumption that their adoption are strategic choices that the company may make (or is obligated to make) to reach the desired performance. The first concepts that come to mind when people think about how to define and measure performance are accounting and financial ones, because it is simpler and most companies' main goal is to achieve profit. Other concepts will be explored below because there are organizations that do not worry about profit (for instance, NGOs and state-owned companies) and because there is a growing discussion whether the firm's goals should only be to provide rents for their shareholders or if the firms should have a broader social mission.

The authors Cameron and Whetten (1983) wrote about the importance of business performance in organizations' management in three dimensions:

i) Theoretical - the concept of performance is of undeniable theoretical relevance to strategic management as strategies are tested by measuring the performance of firms that apply them;
ii) Empirical – the importance of this dimension is remarkable because constructs and proxies that represent performance are widely used in strategy field research;
iii) Managerial – this dimension is also important because several studies intend to formulate recipes for firms to achieve good performance.

Barney (2011) proposed a comparative classification of performance, considering that, basically, three types of performance exist: i) standard performance, that happens when the company generates the amount of rent expected by its investors or on the market average; ii) below normal performance, when the firm generates less rents than expected by the investors or by the market average; and iii) above normal performance, when the firm generates a return higher than expected. This classification is valid for the four types of performance measures the author proposed: i) survival measure; ii) stakeholders' approaches to performance measures; iii) simple accounting measures; and iv) adjusted accounting measures.

The survival measure is simple to understand and to apply. Its concept is based on the assumption that a firm continues operating only if it obtains at least a standard performance. The easiness of application is the main advantage of this type of measure. However, it presents several disadvantages. Using this indicator, it is not possible to compare the performance of two firms that survived in the same period. If an investor is willing to decide from which of the two companies to buy shares, the survival measure would mean nothing. It also does not inform anything about above normal performance. Another issue is that a firm which obtains above normal rents during some time may invest these extra rents in avoiding bankruptcy during a crisis in the future, extending its survival during a below normal performance period.

The stakeholder's approach considers indicators that measure the results compared to the goals of the organization from the perspective of each stakeholder (i.e. shareholders, employees, directors, suppliers, community, government), such as the satisfaction of the stakeholder. Examples of this type of measure are the quality of products or services, from the customers' point of view; organizational health, from the employees' point of view; or the level of environmental impacts, considering the community's interests. This type of measure has the advantage of considering multiple stakeholders, not only the shareholders, unlike accounting measures. On the other hand, it can lead to controversial conclusions about organizational performance, because a firm may have above normal results from the employees' perspective, but not present the expected return to the shareholders, for example.

Simple accounting measures are the most used performance indicator in both academic empirical research and in practical management. They have the advantage that they are well defined by accounting legal rules (usually as ratio formulas), simple to measure with accounting data, and present a good perspective of comparison among firms. The main criticism is that it usually considers only the shareholders' perspective. Other practical criticisms are that there is some space for managerial discretion, whereas managers can choose some not well-defined assumptions for their calculations that jeopardize the comparison; they tend to cause short-term bias in the performance analyses when

some decision needs to be taken; and the difficulty to assess intangible assets. As an attempt to overcome some of the issues presented by simple accounting measures, scholars proposed some adjusted accounting measures. They usually rely on the concept of cost of capital, that is the return of capital investors expect to receive. Table 9 presents some of the most popular simple and adjusted accounting measures.

Ratio	Description
Simple accounting measures	
Return on assets (ROA)	Ratio between profit after taxes and total assets value
Return on equity (ROE)	Ratio between profit after taxes and total shareholders' equity
Earnings per share (EPS)	Ration between net income and weighted average number of shares.
Gross net profit	Ratio between sales minus cost of goods sold and sales
Debt to assets	Liquidity measure that is defined by the ratio between total debt and total assets
Adjusted accounting measures	
Return on invested capital (ROIC)	Ratio between the after-tax operating income and the invested capital
Tobin's q	Ratio between total market value of the firm and total assets value

Table 9 - Some simple and adjusted accounting measures

A broader concept for performance measurement is the layered model proposed by Venkatraman and Ramanujam (1986). According to this model, there are three domains of performance, and the deeper ones are encompassed by the broader ones. Financial performance is the deepest level, followed by business performance that, in turn, is a subset of the broadest domain, that is called organizational effectiveness (Figure 14). The levels are described below:

i) Financial performance - accounting measures already explained above. This domain is most commonly used in empirical research;

ii) Business Performance - measures of operational or non-financial performance, which drives financial performance. Some indicators of this type are market-share, introduction of new products, product quality, service quality, effectiveness of marketing etc.;

iii) Organizational Effectiveness - this layer covers more general aspects of organizational performance. It includes the stakeholders' approach measures already explained.

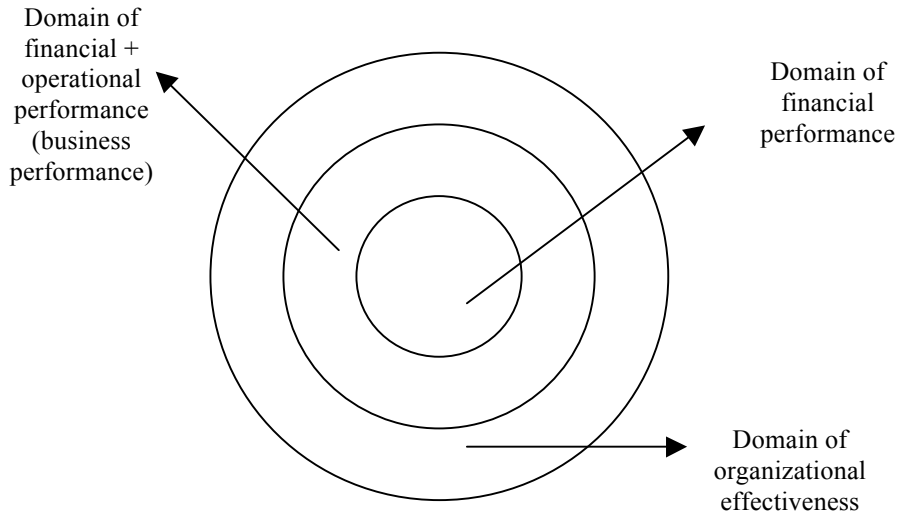


Figure 14 - The domains of performance (VENKATRAMAN; RAMANUJAM, 1986)

An alternative measure of performance is firm's growth. Baum, Locke and Smith (2001) proposed some measures for growth, such as: i) annual average sales growth; ii) annual average number of employees' growth; and ii) average net profit growth. Growth as a measure of performance is controversial. According to Penrose (1959), it is an attempt to measure better performance in the long term. However, a firm usually needs to retain profits to grow and it may be more interesting for managers than for shareholders. The same fact is advocated by Chandler and Hikino (2009). According to the authors, growth interests more managers because their variable earnings are usually calculated using this kind of indicator. In contrast, the shareholders are more interested in profits and dividends. This conflict between the concerns of managers and owners is described by the agency theory (EISENHARDT, 1989; JENSEN; MECKING, 1976).

2.5.
The role of internal and external sources of innovation on the innovation performance

The integration of internal and external sources of knowledge is very important for the firm to develop its innovation capabilities, which are directly linked to the former's innovation performance (BELL; FIGUEIREDO, 2012). Internal sources of knowledge, which can be generated by internal R&D, but also by other internal activities, are important as they can help to generate innovation by themselves and they also improve the firm's capacity to recognize, acquire, assimilate and apply external knowledge, which is a capability called absorptive capacity (COHEN; LEVINTHAL, 1989, 1990).

Internal R&D, construct mainly represented in the literature by the proxies R&D expenditures and R&D intensity (HAGEDOORN; WANG, 2012), is mentioned in the literature mostly causing a positive impact on innovation (BELUSSI; SAMMARRA; SEDITA, 2010; FRENZ; IETTO-GILLIES, 2009; HAGEDOORN; WANG, 2012; OERLEMANS; KNOBEN; PRETORIUS, 2013; ZAHEER; BELL, 2005). This positive relationship between R&D expenditures and innovation performance indicates that the effort to produce internal knowledge is highly related to its effective generation.

The level of the impact of internal R&D on innovation performance depends on the type of innovation. Hall and Bagchi-Sen (2007) found that a high level of internal R&D is associated with high levels of research-based innovation, which is more associated to the patenting of new technologies, but not with high levels of product-based innovation, which is related to the introduction or changes in products and services. In contrast, in a longitudinal research about startups, Stam and Wennberg (2009) found a positive relationship between internal R&D development and new product development. The authors also verified a relationship between R&D activities and firm's growth in high-tech industries. The fact is that most authors found a positive relationship between internal R&D and innovation outcome, regardless of the innovation type.

External sources of knowledge, as well as internal sources, are very important to build a firm's innovation capabilities. The literature recognizes strategic alliances as important external sources of innovation. This is consistent with the already discussed concept of open innovation that, according to Chesbrough (2003), consists on the usage by the firm of external ideas as well as internal ones, and internal and external paths to the market. Many authors consider that a firm cannot innovate while being isolated (CHESBROUGH, 2003; DAHLANDER; GANN, 2010; LAURSEN; SALTER, 2006), therefore, the adoption of open innovation would be a necessity for innovation development. In a bibliometric study about open innovation, Dahlander and Gann (2010) identified four different types of openness in the literature, all of them with both advantages and disadvantages. The first two types are forms of inbound innovation and the last two are forms of outbound innovation:

i) Acquiring innovation from other firms - advantages may be achieved if the firm has the expertise to seek and evaluate opportunities. There is an inverted U-shape relationship between innovation acquisition and the proximity among the knowledge-bases acquired and the existing ones. If they are very close, it may be difficult for the company to find new combinations. If they are too far, the alignment among the acquired practices and the ones already existent internally may be hard to accomplish;
ii) Outsourcing of innovation - if the firm can manage the creation of synergy among its own processes and externally available ideas, outsourcing of innovation may have advantages. In contrast, some studies concluded that the effect is an inversed U-shape relationship between the search of possibilities of outsourcing and its results, because manage many procurement fronts is not viable (that is called super-looking of external innovations);
iii) Selling innovation for other firms - an advantage is that it helps to leverage the firm's internal R&D and increases its potential revenues. A disadvantage is that there is a tendency that the company become afraid to share sensible information that the buyer may use opportunistically. Often, there are also not considered transaction costs in licensing. Another problem is that the

innovator may not recognize the innovation's sales potential, by not having the structure to exploit it;

iv) Revealing innovation to the market - many firms reveal deliberately its innovation to encourage collaboration, which is an advantage. Formal (patents, trademarks and copyright) and informal (lead times, advantages of firs move, lock-ins) appropriability methods can allow the firm to appropriate the income generated by the disclosed innovation. A disadvantage of this type of open innovation is that other firms may unduly appropriate the rents generated by the revealed innovation. Another risk is that the developer company may exaggerate in the usage of appropriability mechanisms, which can cause myopia.

The reasons to invest in innovative collaboration through strategic alliances are diverse (FAEMS et al., 2005), as, for example, access to complementary assets, transference of tacit and codified knowledge to help develop resources otherwise hard to create, and spread costs of R&D. According to Mowery, Oxley and Silverman (1996), firms make alliances to acquire capabilities for themselves, access other firms' capabilities, share costs and risks, penetrate new markets, formulate technical patterns and gain bargain power. Teece (1986) stated that innovators of new industries may use partnerships to guarantee the necessary complementary assets. This tendency disappears as an industry matures and incumbents tend to end up possessing all those assets.

Hagedoorn (1993), in an effort to understand "why companies cooperate in their business efforts" (HAGEDOORN, 193, p. 371), made an overview of the reasons to invest in strategic technology cooperation proposed by the literature (see Table 10). The author identified three main group of reasons: i) reasons related to basic and applied R&D; ii) reasons based on concrete innovation processes; and iii) reasons related to market access and search. He founded that R&D alliances are more common in high-technology industries while market alliances are more indicated in non-technology industries. For basic research, however, cooperation is not always a good strategy and firms usually develop it internally.

I - Motives related to basic and applied research and some general characteristics of technological development:
Increased complexity and intersectoral nature of new technologies, cross-fertilization of scientific disciplines and fields of technology, monitoring of evolution of technologies, technological synergies, access to scientific knowledge or to complementary technology: Mariti and Smiley (1983), Harrigan (1985), Ohmae (1985), OECD (1986a, b), Porter and Fuller (1986), Fusfeld (1986), Haklisch (1986), Mariotti and Ricotta (1986), Auster (1987), Hladik (1988), Klepper (1988), Mowery (1988a, b), Ouchi and Bolton (1988), Obleros and MacDonald (1988), Pisano, Russo and Teece (1988), Pisano, Shan and Teece (1988), Steinmueller (1988), Womack (1988), Hagedoorn and Schakenraad (1990a, b).
Reduction, minimizing and sharing of uncertainty in R&D: Berg, Duncan and Friedman (1982), Ohmae (1985), Harrigan (1985, 1988), Mariotti and Ricotta (1986), Porter and Fuller (1986), Auster (1987), Mytelka and Delapierre (1987), Hladik (1988), Mowery (1988b), Obleros and MacDonald (1988).
Reduction and sharing of costs of R&D: Ohmae (1985), Harrigan (1985, 1988), OECD (1986a), Mariotti and Ricotta (1986), Auster (1987), Mytelka and Delapierre (1987), Hladik (1988), Mowery (1988b), Obleros and MacDonald (1988), Steinmueller (1988), Link and Bauer (1989).
II - Motives related to concrete innovation processes:
Capturing of partner's tacit knowledge of technology, technology transfer, technological leapfrogging: Mariti and Smiley (1983), Harrigan (1985), Hamel, Doz and Prahalad (1986), Lynn (1988), Pisano, Shan and Teece (1988), Hagedoorn and Schakenraad (1990a, b).
Shortening of product life cycle, reducing the period between invention and market introduction: OECD (1986a), Mariotti and Ricotta (1986).
III - Motives related to market access and search for opportunities:
Monitoring of environmental changes and opportunities: Mariotti and Ricotta (1986), Obleros and MacDonald (1988).
Internationalization, globalization and entry to foreign markets: Ohmae (1985), OECD (1986a), Porter and Fuller (1986), Harrigan (1988), Lynn (1988), Mowery (1988b), Pisano, Russo and Teece (1988), Steinmueller (1988), Womack (1988), Vonortas (1989).
New products and markets, market entry, expansion of product range: Hladik (1985, 1988), Harrigan (1985, 1988), OECD (1986a, b), Mariotti and Ricotta (1986), Porter and Fuller (1986), Klepper (1988), Mowery (1988a), Steinmueller (1988), Pisano, Shan and Teece (1988), Womack (1988), Hagedoorn and Schakenraad (1990a, b).

Table 10 - An overview of reasons for innovation's strategic alliances formation (HAGEDOORN, 1993)

Positive relationships between external sources of R&D and innovation have been reported in various empirical studies (BELUSSI et al., 2010; FAEMS et al., 2005, 2010; NIETO; SANTAMARÍA, 2007). Ordanini and Parasuraman (2011) found a positive relationship between collaboration and service innovation.

Love et al. (2014) concluded that the more types of alliances a firm uses, higher is the chance for it to succeed in learning and innovating. However, several researchers have detected an inverted U-shape relationship between innovation alliances and innovation performance (DUYSTERS; LOKSHIN, 2011; BERCHICCI, 2013). The positive relationship inverts with the increasing of partner types because of the increasing coordination and monitoring costs to avoid misappropriation of knowledge and innovation (HALLEN; KATILA; ROSENBERGER, 2014). This effect is similar to that of other influencing factors in innovation, such as marketing capabilities that, given their complexity, breadth, and the lack of ability of organizations to develop their whole spectrum, positively influence innovation to a certain extent, above which the influence decreases (TREZ, 2009). To smooth that inverted U-shape effect, a firm should develop social capital (TSAI; GHOSHAL, 1998) and use conflict management to increase the appropriation regime capacity to protect essential assets (KALE; SINGH; PERLMUTTER, 2000).

According to OECD (DEBACKER, 2008), strategic alliances for innovation usually occur with seven partner types: i) suppliers, ii) customers, iii) competitors, iv) consultants, v) private R&D institutes, vi) Universities and other higher education institutions, and vii) government and public research. Table 4 already showed a similar classification of external sources of innovation that identifies types of partners that may collaborate with the firm in the innovation process. Different types of partnerships promote different results. The literature presents several studies that tried to identify the effect of different types of innovation alliances on innovation performance. According to von Hippel (1988), clients are the most frequent sources of innovation, a fact that is illustrated in Table 4. Chatterji and Fabrizio (2014) detected a positive relationship between the partnership with clients and innovation performance. On the other hand, Un, Cuervo-Cazurra, and Asakawa (2010) found empirical evidences that R&D alliances with suppliers provide better results for increasing innovation performance than the other types, followed by collaboration with Universities. Alliances with competitors have a negative impact according to this study. Aschhoff and Sofka (2009) found evidences that government incentives to firms have positive effects in the company's innovation. Soh and Subramanian (2014)

stated the importance of collaboration with Universities in the firm's innovation, mainly in basic research.

The effect of alliances on innovation outcomes is also contingent on firm's and industry's aspects, and on the nature of the innovation. Belderbos et al. (2006) tested the complementarity among different types of R&D cooperation with performance and found that it is contingent on the firm's size. While partnerships with competitors and clients at the same time are complementary for all types of firms, alliances with suppliers are complementary only for large firms. Oerlemans et al. (2013) attested an inverted U-shape relationship between partner diversity and the innovation outcome. Rothaermel (2001) found that the formation of alliances has a greater impact on exploiting existing innovation than on exploring radical innovation. Oerlemans et al. (2013) found that a more diversified alliance portfolio is more effective for incremental than radical innovation.

The conversion of external knowledge obtained from alliances or other external sources to successful innovation is not automatic. Cohen and Levinthal (1990) proposed that, to succed in this effort, firms should have a high absorptive capacity (AC). According to the authors, AC is defined as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends." AC is a capability that is firm specific and cannot be purchased. Some items are intrinsically related to a firm's specific AC: i) previous knowledge level, as learning is cumulative and depends on the relationship between learning and something already known; ii) absorptive capacities of individual members of the firm, that depend on investment in training in these skills; iii) the firm's interface with the external environment and the transmission of knowledge across firm's units (communication system); iv) some level of overlap of knowledge among the internal employees so that there is communication, but with different knowledge structures among individuals to increase innovativeness; v) technical personnel and scientists should be competent and understand the idiosyncratic needs of the firm; and vi) further investments on R&D.

Kim (1997) proposed a model of knowledge assimilation and innovation generation for latecomer firms in developing countries that is based on three activities: acquisition of knowledge (related to the production of a specific technological product), assimilation of knowledge and improvements in the product in the form of incremental innovation. For this model to succeed, the assimilation phase depends on the firm's absorptive capacity, that the author defines as a conjunction of two factors or dimensions:

i) Existing knowledge base – this is an essential element of technological learning, because internal "today's tacit knowledge enables individuals and organizations to create tomorrow's tacit knowledge" (Kim, 1997, p. 97)
ii) Intensity of efforts – the effort is important because only the exposition to internal knowledge is not enough to assimilate external knowledge. Firm's policies and investments should be directed to the assimilation success and the employees must be aligned with these policies.

The various combinations of these two dimensions are illustrated in Figure 15. Existing knowledge base, according to it, represent the level of technological capabilities the firm already possesses. The improvement on this level of technological capabilities depends of the intensity of efforts. If it is low, the level of technologic capabilities will fall, and it will rise if the intensity of efforts is high.

The two dimensions proposed by Kim (1997) justify the choice of some of the most used proxies of AC. Cohen and Levinthal (1990) used the firm's R&D intensity (the relationship between internal R&D expenses and total revenue) as a proxy of AC. R&D intensity is related to Kim's dimension intensity of efforts. Other authors such as Dushnitsky and Lenox (2005a, 2005b) used patent stock as a proxy of AC, that is an indicator more related to the dimension existing knowledge base. Table 11 presents several AC proxies that may be found in the literature.

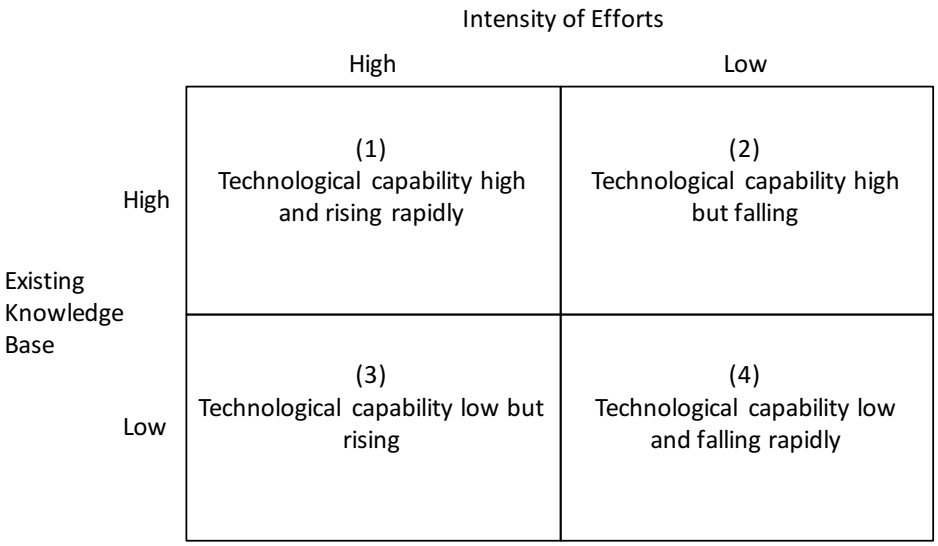


Figure 15 - Dimensions of absorptive capacity (KIM, 1997)

However, knowledge transfer among firms does not depend only on the receptor of the knowledge. It also depends on the firm that transfers it. Lane and Lubatkin (1998) proposed the idea of a relative absorptive capacity, that is the capacity for a firm to assimilate knowledge from a specific partner. The ability of two firms to learn from each other depends on: i) both firms' knowledge bases; ii) both firms' organizational structures and remuneration policies, and iii) the dominant logic. Relative absorptive capacity justifies the usage of some of the listed proxies listed in Table 11, as for example technological distance among partners (DUSHNITSKY; LENOX, 2005b; LANE; LUBATKIN, 1998).

Proxies	Articles
Internal R&D spending / total revenue (R&D intensity)	Cohen & Levinthal (1989); Cohen & Levinthal (1990); Berchicci (2013)
Internal R&D spending / number of employees	Tsai (2009); Berchicci (2013)
R&D engagement (firm is engaged in at least one R&D activity)	de Faria et al. (2010); Giuliani & Bell (2005)
Total internal R&D expenses	Dushnitsky & Lenox (2005); Belussi et al. (2010)
Patent stock	Dushnitsky & Lenox (2005a,2005b)
Technological distance among partners	Dushnitsky & Lenox (2005b); Lane & Lubatkin (1998)
% Staff in internal R&D	Berchicci (2013)
Level of education of employees	de Faria et al. (2010); Giuliani & Bell (2005)
Employees experience	Giuliani & Bell (2005)
AC scales	Lane et al. (2001); Azadegan & Dooley (2010); Ritala & Hurmelinna-Laukkanen (2013)

Table 11 - Absorptive capacity measures

A higher AC is associated with an increase of the positive effect between external R&D, from strategic alliances or other sources, and innovation performance in several studies (BELLAMY; GHOSH; HORA, 2014; BERCHICCI, 2013; MACEDO-SOARES et al. 2016; PAULA; SILVA, 2017; SRIVASTAVA; GNYAWALI; HATFIELD, 2015; VANHAVERBEKE; BELDERBOS; DUYSTERS; BEERKENS, 2015). In contrast, some authors found substitutability between internal and external R&D (HAGEDOORN; WANG, 2012). Some authors also found that the complementarity or substitutability of internal and external R&D is contingent on the level of investments in internal R&D (HAGEDOORN; WANG, 2012; LIN et al., 2012). Tsai (2009) detected that the effect of AC on the relationship between R&D alliances and innovation performance is contingent on partner type and whether the innovation is radical or incremental. On the other hand, some authors did not find a positive effect of the interaction between internal and external sources of R&D (BELUSSI et al., 2010; MOWERY et al., 1996).

One reason for these contrasting results could be that the nature of AC has several dimensions that are hard to capture. Srivastava, Gnyawali, and Hatfield (2015) criticized the one-dimensionality of many studies considering absorptive

capacity by affirming that AC has two dimensions, such as Kim (1997). The first dimension, that was called technological effort, represents a "broad-based preparedness to understand new technologies and R&D investment" and this dimension's moderation role is positive. The second dimension is technological capability, that is the "proven success and the firm's technological prowess…indicative of the past success" and the moderator effect of it is negative, as far as firms with high technological capability may already have acquired the internal qualifications to innovate and may not be so interested in using external sources of knowledge.

2.6. How innovation performance influences financial performance

The relationship between innovation and financial performance at the firm level has been consistently found in several empirical studies (DECAROLIS; DEEDS, 1999; DU et al., 2014; FAEMS et al., 2010; ROTHAERMEL, 2001; YAMAKAWA; YANG; LIN, 2011). In today's uncertain environment, innovation is essential for firm survival (TEECE, 2007). When a radical innovation occurs in the industry, the performance of the incumbents tends to decrease, whereas new ventures that pioneer the innovation introduction take their places (HILL; ROTHAERMEL, 2003). Even if the introduction of a radical innovation which changes the industry patterns does not happen, many authors recognize the importance of innovation for performance. Tomlinson (2010) found a positive relationship between product and process innovation and factors that can influence performance, such as firm size and sales growth. Some authors verified that open innovation activities performed by firms have a positive relationship with customer and financial performance (CHENG; HUIZINGH, 2014; DU et al., 2014).

However, other studies recognized the difficulty in finding a relationship between innovation and performance. Heeley and Jacobson's (2008) study, that related patents' age with financial performance, found that the fast follower strategy (a strategy in which a firm waits for the technological leader to launch a new product and, through coping or creating a similar substitute fast enough, tries

to gain market-share) is more related to a superior financial performance than the first mover strategy, taken by the technological leader, or innovator. Freeman (1982) sustained that R&D efforts are more important for performance at the industry level than at the firm level. This assertion implies that innovation generated by the firms and other organizations related to an industry potentially increase the financial performance of the industry as a hole. Stam and Wennberg (2009) found a relationship between R&D activities and firm's growth contingent on the level of how technological the firms are. For high-tech firms, the relationship was positive, however, for low-tech firms, this relationship was not found significant.

Teece (1986) realized that innovator and imitator performance varies depending on the industry. In some cases, innovators have a better performance than imitators and in other cases, the reverse happens. According to the author, three factors explain the relationship between a firm's innovation level and its financial performance, because they define how the rents of an industry will be shared among its actors (innovators, followers, customers and suppliers):

i) Appropriability regime - which are the mechanisms an innovator firm has to guarantee that it will benefit from a fair part of the innovation' rents. According Cohen and Walsh (2001), appropriability mechanisms are ways to protect innovation from imitation. They can be classified, according to Hurmelinna-Laukkanen and Puumalainen (2007), as: 1) nature of knowledge; 2) institutional protection; 3) human resources management; 4) practical/technical means; and 5) lead time. The way the appropriability mechanisms favor the innovator depend on the nature of technology (tacit or codified), and the effectiveness of protection mechanisms (patents, copyrights, trade secrets). It is important that the firm achieve a strong appropriability regime in order to make the innovation performance turn into financial performance (COHEN; WALSH, 2001). However, strong appropriability regimes that favors the innovator are available in a minority of industries and environments. If on the one hand, the application of the appropriability mechanisms may increase the performance, on the other

hand it can be detrimental as it may compensate cost cutting of sharing R&D with partners (COHEN; LEVINTHAL, 1989);

ii) Dominant design paradigm - if the innovator company has the opportunity to make its innovation become the industry standard, this will strongly contribute to financial results. For this to happen, the innovator must be strongly connected to the market. When the chances for this to happen increase, the relative cost of the prototype decreases. When the innovation can emerge as the dominant paradigm in the industry, the innovator will be better positioned in the cases in which the innovation is hard to imitate;

iii) Complementary assets - how much of the assets necessary to put innovation into market (marketing, distribution, manufacturing) the innovator firm possesses. The innovator needs to have marketing, manufacturing, after-sales, and other general and specialized capabilities that can be source of competitive advantage. If the innovator does not have them, other firms that have will achieve market leadership.

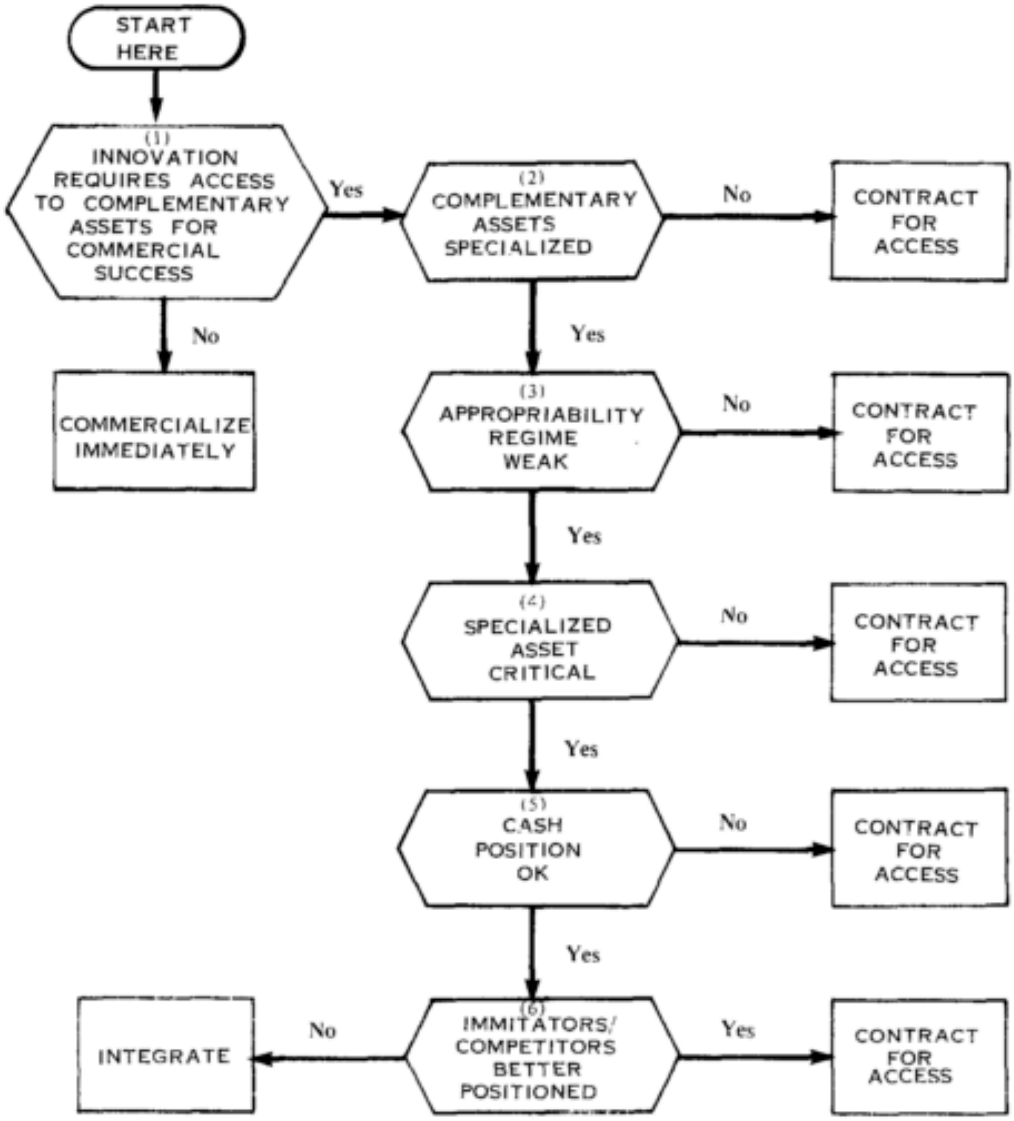


Figure 16 - Strategies for innovators to improve their financial performance according to Teece's factors (TEECE, 1986)

Teece also proposed some strategies for the innovator to go into market with its innovation and succeed, depending on its position according the three factors discussed above (Figure 16). The strategies include that of commercializing directly, without making any alliance, in which case the firm has all complementary assets necessary for achieving commercial success, that of contracting with partners in the case of an absence of specialized complementary assets that are critical or if the appropriability regime available is weak, and that of integrating through merges and acquisitions if the imitators are better positioned in the market.

2.7.
The role of the environment on strategic alliances, innovation and financial performance

The importance of innovation is increasing in today's turbulent environment, where the uncertainty is growing (EMERY; TRIST, 1965), since the innovation strategies are usually efficient in high-uncertainty environments (DIXIT; PINDYCK, 1994; GOERZEN, 2007). Environmental uncertainty is the lack of management in reading the external environment or future changes in the environment (MILLIKEN, 1987). Dickson and Weaver (1997) identified five sources of environment uncertainty: i) general uncertainty (the impact of future environmental changes in the organization concerning, for example, product markets, changing barriers to foreign trade and investments, fast change in economies of scale, etc.); ii) technological demand and volatility; iii) potential for future growth and profits; iv) unpredictability of customer demand and competitor actions; and v) demands for internationalization.

Environmental uncertainty, as well as competitive intensity (ANG, 2008), motivate the formation of strategic alliances (DICKSON; WEAVER, 1997). Lamberg et al. (2009) advocated that, regarding a firm's performance, a strategy consistent with the environment is essential to obtain competitive advantage. If the environment is stable, the strategies should also be stable over time. On the other hand, if the environment is dynamic, strategic actions should change across time, and the firm should develop new capacities and competitive actions based on its goals, that should always be reviewed.

The positioning school as well as integrative theories of competitive advantage consider the environmental analysis imperative for strategic choice. This analysis includes the innovation strategies and the choices to form strategic alliances and alliance portfolios. Austin (2002) proposed a classification of environmental factors in four types that influence each other, as suggested by Figure 17.

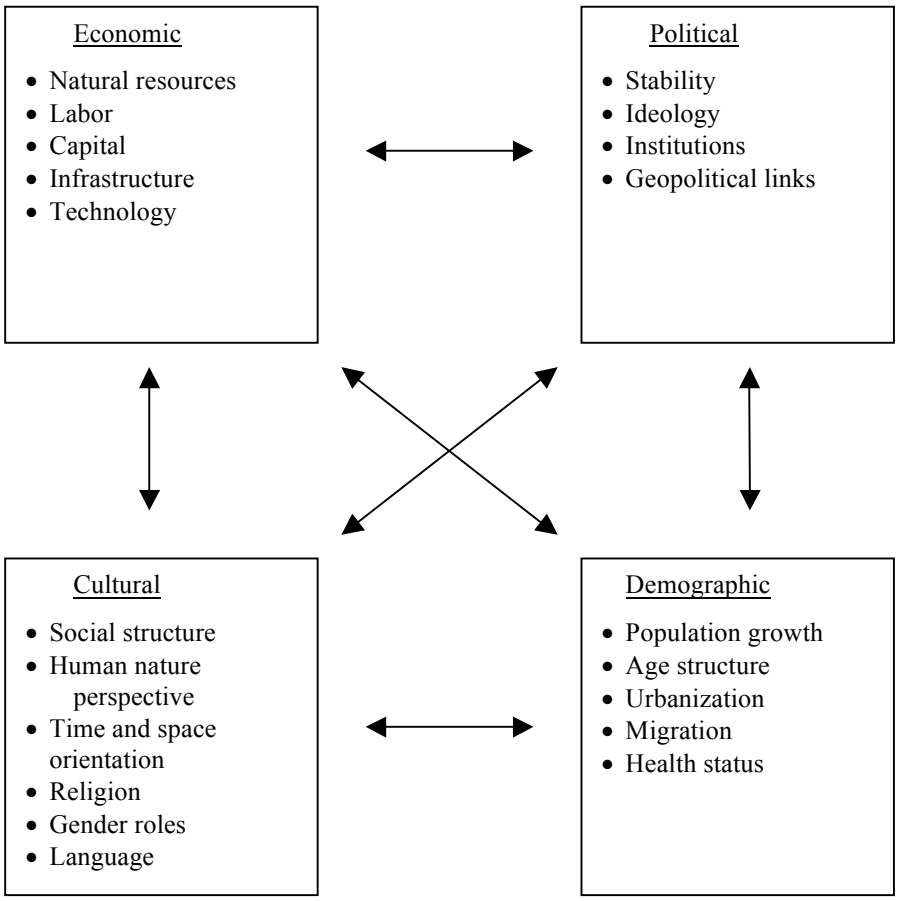


Figure 17 - Environmental factors (AUSTIN, 2002)

i) Economic factors - these factors focus on the difference among the environmental economic characteristics of the place where the firm operates. Among the economic factors, there are natural resources, labor, capital, infrastructure and technology;

ii) Political factors - these factors represent the political structure of the location of the firm, considering the way the latter influences the former's growth. These factors are political instability, ideology, institutions (i.e. public institutions such as justice and police; bureaucratic institutions, IRS, etc.) and international links of the country where the company is installed;

iii) Cultural factors - how the values, attitudes and behavior of the people influence the success or failure of a firm. These values guide the behavior of people and have huge influence on how the firm will act. These factors are social structure, human nature, time and space orientation, religion, gender role and language;

iv) Demographic factors - demography influences both the available workforce and the consumer market profile. Demographic factors are population growth, age structure, urbanization, migration and population's health status.

As noted before, in connection with the innovation process, innovation inside firms occur through activities that create and implement changes in products, processes and in the organization. The effectiveness of the innovation process depends on the investments firms makes to build innovation capabilities (investments in internal R&D, establishment of alliances, licensing of existent technologies, etc.) and the results of these investments and of the internal learning processes in terms of accumulation of innovative capabilities (BELL; FIGUEIREDO, 2012). However, as shown in Figure 18, Bell and Figueiredo also considered the external factors, that they call explanatory factors, relevant for innovation performance.

Steps A and B of Figure 18 depend on the innovation strategy chosen by the firm and on the effectiveness of the application of this strategy. However, for the innovation strategy to succeed, leading to a satisfactory innovation performance (step C), it also must have a fit with the characteristics of the environment in which the firm is inserted and be able to leverage firm's resources and capabilities (BARNEY, 2011; HOFER; SCHENDEL, 1978). According to Ahuja, Lampert and Tandon (2008), among several factors that drive innovation (i.e. industry structure, firm's characteristics, intra-organizational attributes and institutional influence), some are external to the firm, such as the industry structure, and some are related to how firms deal with these external factors, such as the intra-organizational attributes and the institutional influence. For Bell and Figueiredo (2012), the drivers of innovation are firm-specific factors, industry-level factors, economy-wide incentives and economy-wide institutions. Therefore, the authors also highlight the external drivers.

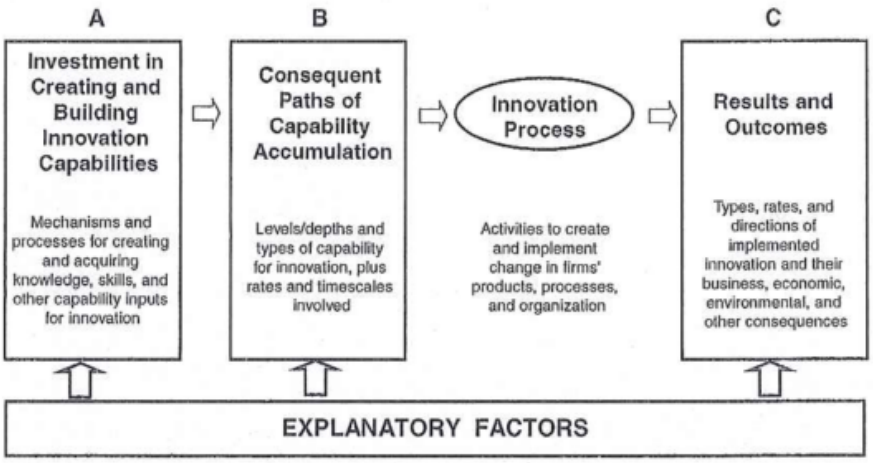


Figure 18 - Innovative capability accumulation (BELL; FIGUEIREDO, 2012)

Some authors, studying the innovation process of latecomer firms in developing economies found that the path for these companies is totally different from the process followed by firms of developed countries (CHOUNG; HWANG; SONG, 2014; FIGUEIREDO, 2003, 2016; KIM, 1997). However, it is very simplistic to divide the innovation process in two types, namely from firms of developed countries and from firms of developing countries. Other external factors are relevant, and some of the main factors are the industry in which the firm competes and the country where the firm is located, that has its influence generated by the National System of Innovation - NSI, defined by Freeman (1989) as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies". Among the organizations that participate of the NSI, the role of the government as an inductor or detractor of the firms' innovation outcomes and the role of industrial clusters may be highlighted. In the case of specific industries in some countries, the environmental conditions allow the formation of industrial clusters, in which firms that compound the value chain of the industry locate together with other organizations, such as Universities and research institutes, and act jointly with the government and local associations to improve innovation and competitiveness of the local firms in the industry.

2.7.1.
The influence of the industry

Empirical studies frequently consider the industry sector as a control variable for models that investigate innovation performance (CASSIMAN; VEUGELERS, 2006; FAEMS et al., 2010; LAURSEN; SALTER, 2014; NOOTEBOOM et al., 2007; RITALA; OLANDER; MICHAILOVA; HUSTED 2015). Dosi (1988) addressed the differences of innovation ratios and modes over sectors. Those differences are mainly caused by: i) the opportunities of innovation that the industry or epoch provides; ii) the degree of appropriability of innovation that is characteristic of the industry; and iii) the pattern of the demand the firm faces in the industry / time. Considering these three factors, Pavitt (1984) identified four types of sectors with different influences on innovation:

i) Supplier-dominated sectors – in these industries, which include textile, printing, clothing, etc., innovation is mainly of process. The innovation process is mainly through incremental improvements on equipment and methods and the appropriability regime is weak;
ii) Scale-intensive sectors – product and process innovation is common. Firms in these industries have high expenses with innovation that are generated frequently through internal R&D. Diverse appropriability mechanisms are used, as lead-time, secrecy, tacit technology, etc. The companies are always seeking for economies of scale and are generally big. Industries as automobile, electrical consumer products and processed food are examples of this type;
iii) Specialized suppliers – product innovation is central in this type of industry. Firms are usually small and open innovation occurs more through alliances with clients. Software development industry is an example of this type. Appropriability is usually by tacit knowledge;
iv) Science-based sectors – this group innovates through R&D labs and follows opportunities generated by the scientific advances. Chemical, pharmaceutic and electronic industry are examples of this type. Appropriability in these sectors is by diverse mechanisms, such as patents and lead-times.

2.7.2.
National Systems of Innovation

Another external factor that influences innovative performance of firms is the country and several authors use this factor as a control variable when studying innovation (BELDERBOS et al., 2010; BERRY, 2014; ROTHAERMEL, 2001). Specific country factors that induce or restrict innovation are a result of interactions among the organizations that form the National Systems of Innovation – NSI. Several authors studied NSIs and all of them recognize its relationship with technological learning and innovative performance of national firms. According to Patel and Pavitt (1994), NSI is "the national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning…in a country." Nelson (1993) proposed that the interaction among the institutes that compose the NSI determines the innovative performance of national firms. This network of institutions includes the government, with its policies and programs, universities, research institutes and local firms in the industries - competitors, clients, suppliers and complementors (NELSON, 1993).

An application of the theory of NSIs is the previously discussed Global Innovation Index - GII (DUTTA et al., 2016), that ranks countries by its innovativeness. As previously seen in Figure 1, the rank is determined by several country dimensions, from institutions to human capital. According to the ranking of 2016, Brazil is at 69th position of the most innovative countries of the world. On the other hand, the list of countries in the first 25 positions, are mainly formed by traditional developed countries (as previously mentioned in Figure 2). This finding is an evidence that it is hard for developing countries to catch-up to the technological frontier and that is very important to study the catch-up process of firms of developing economies.

As discussed in Section 2.2.2, Kim (1997, 1998) studied the technological catch-up process of Korean firms and developed a model for the innovation process of developing countries composed of acquiring capabilities, assimilating and improving activities (as previously illustrated in Figure 9). It is easier for a latecomer firm to start the process by acquiring products by firms in the

technological frontier in the mature stage of Utterback model (UTTERBACK; ABERNATHY, 1975) because firms in developing countries does not have money to invest strongly in R&D to develop radical innovation. Then, the firm learns from operating, reverse engineering, etc., accumulate production capabilities and start make minor improvements. If the firm succeeds in this process with a product in the mature stage, it may want to try to do it in more challenging stages to become a really innovative firm. This accumulation process improves firm's capacity to innovate. If several firms in the country catch-up, the country can benefit from innovative development and economic development as a whole.

2.7.3. The role of the government

The government has an important role as an inductor or a detractor of innovation, specifically in developing economies. Kim's model of the innovation process in developing countries (KIM, 1997) considers that the government influences the availability of domestic and international sources of technological learning as it defines national industrial, trade, monetary and educational policies. For Bell and Figueiredo (2012), economy-wide factors that are influenced by the government are important for influencing firm's investments in technological capabilities and R&D, such as the degree of competition controlled by the level of protection versus the openness of the trade policy and the level of subsidies. However, these policies can be counterproductive if they are not followed by performance incentives, such as an obligation to compete in the international market through exports.

Lazzarini (2015) proposed three conditions in which the governmental industrial policy may lead to accumulation and rearranging of resources and capabilities of firms that can lead to a real competitive advantage: i) when there is an insertion of local firms in the global production networks; ii) when the policies encourage firms to build upon favorable geographical specific resources; and iii) when there is a governmental capability to conduct the process of choosing policies to collectively induce competitive advantage for local firms. The author also proposed that the measurement of the competitive advantage should be

adjusted considering the level of subsidies, because low performance companies can reach a fake good accounting performance by considering the subsidies in the final numbers.

Obviously, the subsidies and other governmental incentives may create distortions that should be evaluated. However, in many cases in developing economies, only with them local firms can catch-up the technologically, become world-leading innovators and help to improve the country's economic development. Kim (1998) and Lee and Lim (2001) showed that, in the case of some Korean firms, governmental incentives succeeded by the creation of a crisis. The latter indeed imposed firms to be creative and to innovate so as to achieve hard goals in the first case, the crises that challenged Hyundai to develop a Korean style car to export to the USA, and in the second case, the sponsorship of the establishment of technological standards, notably the transformation of CDMA into world-standard in the telecommunication industry. All those governmental incentives came with performance incentives based on exporting goals. It seems that governmental incentives should be temporary and should encourage firms to be able to compete against the global leaders by themselves in the future, encouraging technological accumulation that allow them to become world-leading innovators.

2.7.4. Industrial clusters

There are cases in some countries in which the NIS, the local context and the industry combine in a way that favors competitiveness and innovation and allows the creation of an industrial cluster. According to Giuliani and Bell (2005), an industrial cluster is a geographic agglomeration of economic activities operating in the same sector or in sectors interconnected. The existence of an industrial cluster favors the success of that industry in the country where it is located by the existence of factors such as the access to skilled labor, the abundance of intermediate suppliers, or the proximity of markets associated with economies of the spatial clustering. Proximity also contributes to the inventiveness of the firms, particularly when informal, non-encoded knowledge is

involved in the production of new knowledge, or when it comes from practice, from learning-by-doing or learning-by-innovating (AHARONSON; BAUM; PLUNKET, 2008). Ozer and Zhang (2015) specified some factors that improve the innovation performance of geographical clusters:

i) Firms in the cluster may observe rivals closely inside the cluster and learn about new product features, design and marketing efforts;
ii) Firms may engage in informal exchanges of information which can improve product development and the manufacturing process;
iii) Firms tend to identify themselves in a joint cluster enterprise, that encourages engagement in mutual industry events, development of shared concepts, tools, language and business conduct standards. This fact increases the sense of belonging, trustiness and reciprocity that facilitates information sharing and improves innovation.

Industrial clusters can be found in developed and developing economies and there are several cases in which they favored innovation. The Chilean wine cluster is a famous case in a South American developing economy in which knowledge acquisition, accumulation, creation and diffusion through the cluster can be found and boosted joint innovation (GIULIANI; BELL, 2005). The Canadian biotechnology industry is a case identified in a developed economy (AHARONSON et al., 2008). An example of an industrial cluster in Brazil is the Sinos Valley's footwear cluster (HUMPHREY; SCHMITZ, 2002). It is important to realize that clustering formation many times happens because of a natural vocation of the region, as can be shown in the case of the wine cluster. However, the existence of a cluster does not guarantee the innovative success of its firms. Two wine clusters in Argentina have totally different performance outcomes. On the one hand, the wine firms in the cluster formed in the region of Mendoza are successful and innovative; on the other hand, a cluster of wine firms in the region of San Juan failed to be competitive, although both regions have rare natural conditions to produce high quality wine (LAZZARINI, 2015). Lazzarini argued that distinctive interactions among local government, firms and associations are necessary to allow an industrial cluster to take off.

2.8.
Proposed model and hypotheses

To attend to the main and secondary goals of this research (see Section 1.2), six hypotheses were developed (see Table 12) and a theoretical model was proposed (see Figure 19) based on the literature review. The model and the hypotheses were tested according to the method described in Section 3. As shown in Figure 19, the model is composed of six constructs, which are: i) External R&D - Strategic Alliances; ii) Internal R&D - Absorptive Capacity; iii) Innovation Performance; iv) Appropriability Regime; v) Current Financial Performance; and vi) Future Financial Performance.

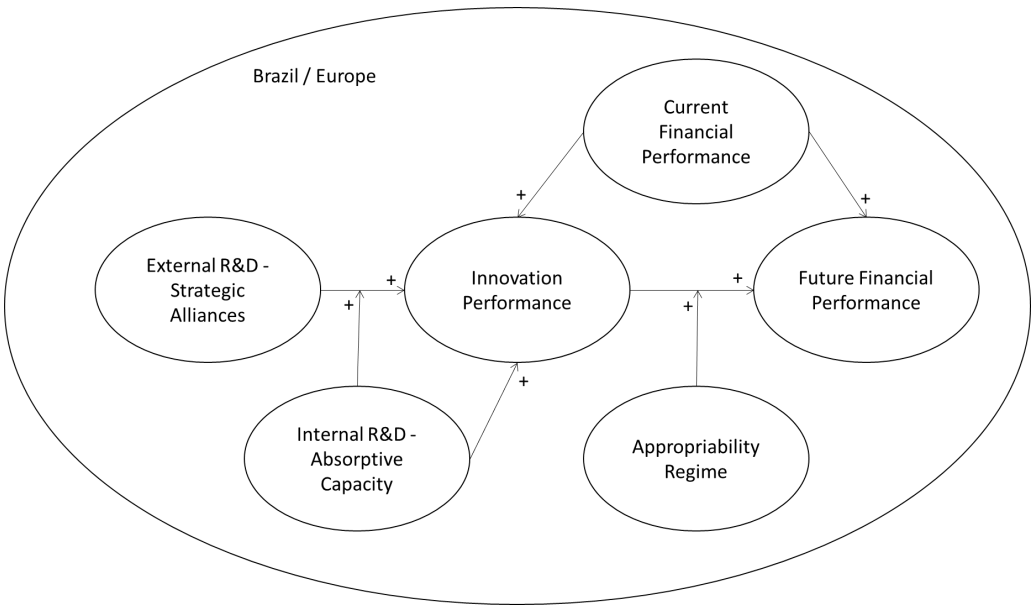


Figure 19 - Theoretical model

Hypothesis 1. The more a firm invests in external R&D, the higher the firm's innovation performance
Hypothesis 2. The more a firm invests in internal R&D, the higher the firm's innovation performance.
Hypothesis 3. The higher a firm's level of internal R&D, which improves its absorptive capacity, the higher is the positive effect of the investments in external R&D on the firm's innovation performance.
Hypothesis 4. The higher a firm's innovation performance, the higher the firm's future financial performance.
Hypothesis 5. The stronger the appropriability regime a firm uses to protect its innovation, the higher the positive effect of innovation performance on the firm's future financial performance.
Hypothesis 6a. The fact that a firm is located in Brazil or in Europe affects differently the innovation strategy, represented by its choices of internal and external R&D. **Hypothesis 6b.** The fact that a firm is located in Brazil or in Europe affects differently its innovation performance. **Hypothesis 6c.** The fact that a firm is located in Brazil or in Europe affects differently its current and future financial performance.
Hypothesis 7a. The higher a firm's current financial performance, the higher the firm's innovation performance. **Hypothesis 7b.** The higher a firm's current financial performance, the higher the firm's future financial performance.

Table 12 - Model's hypotheses

3
Research Methodology

The goal of this chapter is to explain how the research was conducted. It first shows a methodological diagram explaining all the steps adopted by the research to test the research questions, then describes how the constructs were operationalized, characterizes the sample and the data sources, and describes the method that was used to test the hypotheses.

3.1.
Steps of the research and methodological diagram

This research was conducted according to the following steps:

i) A review of the literature of the fields of innovation management, strategic alliances and performance to develop a conceptual model and the hypotheses to test the research questions. This step was necessary to develop the Section 2 of this manuscript. The conceptual model and the hypotheses were presented in Section 2.8;
ii) Proposition of the proxies to operationalize the constructs of the conceptual model based on the literature review. The proxies are described in Section 3.3;
iii) Obtaining data from Brazilian and from some selected European countries' firms to fill the proxies. The data were obtained from the secondary databases PINTEC 2011 (Innovation Survey) and PIA-Enterprise from 2009 to 2013 (Annual Industry Survey) for the Brazilian firms and from CIS 2010 (Community Innovation Survey) for the selected European countries' firms. Only firms from manufacturing sectors with no missing data were selected;
iv) Running the multivariate statistic techniques separately on Brazilian firms and on the selected European countries' firms:

a. Checking the data concerning the assumptions necessary for the multivariate statistical methods applied in the next steps;
b. Running an exploratory factor analysis to find the intrinsic dimensions formed by the proxies proposed for each of the constructs. The final dimensions were formed by summated scales of the variables that were significant for each dimension;
c. Running a confirmatory factor analysis 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;
d. Running a Bayesian structural equation modeling to test the hypotheses H1, H2, H3, H4 and H7. H5 will not be tested in this work as the databases used do not measure the appropriability mechanisms (they were measured in CIS 2012 and PINTEC 2014), which demanded a simplification of the complete model. Although there is a theoretical time-lapse between innovation performance and financial performance, the financial performance indicators available were limited. Financial performance indicators for the selected European countries' firms through time could not be obtained, which demanded another simplification in the European model, that was the removal of the construct Current Financial Performance, making impossible to test H7 for this group.

v) A qualitative comparative analysis of the results of both models (for Brazilian and the selected European countries' firms). The hypotheses H6a, H6b and H6c, that proposed to identify the differences between Brazilian and the selected European countries' firms were not possible to be statistically tested because Brazilian and European firms' data could not be merged. So, the models for both were run separately and the results analyzed comparatively;
vi) Interpretation and discussion of the results to draw conclusions on how Brazilian firms can have better innovation performance and financial performance through alliances and internal R&D. The conclusions could improve the knowledge of the relationship among strategic alliances,

innovation performance and financial performance in different geographical contexts (Brazil and the selected European countries).

Figure 20 shows a methodological diagram that illustrates all the steps followed in this research.

3.2. Sample and data sources

The universe of this research is the totality of firms of the manufacturing sectors of Brazil and of the selected European countries, which includes the countries that made their research available in a CD-ROM (Germany, Cyprus, Bulgaria, Czech Republic, Spain, Croatia, Portugal, Hungary, Slovenia, Norway, Lithuania, Romania, Slovakia and Estonia) plus Italy, that the authors accessed previously by the homepage of the Italian National Institute of Statistics (ISTAT, 2015). Germany was taken out of the research because of the absence of answers concerning the Strategic Alliance construct's variables. The sample was limited by the firms that answered the surveys used as sources of secondary data, which are described in the next section, followed by the sample's characteristics. The description of the proxies used to operationalize the constructs of the model are also described in the next section. The proxies may be different for the operationalization of the model for the Brazilian and the selected European countries' firms because the surveys of each location, although very similar, have a few differences.

3.2.1. Brazilian firms

The survey data used to operationalize the model for Brazilian manufacturing firms were PINTEC 2011 - Survey of Technological Innovation (IBGE, 2016a) and PIA - Empresas 2009/2010/2011/2012/2013 (Annual Survey of Industry – Enterprise) (IBGE, 2016b), both provided by the governmental agency IBGE.

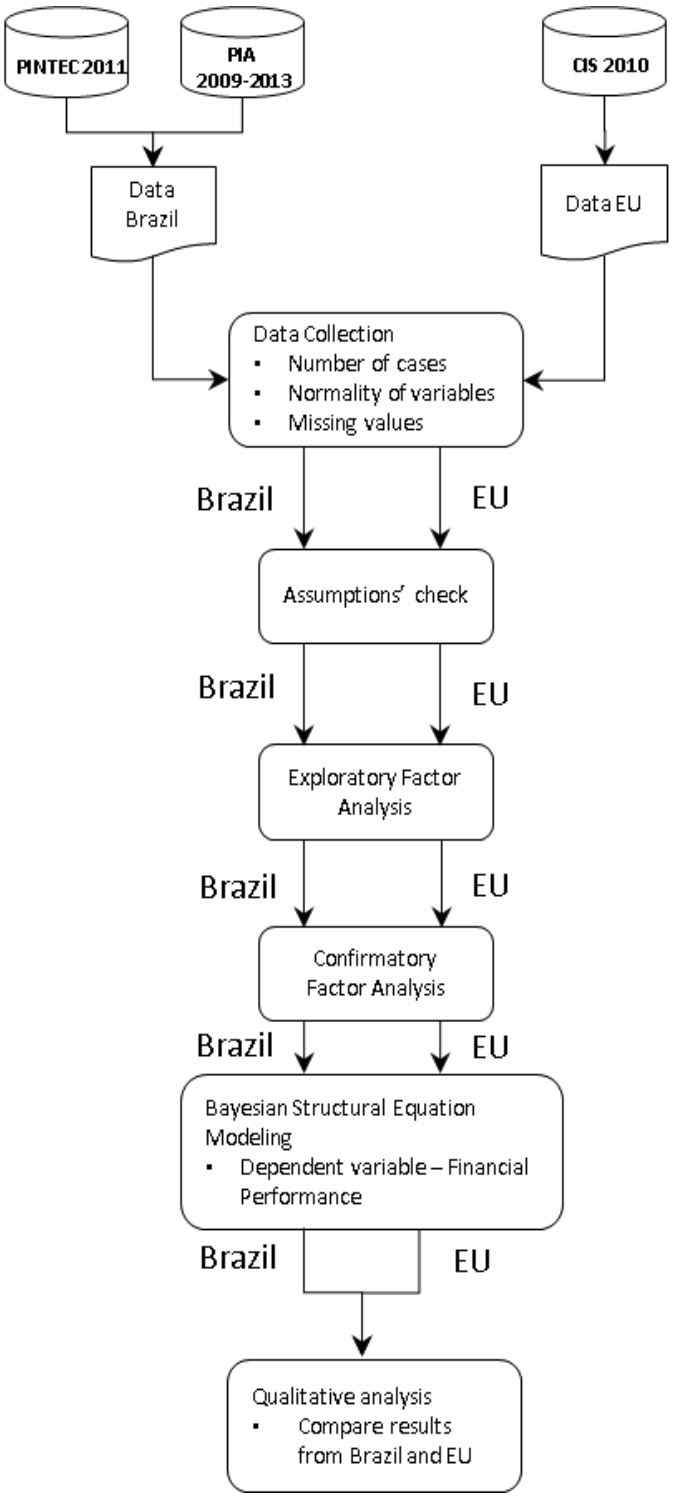


Figure 20 - Methodological diagram

3.2.1.1.
PINTEC 2011

The PINTEC survey is conducted by IBGE with the support of FINEP (governmental funding agency) and of the Ministry of Science and Technology. The survey, which is conducted since the year 2000, has the aim to build national and regional indicators of the technological innovation activities developed by Brazilian industrial firms with 10 or more employees. Each survey investigates innovation activities of firms and its results, considering three years in a sequence. In the case of PINTEC 2011, the years covered were 2009, 2010 and 2011. The survey was used to operationalize the constructs External R&D - Strategic Alliances, Innovation Performance and Internal R&D - Absorptive Capacity of the Brazilian firms. The research included questions about the efforts made by the firms to innovate, sources of information and alliances with other organizations to induce innovation, governmental support for the innovative activities, influence of the innovations on the performance of the firms, etc. This survey was based on the concepts of the Oslo Manual (OECD, 2005), from which this research based its concepts about innovation.

3.2.1.2.
PIA - Enterprise 2009/2010/2011/2012/2013

This survey is also conducted by IBGE and is the most complete source of data on economic and finance of Brazilian firms of the industrial sectors, covering industrial firms with 30 or more employees. It presents data on variables such as employees, salaries, withdrawals and other compensations, revenues, costs and expenditures, value of production and value added by manufacturing on an annual basis. This survey was used to operationalize the constructs Current and Future Financial Performance of Brazilian manufacturing firms. In order to try to find a relationship among the constructs operationalized by PINTEC 2011 survey (External R&D - Strategic Alliances, Internal R&D - Absorptive Capacity and Innovation Performance) and Current and Future Financial Performance, that was operationalized by the PIA – Enterprises survey, this work considered the surveys from 2009 (first year covered by PINTEC 2011), until 2013 (the last one available at the time of obtaining data), two years after the period covered by PINTEC

2011. This was made to try catch the time-lapse that occur between the innovation implementation (that is represented in the model by Innovation Performance) and its effects on Financial Performance. The methodological diagram of Section 3.2 described how these effects were tested by the method.

3.2.1.3. Sample of Brazilian firms

The sample of Brazilian firms consisted of all manufacturing firms that answered all the surveys: PINTEC 2011, PIA-Enterprise 2009, 2010, 2011, 2012 and 2013 and that conducted some innovation development activity from 2009 to 2011. From these firms, only cases without missing values on all variables described in Table 14 were selected. The selection of manufacturing firms was based on the CNAE 2.0 classification (IBGE, 2017). Firms that conducted innovation development activities from 2009 to 2011 were the ones that declared in PINTEC 2011 that have developed at least one product or process innovation in the period, had an ongoing innovation project by the end of 2011 or had abandoned or suspended some innovation project in the period between 2009 and 2011. The merge of data of PINTEC and PIA – Enterprise was requested by the author and conducted by the IBGE technical team through the firms CNPJ, that is the national identification code of firms and the database were available for analysis at SAR – Restricted Data Room – at Rio de Janeiro, Brazil during the months of July and August of 2016. The number of firms in the Brazilian sample was 2,810.

Some difficulties emerged at the time of the access of Brazilian data. The access of the surveys' microdata had to be requested to IBGE by a formal process in which the researcher fill some forms explaining the project and the necessary data. By the end of the process, if the authorization is given, the researcher must to go to SAR to access the data. In the case of this research, the authorization took ten months, with one negative and a project reformulation in the middle of this time. The computers in the safe datacenter had only STATA software. As it was necessary to use AMOS, the researcher had to acquire the software to install in the lab. However, as the datacenter network safety did not allow the installation of the software, IBGE made available an older computer that was not in the network, but

was much slower. By the end of every day of work in the lab, the researcher had to copy the produced files to a pen-drive and save them into the server to guarantee the network daily backup to safeguard the data. After two months working in the lab, the researcher had to do a report and wait for the release of the results by IBGE, which took three months. It took around 15 months from the initial sending of the access request for IBGE to receiving the final results.

3.2.2.
Selected European countries' firms

The survey used to operationalize the model for the selected European countries' firms was CIS 2010 - Community Innovation Survey, provided by the European Commission agency - Eurostat (EUROPEAN COMISSION, 2016a).

3.2.2.1.
CIS 2010

The CIS survey is centralized by Eurostat and conducted in each European Union country plus Norway and Iceland by the local governmental statistical institutes. The survey, that was first conducted in 1992, has the same goal of PINTEC, that is building national and regional indicators of the innovation activities developed by industrial firms with 10 or more employees. The survey investigates innovation activities of firms and its results, considering three years. In the case of the survey used in this research, the years covered were 2008, 2009 and 2010.

This survey was the only one the author had access for the European countries, therefore, it was used to operationalize all the constructs of the European model. The research included questions about the efforts made by the firms to innovate, sources of information and alliances with other organizations to induce innovation, governmental support to the innovative activities, influence of the innovations on the performance of the firms, firm's turnover and number of employees. This research was also built based on the concepts of the Oslo Manual (OECD, 2005). For the access of the microdata of CIS 2010, it was necessary to be part of an organization registered as a research entity by Eurostat and it was

guaranteed by a partnership with the School of Business of Aalto University in Helsinki, Finland, with the support of Professor Liisa Välikangas. The author was accepted as a guest student by the University from August, 2016 to July, 2017 and the application for data access was made jointly with professor Liisa. The data was available for analysis through a CD-ROM for the countries Germany, Bulgaria, Cyprus, Czech Republic, Spain, Croatia, Portugal, Hungary, Slovenia, Norway, Lithuania, Romania, Slovakia and Estonia. Italian data, that was obtained in the ISTAT homepage, were also included.

3.2.2.2. Sample of the selected European countries' firms

The sample of the selected European countries' firms, such as in the case of the Brazilian sample, consisted of all manufacturing firms that answered the CIS 2010 survey and that conducted some innovation development activity from 2008 and 2010. From these firms, only cases without missing values on all variables described in Table 15 were selected. The selection of manufacturing firms was based on the NACE 2.0 classification (European Commission, 2016b). Firms that conducted innovation development activities from 2008 to 2010 were the ones that declared in CIS 2010 that had developed at least one product or process innovation in the period, had an ongoing innovation project by the end of 2010 or had abandoned or suspended some innovation project in the period between 2008 and 2010. As the response rate of firms in CIS 2010 varied for each country, the number of firms that was used to test the final model was weighted by the total number of manufacturing firms from each country, based on the number of total firms estimated and the response rates by country provided by Eurostat in the survey documentation. The cases were randomly selected. The total number of firms for each country before and after this final selection are presented in Table 13. The regional group column in Table 13 represents the group in which each country was classified and worked as a control variable in the model.

Country	GII	Total sample	Weighted sample	Group	Total sample by group	Weighted sample by group
Bulgaria	38	1,509	50	1	1,783	141
Romania	48	274	91	1		
Italy	29	731	731	2	731	731
Portugal	30	1,496	209	3	9,083	1,336
Spain	28	7,587	1,127	3		
Estonia	24	478	30	4	709	59
Lithuania	36	231	29	4		
Croatia	47	535	53	5	1,144	90
Cyprus	31	162	7	5		
Slovenia	32	447	30	5		
Czech Republic	27	1,094	202	6	1,976	306
Hungary	33	671	76	6		
Slovakia	37	211	28	6		
Norway	22	181	83	7	181	83
Total	33*	15,607	2,746			

* Average position of all countries in the Global Innovation Index (DUTTA et al., 2016)

Table 13 - Sample size by country

Although the access to the European data was easier than in the case of Brazil, it was not done without problems. The access to the surveys' microdata should be requested to Eurostat by a formal process in which the researcher fill some forms explaining its project and the necessary data, that should be signed by the co-supervisor of the European University (in the case, professor Liisa Välikangas) and by the official University representative. As previously mentioned, not all countries authorize sending data by CD-ROM, which limited the scope of the research to the 14 countries in Table 13. The CD arrived after three and a half months and the researcher could work freely with the data inside the scope of the project. However, Eurostat do not merge databases, which limited the possibilities of the research as described in Section 3.5. By the end of the study, a report with the results should be sent to Eurostat and the data should be destroyed.

3.3.
Operationalization of the constructs

This Section presents the proxies that operationalized the constructs of the model of the Brazilian firms (Table 14) and of the selected European countries' firms (Table 15). The next two tables present the description of the proxies of the constructs, the data source from which the data were taken and the period that the proxy represents. All the constructs in the model were considered reflexive. It is important to observe that the proxies can be slightly different for the models of both locations because of the different data sources. However, all proxies were based on the literature review. The construct Appropriability Regime, although part of the theoretical model, was not operationalized because PINTEC 2011 and CIS 2010 did not measure appropriability mechanisms. They were measured in PINTEC 2014 and CIS 2012, however, at the time of the analysis, PINTEC 2014 was not available and CIS 2010 was chosen as it is more similar to PINTEC 2011 than CIS 2012. The construct Current Financial Performance was only used in the Brazilian model as panel data of Financial Performance indicators from 2009 to 2013 in the Brazilian case (by PIA-Enterprise) was available. In the selected European countries' case, on the other hand, only CIS 2010 was available, allowing only a cross-section view of Financial Performance, and a simplification of the model was necessary.

Construct	Proxy name	Proxy format	Data Source
Innovation Performance	% Turnover from new products or services - %_TURN_IPROD	0 to 100%	PINTEC 2011
	Introduction of product innovation – INOVPROD	Yes/No	
	Introduction of process innovation – INOVPROC	Yes/No	
	Innovative degree of product innovation – IPROD_DEGREE	0- Did not introduced product innovation 1- New to the firm 2- New to national market 3- New to the world	
	Innovative degree of process innovation – IPROC_DEGREE	0- Did not introduced process innovation 1- New to the firm 2- New to national market 3- New to the world	
	Product innovation is incremental or radical – IPROD_RAD_IN	0- Did not introduced product innovation 1 – Incremental 2 – Radical	
	Process innovation is incremental or radical – IPROD_RAD_IN	0- Did not introduced process innovation 1 – Incremental 2 – Radical	

	Innovation impact: - Improved the quality of goods or services – IN_IMP_1 - Extended the range of goods or services offered - IN_IMP_2 - Allowed to keep market-share - IN_IMP_3 - Extended market-share - IN_IMP_4 - Allowed to open new markets - IN_IMP_5 - Increased production or service capacity - IN_IMP_6 - Increased production or service flexibility - IN_IMP_7 - Reduced production or service costs - IN_IMP_8 - Reduced labor costs - IN_IMP_9 - Reduced raw material consumption - IN_IMP_10 - Reduced energy consumption - IN_IMP_11 - Reduced water consumption - IN_IMP_12 - Allowed the reduction of the environmental impact - IN_IMP_13 - Allowed the control of healthy and security issues - IN_IMP_14 - Allowed to fit norms and regulations relative to internal or external market - IN_IMP_15	0- Not relevant[2] 1- Low 2- Medium 3- High	
External R&D - Strategic Alliances	Importance of the partnership by partner type: - Clients – AL_CLI - Suppliers – AL_SUP - Rivals – AL_RIV - Consulting firms – AL_CONSLU - Universities or research institutes – AL_UNIV - Professional capacitation and technical assistance centers – AL_CENTERS - Test, trial and certification centers – AL_TEST_INST	0- Not used 1- Low 2- Medium 3- High	PINTEC 2011

[2] Although the term "Not important" would be more appropriate, the translation of PINTEC 2011 was "Not relevant" to be consistent with the term in similar questions of CIS 2010.

	Governmental support - SUP_GOV Importance of acquisition of external knowledge: - R&D - IMP_ReD_EXT - Other external knowledge, except software - IMP_KNOW_EXT - Software - IMP_SOFT_EXT - Machinery and equipment - IMP_EQ_EXT	Yes/No 0- Not used 1- Low 2- Medium 3- High	
Current Financial Performance / Future Financial Performance	Turnover growth – 2010_2011_TURN_GRW/ 2013_TURN_GRW Value added growth – 2010_2011_VA_GRW/ 2013_VA_GRW Firm growth – 2010_2011_EMP_GRW/ 2013_TEMP_GRW	Turnover year/Turnover previous year - 1 Value added year/Value added previous year - 1 Num. employees year/Num. employees previous year - 1	PIA 2009 to 2011 / PIA 2012 and PIA 2013
Internal R&D - Absorptive Capacity	Internal R&D spending/total turnover – INT_ReD R&D training expenses/total turnover - TRAIN_EXP R&D personnel level of education - PERS_EDU	0 to 100% 0 to 100% 0 to 3. Formula: (Num. Doctors * 3 + Num. Masters * 2 + Num. Graduates) / total R&D staff	PINTEC 2011

Table 14 - Constructs' proxies – Brazil

Construct	Proxy name	Proxy format	Data Source
Innovation Performance	% Turnover from new products or services - %_TURN	0 to 100%	CIS 2010
	Introduction of product innovation – PRODINOV	Yes/No	
	Introduction of process innovation – PROCINOV	Yes/No	
	Innovative degree of product innovation – RADPRODINOV	0- Did not introduced product innovation 1- New to the firm 2- New to the market	
	Innovative degree of process innovation – RADPROCINOV	0- Did not introduced process innovation 1- New to the firm 2- New to the market	
	Innovation impact: - Increase range of goods or services – ORANGE - Replace outdated products or processes - OREPL - Enter new markets or increase market share - ONMOMS - Improve quality of goods or services - OQUA - Improve flexibility for producing goods or services - OFLEX - Increase capacity for producing goods or services - OCAP - Reduce labor costs per unit output - OLBR - Reduce material and energy costs per unit output - ORME - Reduce environmental impacts - OREI - Improve health or safety of your employees - OHESY	0- Not relevant 1- Low 2- Medium 3- High	

External R&D - Strategic Alliances	Importance of the partnership / source of information by partner type: - Suppliers - SSUP - Clients - SCLI - Competitors - SCOM - Consultants commercial labs, or private R&D institutes - SINS - Universities - SUNI - Government - SGMT - Conferences, trade fairs and exhibitions - SCON - Scientific journals and other publications - SJOU - Professional and industry associations – SPRO	0- Not used 1- Low 2- Medium 3- High	CIS 2010
Future Financial Performance	Turnover growth – TURN_GROWTH Firm growth – EMP_GROWTH	Turnover 2010/Turnover 2008 – 1 Num. employees 2010/Num. employees previous 2008 - 1	CIS 2010
Internal R&D - Absorptive Capacity	Internal R&D spending/total turnover – rrdinx_rat R&D training – RTR Importance of internal R&D as a source of information – SENTG	0 to 100% Yes/No 0- Not used 1- Low 2- Medium 3- High	CIS 2010
Control Variables	Country Group: - GR1/ GR2/ GR3/ GR4/ GR5/ GR6/ GR7	Yes / No	CIS 2010

Table 15 - Constructs' proxies – selected European countries

3.4. Method

This Section describes the method used to test the hypotheses. The analyzes were conducted separately for the Brazilian and for the selected European

countries' firms with the proposed model being slightly modified in both cases as explained in the previous Section. The analysis is similar; however, some steps were different and the differences are highlighted here. As previously explained, only cases without missing values were selected, making the missing value analysis unnecessary. The main method for testing the hypotheses was Bayesian Structural Equation Modeling and, as Bayesian estimation does not suppose linearity and normality of the variables, the analysis of the assumptions was very simple. All the analysis was conducted in Stata 14, SPSS 22 and AMOS 23.

The first step of the analysis was calculating the descriptive statistics of the samples' variables. A Pearson's correlations (LAWRENCE; LIN, 1989) was also run between variables inside the constructs and of all variables of the model together. In the case of the Brazilian model, as the database was built by a merge of several different surveys, from several different years, common-method bias was not considered an issue. In the case of EU model, a single data source was used, and two tests for controlling common-method bias suggested by Podsakoff, MacKenzie and Lee (2003) were conducted: the first one was to run an exploratory factor analysis (EFA) with all the variables used in the model and check the total variance explained in only one common factor. Variances of 50% or more should turn on an alert about the possible existence of a significant common-method bias in the sample. The second test was conducting an additional confirmatory factor analysis (CFA) that included a construct representing the common method variance in which all variables equally loaded on and checked if the common variance (square of the load) was significant.

After, EFAs, using the statistical procedure principal component analysis (PCA), were run separately for the variables of the constructs Innovation Performance and External R&D - Strategic Alliances in both models to reduce the dimensions of each construct. The EFA was not used in the other constructs because they have three or less variables. The number of factors was chosen using the scree-plot method and, then, a varimax rotation (HAIR et al., 2006) was applied. The final factors that were used in the next steps of the analysis were calculated through summated-scales of the variables that weighted 0.7 or more in each dimension. Then, the validation of both measurement models was made with

CFA. In the Brazilian model, the CFA used Bayesian estimation with a convergence statistic below 1,1 considered as acceptable (GELMAN et al., 2014) and a confidence interval of 95% for regression weights. A good fit was if the posterior predictive p-value was not too far from 0.5 (GELMAN, 2013). In the European model, the CFA used maximum likelihood estimation (MLE), instead of Bayesian estimation. For this model, the measurement model was considered having good fit if it had a X^2/df ratio among 2 and 5 (KELLOWAY, 1998), a RMSEA lower than 0.07 and a CFI, a GFI and a AGFI higher than 0.92 (HAIR et al., 2006). Considerations about convergent, discriminant and nomological validity and construct reliability were also conducted in both models. For convergent validity, all the standardized loads of the variables in the constructs should be higher than 0.7 (NUNALLY, 1978), and all the constructs average variance extracted (AVE) should be higher than 0.5 (FORNELL; LARCKER, 1981). For discriminant validity, the AVE for each construct should be greater than the squared estimated correlations between two constructs (HAIR et al., 2006). In order to have nomological validity, the between constructs' covariances should be according to the theory. All covariances between the three constructs was supposed to be significant but low. The construct reliability coefficient (FORNELL; LARCKER, 1981) should measure above 0.7 for all constructs to indicate a construct's reliability and internal validity.

To test the hypotheses and confirm the relationships among the constructs, Bayesian structural equation modelling (SEM) was used for both models. The Bayesian approach is philosophically different from the frequentist approach, in which the traditional SEM approaches, such as MLE, are included. In the frequentist approach, sampling is infinite and data is formed by a repeatable random sample, in which there is a frequency. For this reason, the underlying parameters are constant during the repeatable process and parameters are fixed. On the other hand, in the Bayesian approach, unknown quantities are treated probabilistically. The data is fixed and used to determine unknown parameters probabilistically (CASELLA, 2008).

Besides the philosophical differences, the Bayesian Estimation was chosen as this type of estimation has several advantages over frequentist estimation

techniques, for instance: i) it is not based on the normality of the variables; ii) works better with smaller samples; iii) does not suppose a linear relationship; iv) considers previous knowledge by demanding the imputation of a prior distribution, that may be a result of previous studies (KRUSCHKE; AGUINIS; JOO; 2012). As in the case of the Bayesian CFA, a convergence statistic below 1,1 was considered acceptable (GELMAN et al., 2014) and a confidence interval of 95% for regression weights was considered. The mean-centering technique (LITTLE; BOVAIRD; WIDAMAN, 2006) was chosen to represent the effect of the moderation relationship between Internal R&D - Absorptive Capacity and External R&D - Strategic Alliances on the innovation performance in the model. According to this technique, a new moderation construct that loaded the construct Innovation Performance was added to the SEM. These constructs variables were calculated by multiplying all factors of the construct absorptive capacity with the factors of strategic alliances and applying the Z-score. The residuals of the variables that were formed by the product of a common original factor (e.g. all variables formed by the multiplication of the first factor of absorptive capacity should have its residuals correlated) were also correlated in the SEM.

In the case of the European model, as the firms from Italy do not have EMP_GROWTH information, Future Financial Performance was not used as a latent variable, but two separate models using the variables TURN_GROWTH and EMP_GROWTH separately as endogenous variable were run. For the model that tested TURN_GROWTH, all firms in the weighted sample were used and, for the one that tested EMP_GROWTH, the Italian firms were excluded. Figures 21, 22 and 23 show the moderation construct and all its relationships and how the Future Financial Performance proxies were tested. Also, only for the European model, that have firms from 14 selected countries, country group was used as a control variable, by co-variating all the groups dummies with all the exogenous constructs and weighting them in all endogenous constructs and variables. The model was also tested separately by group. The countries were separate in groups according to a mix of regional (WIKIPEDIA, 2017a) and economic characteristics. The resulting groups are:

- Group 1 (Romania and Bulgaria) - the sample's Danubian countries that were considered modest innovators according to the 2015 Innovation Union Scoreboard (European Union, 2016);
- Group 2 (Italy) – Italy was considered alone by it economic importance;
- Group 3 (Portugal and Spain) – the countries from the Iberian Peninsula;
- Group 4 (Estonia and Lithuania) – the sample's Baltic states;
- Group 5 (Cyprus, Croatia and Slovenia) – the sample's Mediterranean countries, excluding Italy and the Iberian Peninsula;
- Group 6 (Czech Republic, Hungary and Slovakia) - the sample's Danubian countries that were considered moderate innovators according to the 2015 Innovation Union Scoreboard;
- Group 7 (Norway) – the sample's Scandinavian country. Norway is the only country of the sample that is not a member state of the European Union. However, it was included it in the research because it is part of the Schengen area, that have officially abolished passport and all other types of border control at their mutual borders (European Commission, 2008).

4
Results and Discussion

This chapter is organized in three parts. The first part presents the results of the model applied to the Brazilian manufacturing firms and its analysis. The second part contains the results and analysis of the model applied to the selected European countries' manufacturing firms. Finally, the third part makes a comparative analysis between the results of the two applications of the model presented in in the first two parts, identifying similarities and differences among the different contexts.

4.1.
The Brazilian context

From the sample of 2,810 Brazilian manufacturing firms that devoted to some innovation activity between 2009 and 2011, 1,495 introduced successfully at least one product or process innovation, which represents 53.20% of the firms. On the other hand, 1,315, or 46.80% of the firms, did not introduced any innovation during this three-year period. This indicated that almost half of the firms that developed innovation activities during the period failed to introduce new products, services or processes. Table 16 presents the descriptive statistics of all variables of the model, followed by comments about them.

Construct	Variable	Mean	Std. Dev.
Innovation Performance (IP)	INOVPROD	0.385	0.487
	INOVPROC	0.263	0.441
	IPROD_DEGREE	0.435	0.635
	IPROD_RAD_IN	1.011	0.823
	IPROC_DEGREE	0.270	0.509
	IPROC_RAD_IN	1.154	0.738
	%_TURN_IPROD	10.0%	22.7%
	IN_IMP_1	2.176	1.124
	IN_IMP_2	1.892	1.177
	IN_IMP_3	2.169	1.079
	IN_IMP_4	1.931	1.141
	IN_IMP_5	1.783	1.196
	IN_IMP_6	1.861	1.206
	IN_IMP_7	1.744	1.196
	IN_IMP_8	1.501	1.191
	IN_IMP_9	1.393	1.187
	IN_IMP_10	0.961	1.092
	IN_IMP_11	0.968	1.084
	IN_IMP_12	0.665	1.005
	IN_IMP_13	1.287	1.250
	IN_IMP_14	1.527	1.262
	IN_IMP_15	1.527	1.275
External R&D - Strategic Alliances (Ext R&D)	IMP_ReD_EXT	0.502	1.015
	IMP_KNOW_EXT	0.555	1.044
	IMP_SOFT_EXT	1.084	1.307
	IMP_EQ_EXT	1.958	1.242
	AL_CLI	0.695	1.199
	AL_SUP	0.769	1.217
	AL_RIV	0.253	0.726
	AL_CONSUL	0.385	0.871
	AL_UNIV	0.439	0.942
	AL_CENTERS	0.343	0.820
	AL_TEST_INST	0.478	0.980
	SUP_GOV	0.446	0.497
Internal R&D - Absorptive Capacity (Int R&D – AC)	INT_ReD	1.7%	11.5%
	TRAIN_EXP	0.8%	3.3%
	PERS_EDU	0.376	0.497
Current Financial Performance (CFP)	2010_2011_TURN_GRW	36.2%	374.3%
	2010_2011_VA_GRW	23.8%	976.0%
	2010_2011_EMP_GRW	9.7%	24.2%
Future Financial Performance (FFP)	2013_TURN_GRW	13.6%	94.50%
	2013_VA_GRW	21.8%	333.5%
	2013_EMP_GRW	3.0%	31.5%

Table 16 - Mean and standard deviation of the constructs' variables

- INOVPROD – Table 16 shows that 38.50% of the firms introduced product innovation (1,082 firms) and 61.50% did not, which gives a total of 1,728 firms. There is no information about how many firms tried to develop product innovation without achieving success;
- INOVPROC – 26.30% of the firms introduced process innovation (739 firms) and 73.70% did not, which means a total of 2,071 firms. There is no information about how many firms tried to develop process innovation without achieving success either. As 53.20% of the firms introduced at least one type of innovation, only 11.60% (326 firms) introduced successfully both types, 26.90% (756 firms) introduced only product innovation and 14.70% (413 firms) introduced only process innovation;
- IPROD_DEGREE - the average degree of product innovation is low (0.435), which is highly influenced by the 61.50% of firms that did not introduced any product innovation. Excluding these firms, the average increases to 1.130, which indicates a prevalence of product innovations new only to the firms, not even to the market. This shows the low level of innovativeness of the Brazilian manufacturing firms;
- IPROD_RAD_IN - this average is 1.011, but excluding the effect of non-product innovators, the number goes to 1.644, which means that new products had a prevalence of radical, instead of incremental innovation;
- IPROC_DEGREE - the average degree of process innovation is low (0.270), which was also very influenced by the firms that did not introduced any process innovation (739 firms). Excluding these firms, the average increases to 1.027, which indicates a prevalence of process innovations new only to the firms, not even to the market. This is also consistent with the indication of the low level of innovativeness of the Brazilian manufacturing firms;
- IPROC_RAD_IN - this average is 1.154, but excluding the effect of non-process innovators, the number goes to 4.388, which is out of range and means that non-process innovators indicated that introduced incremental or radical process innovation, which is an error of data collection. The EFA conducted to reduce the constructs' variables did not consider this variable in any factor, making this problem not relevant;

- %_TURN_IPROD - the average turnover from new products and services was 10.0% for all firms and 16.3% for product innovators, which are the only ones that did not present 0% in this indicator. There is no indication of the number of new products and services introduced on average and of the percentage of them in the firm's portfolio;
- IN_IMP_1 - the importance of innovation for improving the quality of goods or services in the period had an average of 2.176 in a maximum of 3, which indicates how important innovation for this strategy. This was the most relevant indicator of this nature, as the next indicators' averages show;
- IN_IMP_2 - the importance of innovation for extending the range of goods or services offered in the period had an average of 1.892 in a maximum of 3, which indicates a medium relevance of innovation for this strategy;
- IN_IMP_3 - the importance of innovation in allowing the firm to keep market-share in the period had an average of 2.169 in a maximum of 3, which indicates a high relevance of innovation for this strategy, almost as high as IN_IMP_1;
- IN_IMP_4 - the importance of innovation for extending market-share in the period had an average of 1.931 in a maximum of 3, which indicates a medium relevance of innovation for this strategy;
- IN_IMP_5 - the importance of innovation in allowing the firm to open new markets in the period had an average of 1.783 in a maximum of 3, which also indicates a medium relevance of innovation for this strategy;
- IN_IMP_6 - the importance of innovation for increasing production or service capacity in the period had an average of 1.861 in a maximum of 3, which indicates a medium relevance of innovation for this strategy;
- IN_IMP_7 - the importance of innovation for increasing production or service flexibility in the period had an average of 1.744 in a maximum of 3, which indicates a medium relevance of innovation for this strategy;
- IN_IMP_8 - the importance of innovation for reducing production or service costs in the period had an average of 1.501 in a maximum of 3, also indicating a medium relevance of innovation for this strategy;

- IN_IMP_9 - the importance of innovation for reducing labor cost in the period had an average of 1.393 in a maximum of 3, which indicates a medium to low relevance of innovation for this strategy;
- IN_IMP_10 - the importance of innovation for reducing raw material consumption in the period had an average of 0.961 in a maximum of 3, which indicates a low relevance of innovation for this strategy;
- IN_IMP_11 - the importance of innovation for reducing energy consumption in the period had an average of 0.968 in a maximum of 3, also indicating a low relevance of innovation for this strategy;
- IN_IMP_12 - the importance of innovation for reducing water consumption in the period had an average of 0.665 in a maximum of 3, which indicates a low or almost irrelevant effect of innovation for this strategy;
- IN_IMP_13 - the importance of innovation for allowing the reduction of the environmental impact in the period had an average of 1.287 in a maximum of 3, which indicates a medium to low relevance of innovation for this strategy;
- IN_IMP_14 - the importance of innovation for allowing the control of healthy and security issues in the period had an average of 1.527 in a maximum of 3, which indicates a medium relevance of innovation for this strategy;
- IN_IMP_15- the importance of innovation to fit norms and regulations relative to internal or external market in the period had an average of 1.527 in a maximum of 3, also indicating a medium relevance of innovation for this strategy.

Some analysis of the results presented above is necessary to understand the Brazilian context. The lower occurrence of process innovation may be explained by a vision of Brazilian firms and of some governmental institutions that foment innovation that product innovation adds more value than process innovation, which guarantees a higher level of public financing for the former type of innovation (IBGE, 2016a).

Follows a discussion about the proxies of the construct External R&D – Strategic Alliances. An important observation is that all of them are in a scale of

importance from zero (0) to three (3), except Governmental support (SUP_GOV), that is a dummy variable (Yes / No), and most of them are considered of low importance on average, with only IMP_EQ_EXT having a medium importance. However, as Table 16 shows, their standard deviation are high, which enabled this construct to be relevant in the SEM.

- IMP_ReD_EXT - the importance of acquisition of external R&D had an average of 0.502 in a maximum of 3, indicating a low or almost irrelevant importance of it to the innovation process;
- IMP_KNOW_EXT - the importance of acquisition of external knowledge had an average of 0.555 in a maximum of 3, indicating a low or almost irrelevant importance of it to the innovation process;
- IMP_SOFT_EXT - the importance of acquisition of external software had an average of 1.084 in a maximum of 3, indicating a low importance of it to the innovation process;
- IMP_EQ_EXT - the importance of acquisition of external machinery and equipment had an average of 1.958 in a maximum of 3, indicating a medium importance of it to the innovation process;
- AL_CLI - the alliances with clients had an average of 0.695 in a maximum of 3, indicating a low to irrelevant importance of it to the innovation process;
- AL_SUP - the alliances with suppliers had an average of 0.769 in a maximum of 3, indicating a low importance of it to the innovation process;
- AL_RIV - the alliances with rivals had an average of 0.253 in a maximum of 3, and was considered almost irrelevant for the innovation process;
- AL_CONSUL - the alliances with consulting firms had an average of 0.385 in a maximum of 3, and was considered almost irrelevant for the innovation process;
- AL_UNIV - the alliances with universities and research institutes had an average of 0.439 in a maximum of 3, and was considered almost irrelevant for the innovation process;

- AL_CENTERS - the alliances with professional capacitation and technical assistance centers had an average of 0.343 in a maximum of 3, and was considered almost irrelevant for the innovation process;
- AL_TEST_INST - the alliances with test, trial and certification centers had an average of 0.478 in a maximum of 3, and was considered almost irrelevant for the innovation process;
- SUP_GOV - 44.6% or 1,253 firms had governmental support to develop innovation, which shows how the governmental support programs in Brazil are considered important for the conduction of the innovation process inside manufacturing firms.

Follows comments about the proxies of the construct Internal R&D – Absorptive Capacity:

- INT_ReD – the percentage of total revenues spent on internal R&D is on average 1.7%. It is interesting to notice that firms that succeed in innovate have a higher average, of 2.1%. Firms that failed in introduce innovation had an average percentage of 1.22%, strongly indicating that R&D intensity influences the success of innovation introduction;
- TRAIN_EXP – the percentage of total revenue spent on training was 0.8%. It is also higher for successful innovators (1.36% versus 0.17% from the non-innovators);
- PERS_EDU – the level of education of the R&D personnel, that ranges from zero (0) to three (3) is 0.376. The innovators scored higher, with 0.454 and the non-innovators scored 0.287.

The next proxies discussed are the ones representing the constructs Current Financial Performance (the three next variables) and Future Financial Performance (the last three variables). It is interesting to notice that the three current financial performance proxies have a higher average than their equivalent in the construct future financial performance. This may indicate that the year of 2013 was not very good for the Brazilian manufacturing industry. However, although the growth decayed, all the performance indicators based on growth kept positive, which may indicate that the manufacturing firms are still recovering

from the 2008 global crisis, that hit strongly the Brazilian industry, with the recovery having started in 2010 (CUNHA; LELIS; FLIGENSPAN; 2013).:

- 2010_2011_TURN_GRW - the average turnover growth from 2010 and 2011, compared to the previous years was 36.2%.
- 2010_2011_VA_GRW - the average value-added growth from 2010 and 2011, compared to the previous years was 23.8%
- 2010_2011_EMP_GRW - the average number of employees' growth from 2010 and 2011, compared to the previous years was 9.7%
- 2013_TURN_GRW - the turnover growth from 2013 compared to 2012 was 13.6%;
- 2013_VA_GRW - the value-added growth from 2013 compared to 2012 was 21.8%;
- 2013_EMP_GRW - the number of employees' growth from 2013 compared to 2012 was 3.0%.

Next comes the tables with the Pearson's correlations among all the variables of the model (see Tables 17 to 22).

	v1	v2	v3	v4	v5	v6	v7	v8
INOVPROD (v1)	1.00							
INOVPROC (v2)	0.07	1.00						
IPROD_DEGREE (v3)	0.78	0.08	1.00					
IPROD_RAD_IN (v4)	0.52	0.04	0.45	1.00				
IPROC_DEGREE (v5)	0.13	0.73	0.16	0.08	1.00			
IPROC_RAD_IN (v6)	0.02	0.30	0.02	0.17	0.30	1.00		
%_TURN_IPROD (v7)	0.56	0.06	0.49	0.29	0.12	0.03	1.00	
IN_IMP_1 (v8)	0.20	0.12	0.19	0.27	0.11	0.31	0.15	1.00
IN_IMP_2 (v9)	0.29	0.10	0.25	0.45	0.09	0.25	0.17	0.52
IN_IMP_3 (v10)	0.19	0.11	0.18	0.28	0.11	0.32	0.17	0.60
IN_IMP_4 (v11)	0.22	0.10	0.20	0.33	0.10	0.29	0.16	0.54
IN_IMP_5 (v12)	0.23	0.08	0.20	0.36	0.09	0.23	0.16	0.45
IN_IMP_6 (v13)	0.02	0.18	0.04	0.10	0.17	0.43	0.06	0.47
IN_IMP_7 (v14)	0.03	0.17	0.03	0.11	0.17	0.43	0.06	0.45
IN_IMP_8 (v15)	0.01	0.18	0.02	0.05	0.17	0.37	0.04	0.38
IN_IMP_9 (v16)	-0.01	0.13	-0.01	0.01	0.11	0.33	0.03	0.38
IN_IMP_10 (v17)	0.07	0.13	0.07	0.08	0.12	0.24	0.08	0.30
IN_IMP_11 (v18)	0.05	0.14	0.05	0.06	0.16	0.25	0.05	0.29
IN_IMP_12 (v19)	0.08	0.13	0.08	0.11	0.13	0.18	0.06	0.22
IN_IMP_13 (v20)	0.12	0.16	0.12	0.13	0.15	0.25	0.12	0.33
IN_IMP_14 (v21)	0.05	0.12	0.04	0.09	0.11	0.30	0.08	0.39
IN_IMP_15 (v22)	0.11	0.09	0.10	0.17	0.09	0.22	0.12	0.40
IMP_ReD_EXT (v23)	0.11	0.05	0.15	0.15	0.09	0.07	0.08	0.09
IMP_KNOW_EXT (v24)	0.05	0.05	0.07	0.09	0.06	0.07	0.03	0.13
IMP_SOFT_EXT (v25)	0.02	-0.03	0.04	0.02	-0.01	0.19	0.02	0.13
IMP_EQ_EXT (v26)	-0.04	0.13	-0.03	0.02	0.11	0.36	0.00	0.23
AL_CLI (v27)	0.14	0.08	0.16	0.18	0.11	0.08	0.11	0.13
AL_SUP (v28)	0.10	0.07	0.11	0.15	0.10	0.08	0.09	0.11
AL_RIV (v29)	0.05	0.03	0.05	0.11	0.06	0.04	0.07	0.10
AL_CONSUL (v30)	0.08	0.07	0.12	0.12	0.12	0.08	0.08	0.10
AL_UNIV (v31)	0.13	0.09	0.16	0.15	0.13	0.07	0.10	0.11
AL_CENTERS (v32)	0.07	0.06	0.11	0.11	0.10	0.07	0.08	0.13
AL_TEST_INST (v33)	0.12	0.09	0.14	0.16	0.11	0.09	0.10	0.13
SUP_GOV (v34)	0.06	0.04	0.10	0.11	0.08	0.10	0.06	0.16
INT_ReD (v35)	0.04	-0.01	0.06	0.06	0.00	0.04	0.07	0.05
TRAIN_EXP (v36)	-0.01	0.03	-0.01	-0.02	-0.01	0.00	-0.01	0.00
PERS_EDU (v37)	0.21	0.07	0.26	0.25	0.11	0.06	0.12	0.10
2010_2011_TURN_GRW (v38)	0.00	0.01	0.00	0.00	0.06	0.03	0.01	-0.01
2010_2011_VA_GRW (v39)	0.01	0.01	0.00	0.01	-0.02	0.01	0.04	0.00
2010_2011_EMP_GRW (v40)	0.00	0.00	0.02	0.02	0.00	0.02	0.01	0.04
2013_TURN_GRW (v41)	0.00	-0.01	0.01	0.03	-0.01	0.03	0.00	-0.01
2013_VA_GRW (v42)	0.03	0.03	0.02	0.03	0.07	0.02	0.03	0.00
2013_EMP_GRW (v43)	-0.02	-0.04	-0.04	-0.01	-0.02	-0.03	-0.03	-0.03

Table 17- Pearson's correlations table – part I

	v9	v10	v11	v12	v13	v14	v15	v16
IN_IMP_2 (v9)	1.00							
IN_IMP_3 (v10)	0.52	1.00						
IN_IMP_4 (v11)	0.60	0.68	1.00					
IN_IMP_5 (v12)	0.55	0.56	0.67	1.00				
IN_IMP_6 (v13)	0.34	0.46	0.47	0.38	1.00			
IN_IMP_7 (v14)	0.35	0.46	0.43	0.36	0.73	1.00		
IN_IMP_8 (v15)	0.24	0.41	0.38	0.30	0.63	0.60	1.00	
IN_IMP_9 (v16)	0.21	0.40	0.35	0.29	0.62	0.58	0.81	1.00
IN_IMP_10 (v17)	0.24	0.30	0.29	0.28	0.39	0.39	0.53	0.51
IN_IMP_11 (v18)	0.21	0.30	0.29	0.26	0.44	0.40	0.56	0.55
IN_IMP_12 (v19)	0.21	0.25	0.25	0.24	0.32	0.32	0.38	0.36
IN_IMP_13 (v20)	0.28	0.35	0.32	0.30	0.41	0.38	0.41	0.38
IN_IMP_14 (v21)	0.28	0.42	0.37	0.32	0.48	0.47	0.47	0.48
IN_IMP_15 (v22)	0.32	0.42	0.39	0.35	0.36	0.36	0.32	0.33
IMP_ReD_EXT (v23)	0.15	0.10	0.10	0.13	0.06	0.06	0.07	0.07
IMP_KNOW_EXT (v24)	0.14	0.12	0.14	0.11	0.08	0.10	0.07	0.08
IMP_SOFT_EXT (v25)	0.13	0.15	0.15	0.12	0.16	0.19	0.18	0.19
IMP_EQ_EXT (v26)	0.18	0.24	0.22	0.19	0.37	0.35	0.29	0.30
AL_CLI (v27)	0.16	0.15	0.14	0.16	0.09	0.10	0.12	0.10
AL_SUP (v28)	0.12	0.13	0.10	0.12	0.08	0.09	0.10	0.08
AL_RIV (v29)	0.13	0.12	0.12	0.13	0.07	0.07	0.08	0.09
AL_CONSUL (v30)	0.13	0.15	0.12	0.13	0.09	0.10	0.11	0.10
AL_UNIV (v31)	0.14	0.14	0.15	0.14	0.10	0.10	0.11	0.09
AL_CENTERS (v32)	0.12	0.16	0.13	0.15	0.12	0.13	0.14	0.14
AL_TEST_INST (v33)	0.16	0.16	0.15	0.15	0.11	0.11	0.14	0.11
SUP_GOV (v34)	0.15	0.16	0.15	0.14	0.13	0.14	0.15	0.12
INT_ReD (v35)	0.04	0.05	0.06	0.05	0.01	0.03	0.02	0.02
TRAIN_EXP (v36)	0.02	0.00	0.02	0.00	0.02	0.02	0.02	-0.01
PERS_EDU (v37)	0.19	0.11	0.14	0.12	0.04	0.02	0.08	0.04
2010_2011_TURN_GRW (v38)	0.03	0.02	0.03	0.00	0.01	0.02	0.03	0.00
2010_2011_VA_GRW (v39)	0.00	0.02	0.01	0.02	0.01	0.02	0.01	0.02
2010_2011_EMP_GRW (v40)	0.05	0.03	0.07	0.05	0.04	0.04	0.04	0.03
2013_TURN_GRW (v41)	0.02	0.02	0.03	0.03	0.03	0.03	-0.01	0.01
2013_VA_GRW (v42)	0.00	0.01	-0.01	0.02	0.01	0.01	0.00	-0.01
2013_EMP_GRW (v43)	-0.02	-0.03	0.00	-0.01	-0.02	-0.02	-0.02	-0.01

Table 18 - Pearson's correlations table – part II

	v17	v18	v19	v20	v21	v22	v23	v24
IN_IMP_10 (v17)	1.00							
IN_IMP_11 (v18)	0.54	1.00						
IN_IMP_12 (v19)	0.44	0.60	1.00					
IN_IMP_13 (v20)	0.42	0.49	0.52	1.00				
IN_IMP_14 (v21)	0.36	0.45	0.40	0.61	1.00			
IN_IMP_15 (v22)	0.30	0.32	0.32	0.44	0.54	1.00		
IMP_ReD_EXT (v23)	0.09	0.09	0.10	0.08	0.05	0.08	1.00	
IMP_KNOW_EXT (v24)	0.11	0.07	0.11	0.14	0.13	0.13	0.18	1.00
IMP_SOFT_EXT (v25)	0.13	0.12	0.10	0.11	0.14	0.13	0.09	0.22
IMP_EQ_EXT (v26)	0.15	0.19	0.12	0.21	0.30	0.20	0.01	0.12
AL_CLI (v27)	0.14	0.16	0.17	0.16	0.12	0.15	0.24	0.11
AL_SUP (v28)	0.12	0.15	0.16	0.17	0.11	0.12	0.23	0.15
AL_RIV (v29)	0.11	0.12	0.13	0.10	0.09	0.13	0.14	0.11
AL_CONSUL (v30)	0.13	0.16	0.18	0.17	0.11	0.16	0.29	0.15
AL_UNIV (v31)	0.14	0.16	0.20	0.18	0.13	0.16	0.32	0.12
AL_CENTERS (v32)	0.15	0.21	0.21	0.19	0.16	0.18	0.20	0.15
AL_TEST_INST (v33)	0.15	0.17	0.20	0.18	0.15	0.20	0.27	0.14
SUP_GOV (v34)	0.13	0.12	0.10	0.13	0.11	0.14	0.19	0.02
INT_ReD (v35)	0.04	0.02	0.00	0.01	0.01	0.04	0.06	0.00
TRAIN_EXP (v36)	0.04	0.02	-0.01	0.03	0.01	0.02	-0.01	-0.01
PERS_EDU (v37)	0.08	0.08	0.08	0.10	0.04	0.08	0.22	0.03
2010_2011_TURN_GRW (v38)	0.01	0.02	0.01	0.04	0.03	0.01	0.02	0.01
2010_2011_VA_GRW (v39)	0.01	0.00	0.00	0.02	0.00	0.03	-0.01	0.01
2010_2011_EMP_GRW (v40)	0.04	0.02	0.01	0.02	0.03	0.03	0.02	0.05
2013_TURN_GRW (v41)	-0.01	0.00	-0.01	0.02	0.02	0.04	-0.01	0.05
2013_VA_GRW (v42)	0.02	0.01	0.00	0.01	0.00	0.01	-0.03	-0.02
2013_EMP_GRW (v43)	-0.01	-0.01	-0.02	0.00	-0.01	-0.01	-0.01	0.03

Table 19 - Pearson's correlations table – part III

	v25	v26	v27	v28	v29	v30	v31	v32
IMP_SOFT_EXT (v25)	1.00							
IMP_EQ_EXT (v26)	0.24	1.00						
AL_CLI (v27)	0.05	0.05	1.00					
AL_SUP (v28)	0.07	0.05	0.76	1.00				
AL_RIV (v29)	0.02	0.02	0.53	0.50	1.00			
AL_CONSUL (v30)	0.10	0.08	0.59	0.59	0.45	1.00		
AL_UNIV (v31)	0.05	0.05	0.57	0.54	0.42	0.58	1.00	
AL_CENTERS (v32)	0.07	0.08	0.61	0.60	0.51	0.63	0.64	1.00
AL_TEST_INST (v33)	0.07	0.07	0.67	0.67	0.49	0.64	0.66	0.70
SUP_GOV (v34)	0.06	0.12	0.14	0.13	0.09	0.17	0.21	0.15
INT_ReD (v35)	0.04	-0.02	0.08	0.05	0.08	0.08	0.06	0.04
TRAIN_EXP (v36)	-0.02	0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
PERS_EDU (v37)	0.02	-0.02	0.14	0.11	0.09	0.10	0.22	0.06
2010_2011_TURN_GRW (v38)	0.01	0.03	0.00	0.00	-0.01	-0.01	0.04	-0.01
2010_2011_VA_GRW (v39)	0.01	-0.02	0.00	0.00	-0.03	-0.01	0.01	-0.01
2010_2011_EMP_GRW (v40)	0.06	0.06	0.01	0.01	-0.02	0.02	0.02	0.02
2013_TURN_GRW (v41)	0.03	0.03	0.01	0.04	0.01	0.06	0.05	0.05
2013_VA_GRW (v42)	-0.01	-0.01	0.01	-0.01	-0.02	-0.03	-0.01	-0.03
2013_EMP_GRW (v43)	-0.02	0.02	0.00	0.02	-0.01	0.01	-0.01	0.00

Table 20 - Pearson's correlations table – part IV

	v33	v34	v35	v36	v37	v38	v39	v40
AL_TEST_INST (v33)	1.00							
SUP_GOV (v34)	0.17	1.00						
INT_ReD (v35)	0.06	0.05	1.00					
TRAIN_EXP (v36)	-0.01	-0.02	0.00	1.00				
PERS_EDU (v37)	0.17	0.23	0.11	-0.01	1.00			
2010_2011_TURN_GRW (v38)	0.01	-0.01	0.01	0.00	0.04	1.00		
2010_2011_VA_GRW (v39)	-0.01	0.00	0.01	0.00	0.02	-0.06	1.00	
2010_2011_EMP_GRW (v40)	0.01	0.06	0.03	-0.02	-0.01	0.08	0.03	1.00
2013_TURN_GRW (v41)	0.05	0.02	0.05	0.00	0.03	0.01	0.00	0.02
2013_VA_GRW (v42)	-0.03	0.00	-0.01	0.00	-0.01	0.00	0.00	0.01
2013_EMP_GRW (v43)	0.02	0.02	-0.03	0.04	0.02	0.00	-0.01	0.03

Table 21 - Pearson's correlations table – part V

	v41	v42	v43
2013_TURN_GRW (v41)	1.00		
2013_VA_GRW (v42)	0.08	1.00	
2013_EMP_GRW (v43)	0.18	0.05	1.00

Table 22 - Pearson's correlations table – part VI

After applying the Z-core to all scalar variables to avoid scale problems, the next step of the analysis was to execute an EFA to reduce the number of variables that would reflect the constructs of the SEM. The EFA was applied separately in

the constructs Innovation Performance, reducing it to four factors; and External R&D - Strategic Alliances, reducing it to one factor; both using the scree-plot method. For both constructs, the Bartlett's test of sphericity was significant ($p < 0.01$), indicating that the reduction was valid. The resulting factors of these two constructs, as a result of the EFA after the varimax rotation, are presented in Tables 23 and 24. Only variables that weighted 0.7 or higher in each factor were used to calculate the final variable and are shown in the cited tables.

Innovation Performance				
Variable	Factor1	Factor2	Factor3	Factor4
Introduction of product innovation (INOVPROD)			0.88	
Introduction of process innovation (INOVPROC)				0.81
Innovative degree prod. innov. (IPROD_DEGREE)			0.80	
Prod. innov. radical (IPROD_RAD_IN)				
Innovative degree proc. innov. (IPROC_GRAU)				
Proc. innov. radical (IPROC_RAD_IN)				
% turnover of product innov. (%_TURN_IPROD)				
Improved quality of goods or services (IN_IMP_1)				
Extended range of goods or services (IN_IMP_2)				
Allowed to keep market-share (IN_IMP_3)		0.70		
Extended market-share (IN_IMP_4)		0.77		
Allowed to open new markets (IN_IMP_5)				
Increased prod. or service capacity (IN_IMP_6)				
Increased prod. or service flexibility (IN_IMP_7)				
Reduced production or service costs (IN_IMP_8)	0.76			
Reduced labor costs (IN_IMP_9)	0.75			
Reduced raw material consumption (IN_IMP_10)				
Reduced energy consumption (IN_IMP_11)	0.74			
Reduced water consumption (IN_IMP_12)				
Reduction of environmental impact (IN_IMP_13)				
Control of healthy and security issues (IN_IMP_14)				
Fit norms and regulations (IN_IMP_15)				

Table 23 - Results of the EFA: Innovation Performance

For Innovation Performance, factor 1 was formed by the average of Reduced production or service costs (IN_IMP_8), Reduced labor costs (IN_IMP_9) and Reduced energy consumption (IN_IMP_11), which are variables that measured the impact of the innovation in costs (in the case of these variables, production costs, labor costs and energy costs). For that reason, factor 1 was

called *Innovations' Cost-Reduction Performance* (CR_PERF). Factor 2 was formed by IN_IMP_3 and IN_IMP_4, that represent the impact in keeping and increasing the firm's participation in the market. Therefore, factor 2 was called *Innovations' Market Performance* (IN_PERF). Factor 3 was formed by the Introduction or not of product innovation (INOVPROD) and by the Innovativeness degree of the product innovation (IPROD_DEGREE) and, for that reason, was called *Product Innovation Introduction* (INTRO_PROD). Factor 4, that was formed by the Introduction or not of process innovation (INOVPROC), was called *Process Innovation Introduction* (INTRO_PROC).

External R&D - Strategic Alliances	
Variable	Factor1
Acquisition of external R&D (IMP_ReD_EXT)	
Acquisition of other external know. (IMP_KNOW_EXT)	
Acquisition of software (IMP_SOFT_EXT)	
Acquisition of equipment (IMP_EQ_EXT)	
Alliance with clients(AL_CLI)	0.81
Alliance with suppliers (AL_SUP)	0.79
Alliance with rivals (AL_RIV)	
Alliance with consulting firms (AL_CONSUL)	0.76
Alliance with Universities (AL_UNIV)	0.75
Alliance with technical centers (AL_CENTERS)	0.80
Alliance with test centers (AL_TEST_INST)	0.85
Governmental support (SUP_GOV)	

Table 24 - Results of the EFA: External R&D – Strategic Alliances

In the case of the construct External R&D - Strategic Alliances, the EFA resulted in only one factor, that was formed by Alliance with clients (AL_CLI), suppliers (AL_SUP), consulting firms (AL_CONSUL), Universities (AL_UNIV), technical centers (AL_CENTERS) and test centers (AL_TEST_INST). All these forming variables measures the importance of some type of partner for innovation. Therefore, this factor was named *Strategic Alliances* (STR_ALL). All the other variables of the constructs that did not form one of the factors were not considered in the SEM. For the other constructs (Internal R&D - Absorptive Capacity, Current Financial Performance and Future Financial Performance), all the variables were separately used to reflect the latent variables on the SEM.

The next step of the analysis was a CFA considering the four constructs of the model that contains more than one proxy (as the construct External R&D – Strategic Alliance was reduced to a unique variable; it did not participate of the CFA). The CFA analysis was run using Bayesian estimation. After several runs and the analysis of the modification indexes, the variable CR_PERF was removed from the construct innovation performance and the error variance of IN_PERF was fixed as 0. No other changes were made to the measurement model. The results of the measurement model and the tests for discriminant validity are presented in Tables 25 and 26 respectively.

Construct	Variable	Std. Regression Weights	t-test	CR	AVE
Innovation Performance	IN_PERF	1.000	***	0.911	0.502
	INTRO_PROD	0.165	***		
	INTRO_PROC	0.691	***		
Internal R&D - Absorptive Capacity	INT_ReD	0.113	***	0.384	0.333
	TRAIN_EXP	-0.016	-		
	PERS_EDU	0.993	***		
Current Financial Performance	2010_2011_TURN_GRW	0.083	***	0.342	0.334
	2010_2011_VA_GRW	-0.062	***		
	2010_2011_EMP_GRW	0.996	***		
Future Financial Performance	2013_TURN_GRW	0.181	***	0.489	0.344
	2013_VA_GRW	0.078	***		
	2013_EMP_GRW	0.997	***		

*** p<0.05

Table 25 - Results of the CFA

Although all the standardized regression weights of the measurement model should be all greater than 0.7 to guarantee the reliability of the individual index, all the regression weights were significant, with the p-value of 0.05, except for TRAIN_EXP in the construct Internal R&D - Absorptive Capacity. However, it was kept so as to have a minimum of three proxies in each construct. The only constructs that presented the minimum level of average variance extracted – AVE, that should be 0.5, and of composite reliability – CR, that should be 0.7, was Innovation Performance. All the others were below these levels. However, some authors considered that the AVE is a very conservative criterion for convergent validity and the researcher may decide that the construct have convergent validity

even with more than 50% of the variance explained by error (MALHOTRA; DASH, 2011). Considering this, Future Financial Performance is almost acceptable and the other constructs were not changed in order to keep three variables in each one.

	IP	AC	CFP	FFP
Innovation Performance (IP)	**0.502**			
Internal R&D - Absorptive Capacity (AC)	0.018	**0.333**		
Current Financial Performance (CFP)	0.002	0.002	**0.334**	
Future Financial Performance (FFP)	0.000	0.001	0.000	**0.344**

Table 26 - Discriminant validity

The discriminant validity check was successful in discriminating the constructs among each other, as could be seen in Table 26, in which the main diagonal shows that the construct's AVE is much higher than all the off-diagonal elements, which presents the squared estimated correlations between the constructs. For nomological validity, significant but low covariances between constructs were expected. Covariances were significant for $p<0.05$ and low between Internal R&D - Absorptive Capacity and Current Financial Performance (0.045), between Internal R&D - Absorptive Capacity and Innovation Performance (0.134) and between Innovation Performance and Current Innovation Performance (0.047). The covariances between Future Innovation Performance and the other three constructs were not significant. This may indicate a specific problem with the construct Future Innovation Performance. However, considering the importance of it for our study, the decision was to move forward without additional changes.

The following step of the analysis was the test of the causal model with SEM using Bayesian estimation. The results of the analysis are summarized in Table 27. Figure 21 shows the complete model, the standardized coefficients and the error terms. The model presents a fourth construct, Ext.R&D x AC, representing the moderation relationship of absorptive capacity, as explained in the method section. The model's posterior predictive was 0.56, which can be considered a good fit, as it is close to 0.5 (GELMAN, 2013).

Brazilian Manufacturing Firms (n = 2,810)			
Relationship	Std. Regression Weight	Sig. *** p < 0.05	Hypothesis test
Ext. R&D → IP	0.105	***	H1: Supported
Int. R&D → IP	0.004	-	H2: Rejected
Ext. R&D x Int R&D(AC) → IP	0.993	***	H3: Supported
IP → FFP	-0.897	***	H4: Rejected
CFP → IP	0.001	-	H5a: Rejected
CFP → FFP	0.259	-	H5b: Rejected

Table 27 - Results of the SEM analysis

The standard regression weights of the relationships in Table 27 were analyzed for the rejection of the null hypotheses. The first hypothesis suggested that the higher the level of external R&D of a Brazilian manufacturing firm, mainly accessed through strategic alliances, the higher its innovation performance. This hypothesis (H1) was supported, with a positive and significant ($p < 0.05$) path coefficient of 0.105. The open innovation that occurs mainly through strategic alliances in manufacturing Brazilian firms is illustrated by the fact that the construct External R&D was reduced to a variable formed only by the proxies representing the importance of alliances with several types of partners (clients, suppliers, consulting firms, Universities, research centers and test institutes). The proxies that represent purely acquisition of external knowledge or R&D were excluded from the model by the EFA. All the types of partners have a similar weight in the factor that represented External R&D, which indicates that the firms that use strategic alliances for open innovation use all those types of partners and consider them as similarly important.

Hypothesis 2 was rejected. The path coefficient between the constructs Internal R&D – Absorptive Capacity and Innovation Performance is positive (0.004), but not significant for $p < 0.05$. In our model, this construct was represented by internal R&D intensity, training expenses and personnel education. However, training expenses did not reflect significantly the construct. High investments in internal R&D are costly for the firms and are more intensely made by firms in high-tech industries, that are closer to the technological frontier. In the case of Brazil, manufacturing firms are mainly concentrated in low-technology

based industries and the ones in more high-tech industries are not close enough to the technological frontier so that their internal R&D and knowledge may generate high-performance innovation. These firms are still in the process of technological capability accumulation; in which it is important to learn from more technologically developed partners. However, higher levels of internal R&D, or absorptive capacity, may be important to potentiate the effects of the strategic alliances on the innovation performance, as proposed by hypothesis 3. Our analysis is consistent with this fact as H3 was confirmed for $p < 0.05$ with a path coefficient of 0.993. It is interesting to observe that the only factor of absorptive capacity that had a significant moderation effect with the strategic alliances in the model was level of education of the employees. This means that, for Brazilian manufacturing firms, it is important to have a well-educated team to work on open innovation activities, as they are more qualified to evaluate opportunities and identify and absorb external knowledge to generate innovation. The level of internal R&D intensity still did not allow enough accumulation of capabilities to improve the absorptive capacity of these firms.

A positive relationship between innovation performance and future financial performance was expected, as indicated by hypothesis 4, however, a negative significant relationship (-0.897 with $p < 0.05$) was found, leading to the rejection of H4. Although the relationship between innovation performance and financial performance has been consistently found in the literature, the observation of economical results from the innovations introduced takes time. In this study, the data presented indicators for the innovations introduced between 2009 and 2011 and the indicators of financial performance measured were from 2013. This two-year time lag might not be enough for the innovations to translate into performance improvements, considering indicators such as turnover growth, firm's growth or value-added growth. But it might be enough to reflect the increase in costs and the decrease in revenues caused by the redirection of resources from marketing and sales to innovation activities (such as internal R&D), and by the management costs of collaboration (FAEMS et al. 2010).

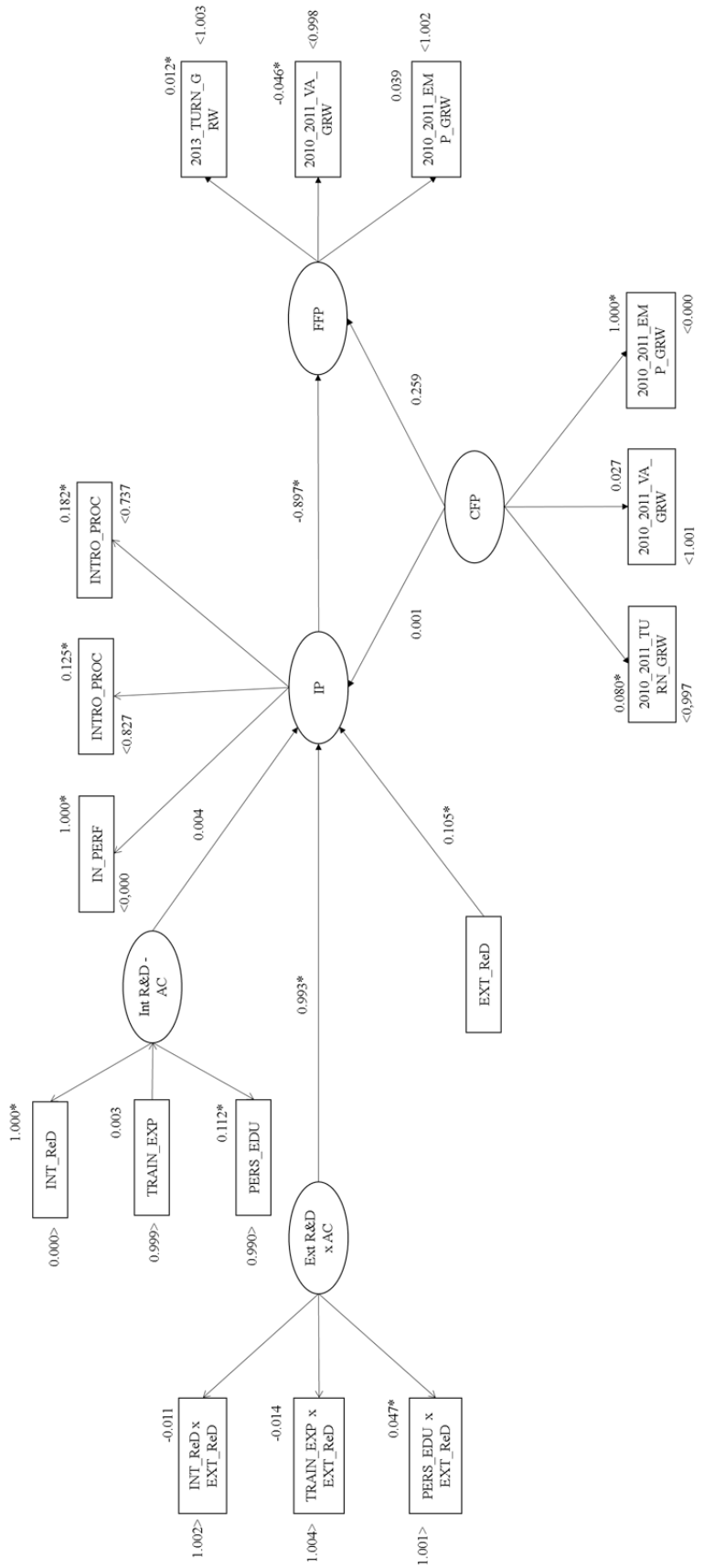


Figure 21 – Structural Model (Brazil)

The effect of current financial performance on the innovation performance, that would indicate that successful firms innovate more, were not verified (path coefficient of 0.001, not significant with $p < 0.05$, indicating the rejection of H5a), suggesting that Brazilian manufacturing firms that are not yet financially successful may still succeed in innovation if they accumulate enough absorptive capacity and balance their strategic alliances. The greater importance of personnel's education in comparison with internal R&D intensity as a dimension of absorptive capacity helps the achievement of this equality of chances as the former demands less money than the latter to be improved. It was not found a significant effect between current financial performance and future financial performance either (path coefficient of 0.259, not significant with $p < 0.05$, indicating the rejection of H5b).

4.2. The selected European countries' context

Table 28 shows the descriptive statistics of the total sample and of each group (means and standard deviations) of the selected European countries in the sample. For all the analysis, one case of group 6 (a firm from Czech Republic), that was an extreme outlier in turn_growth, was excluded of the analysis. A one-way ANOVA with the post-hoc test of Tamahhane T2 was also run to identify differences between variables' means among the groups (HAIR et al., 2006). An analysis of Table 28 shows that all model variables present mean differences among groups. 95% of all firms of the sample (a total of 2,608) succeeded in introducing at least one product or process innovation in the period. Post-hoc analysis could identify that group 7 (Norway), in which 100% of the sample firms introduced innovation, scored higher than, at least, groups 3 (composed by Portugal and Spain), 6 (composed by Czech Republic, Hungary and Slovakia) and 2 (that represents Italy) in this variable (INOV). The sample's levels of product and process innovators were similar (74% or 2,031 firms, and 75% or 2,059 firms). From those, 1,482 (53.99%) introduced both types in the period, 549 (20.00%) only product innovation and 577 (21.02%) only process innovation. In both indicators, group 7 was identified to be superior than all the other groups.

Considering the three internal R&D proxies, group 7 also scored higher than the other groups in two of them (with exception of the proxy rrdinx_rat, in which was not significantly different from group 5, composed by Croatia, Cyprus and Slovenia), with different patterns concerning the average order among the other groups for the three variables. This may indicate that manufacturing firms of Norway have a higher absorptive capacity than the firms from the other countries analyzed in this study. In the case of the financial performance proxies, turnover growth between 2008 and 2010 was 56.20% on average and differences among groups could be found. However, the post-hoc analysis did not identify differences between groups two by two. Group 1 (Bulgaria and Romania) has the highest average, followed by group 4 (Estonia and Lithuania). In the case of number of employee's growth, which was not measured for group 2, a negative total average of – 2.0% was found, with group 4 scoring higher than the others and groups 1, 3 and 6 having a decrease in the number of employees in the period. Significant differences between groups two by two were also not found by the post-hoc analysis for this indicator. Another interesting observation from the ANOVA analysis concerns the variables that represent External R&D – Strategic Alliances. Group 7 scored higher or belongs to the group of firms that scored higher in most cases (for SSUP, SCLI, SCOM, SINS, SUNI, SGMT, SJOU and SPRO). From all these types of strategic alliances, collaboration with suppliers and clients are the ones that were considered more important to the innovation process (1.72 and 1.66 respectively in a maximum of 3). On the other hand, collaboration with the Government (SGMT), with Universities (SUNI) and with professional and industry associations (SPRO) scored less than 1, which indicates that they were considered somehow between irrelevant and of low relevance.

Table 28 - Descriptive statistics

Construct	Variable	All firms (n = 2,745)		Group 1 (n = 141)		Group 2 (n = 731)		Group 3 (n = 1,336)		Group 4 (n = 59)		Group 5 (n = 90)		Group 6 (n = 305)		Group 7 (n = 83)	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Innovation Performance	INOV	0.95*	0.23	0.97	0.17	0.95	0.21	0.93	0.25	0.95	0.22	0.96	0.21	0.94	0.23	1.00	0.00
	PRODINOV	0.74***	0.44	0.79	0.41	0.82	0.38	0.67	0.47	0.63	0.49	0.86	0.35	0.79	0.41	1.00	0.00
	PROCINOV	0.75***	0.43	0.76	0.43	0.76	0.43	0.77	0.42	0.69	0.46	0.78	0.42	0.63	0.48	1.00	0.00
	RADPRODINOV	1.22***	0.83	1.21	0.77	1.47	0.78	1.03	0.83	0.93	0.83	1.36	0.74	1.31	0.80	1.81	0.40
	RADPROCINOV	0.96***	0.68	1.09	0.76	1.16	0.79	0.83	0.52	0.95	0.75	0.97	0.84	0.74	0.80	1.67	0.47
	TURN	12.6%***	22.1%	10.0%	16.0%	27.1%	31.0%	6.8%	15.0%	4.7%	6.9%	7.4%	13.7%	8.5%	14.5%	8.5%	11.8%
	ORANGE	2.17***	1.02	2.50	0.78	2.31	0.88	1.96	1.12	2.17	1.05	2.53	0.80	2.41	0.89	2.58	0.74
	OREPL	1.87***	1.09	2.18	0.98	1.95	0.99	1.68	1.15	2.17	1.02	2.20	0.89	2.07	1.02	2.39	0.85
	ONMOMS	2.09***	1.05	2.32	0.90	2.16	0.90	1.96	1.16	2.22	0.89	2.32	0.90	2.16	0.99	2.58	0.61
	OQUA	2.25***	0.98	2.49	0.81	2.41	0.76	2.06	1.12	2.37	0.74	2.61	0.71	2.38	0.86	2.60	0.58
	OFLEX	1.86***	1.01	2.11	0.92	1.89	0.93	1.76	1.06	2.02	0.78	2.24	0.94	1.85	1.06	2.22	0.80
	OCAP	1.83***	1.05	2.11	1.02	1.79	0.96	1.77	1.11	2.08	0.84	2.11	0.98	1.83	1.07	2.11	0.81
	OLBR	1.73***	1.07	1.96	1.02	1.70	0.99	1.63	1.13	2.08	0.93	2.20	0.93	1.80	1.04	2.39	0.75
	ORME	1.68***	1.08	2.00	1.05	1.74	0.99	1.50	1.12	1.90	0.94	2.11	0.98	1.86	1.04	2.34	0.80
	OREI	1.64***	1.11	1.84	1.12	1.83	1.00	1.48	1.16	1.59	1.02	2.01	1.12	1.57	1.10	2.07	0.93
	OHESY	1.70***	1.13	2.00	1.06	1.95	0.99	1.51	1.19	1.49	1.06	2.06	1.06	1.60	1.12	2.16	0.93
External R&D - Strategic Alliances	SSUP	1.72***	0.98	1.94	0.86	1.77	0.88	1.58	1.06	2.02	0.99	2.08	0.92	1.81	0.86	2.30	0.64
	SCLI	1.66***	1.09	2.02	0.94	1.61	1.05	1.50	1.12	1.36	1.06	2.07	1.00	2.07	1.01	2.51	0.67
	SCOM	1.24***	1.01	1.53	1.00	1.11	0.93	1.14	1.02	1.15	0.94	1.48	1.06	1.58	1.03	1.93	0.84
	SINS	1.07***	1.01	0.96	1.02	1.33	0.97	1.00	1.03	0.80	0.94	0.71	0.94	0.93	0.94	1.33	0.94
	SUNI	0.75***	0.96	0.73	0.96	0.85	0.98	0.69	0.96	0.36	0.71	0.50	0.80	0.76	0.92	1.31	0.90
	SGMT	0.67***	0.94	0.54	0.79	0.51	0.79	0.82	1.03	0.20	0.52	0.36	0.75	0.42	0.74	1.47	0.98
	SCON	1.26***	1.02	1.52	1.08	1.34	0.96	1.10	1.03	1.44	0.99	1.33	1.11	1.53	0.95	1.46	0.86
	SJOU	1.07***	0.94	1.38	1.03	1.08	0.89	0.93	0.93	0.88	0.83	1.23	1.01	1.30	0.88	1.90	0.78
	SPRO	0.88***	0.92	0.89	0.92	0.92	0.88	0.82	0.90	0.63	0.83	0.64	0.88	0.77	0.85	2.18	0.78
Internal R&D - Absorptive Capacity	rrdinx_rat	1.97%***	5.18%	1.03%	2.52%	1.75%	3.67%	2.11%	5.69%	0.64%	2.57%	1.59%	7.39%	1.81%	5.00%	5.10%	8.41%
	RTR	0.37***	0.48	0.50	0.50	0.44	0.50	0.21	0.41	0.61	0.49	0.58	0.50	0.55	0.50	0.89	0.31
	SENTG	2.22***	1.01	2.18	0.93	2.27	1.02	2.15	1.03	1.85	1.06	2.27	1.02	2.33	0.92	2.75	0.46
Financial Performance	turn_growth	56.2%*	1269.6%	385.7%	3140.5%	15.6%	516.6%	53.7%	1417.2%	224.2%	1539.0%	-1.7%	28.3%	11.0%	172.3%	4.5%	37.3%
	emp_growth	-2.0%***	39.9%	-4.5%	38.0%	-	-	-4.1%	27.6%	15.4%	63.8%	5.1%	29.0%	-1.4%	50.6%	12.9%	102.1%

ANOVA - * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Next, the tables with the Pearson's correlations among all the variables of the model are presented (see Tables 29 to 33).

	v1	v2	v3	v4	v5	v6	v7
PRODINOV (v1)	1.000						
PROCINOV (v2)	-0.043*	1.000					
RADPRODINOV (v3)	0.865**	0.009	1.000				
RADPROCINOV (v4)	0.066**	0.816**	0.152**	1.000			
TURN (v5)	0.332**	0.031	0.369**	0.132**	1.000		
ORANGE (v6)	0.408**	-0.004	0.393**	0.094**	0.163**	1.000	
OREPL (v7)	0.237**	0.093**	0.238**	0.160**	0.121**	0.385**	1.000
ONMOMS (v8)	0.341**	0.019	0.329**	0.089**	0.145**	0.601**	0.418**
OQUA (v9)	0.235**	0.094**	0.238**	0.161**	0.094**	0.478**	0.481**
OFLEX (v10)	0.053**	0.275**	0.077**	0.274**	0.040*	0.275**	0.319**
OCAP (v11)	0.021	0.270**	0.022	0.259**	-0.011	0.223**	0.294**
OLBR (v12)	0.069**	0.249**	0.092**	0.270**	0.033	0.267**	0.372**
ORME (v13)	0.121**	0.186**	0.139**	0.251**	0.061**	0.294**	0.366**
OREI (v14)	0.169**	0.157**	0.200**	0.234**	0.096**	0.316**	0.351**
OHESY (v15)	0.135**	0.176**	0.173**	0.252**	0.113**	0.302**	0.361**
SSUP (v16)	0.064**	0.199**	0.084**	0.225**	0.031	0.250**	0.274**
SCLI (v17)	0.291**	0.056**	0.302**	0.126**	0.132**	0.394**	0.304**
SCOM (v18)	0.212**	0.066**	0.202**	0.089**	0.055**	0.334**	0.292**
SINS (v19)	0.148**	0.109**	0.172**	0.157**	0.111**	0.218**	0.205**
SUNI (v20)	0.169**	0.050**	0.200**	0.136**	0.078**	0.202**	0.173**
SGMT (v21)	0.131**	0.061**	0.134**	0.068**	0.005	0.139**	0.128**
SCON (v22)	0.217**	0.091**	0.245**	0.155**	0.115**	0.312**	0.292**
SJOU (v23)	0.224**	0.092**	0.247**	0.159**	0.092**	0.299**	0.270**
SPRO (v24)	0.159**	0.110**	0.180**	0.182**	0.085**	0.217**	0.217**
rrdinx_rat (v25)	0.094**	-0.019	0.129**	0.016	0.070**	0.091**	0.058**
RTR (v26)	0.166**	0.173**	0.197**	0.298**	0.111**	0.181**	0.202**
SENTG (v27)	0.226**	0.135**	0.248**	0.174**	0.099**	0.345**	0.308**
turn_growth (v28)	0.001	-0.016	-0.016	-0.005	0.025	0.018	-0.03
emp_growth (v29)	0.005	0.03	0.005	0.075**	-0.005	0.014	0.013

Table 29 - Pearson's correlations table – part I

	v8	v9	v10	v11	v12	v13	v14
ONMOMS (v8)	1.000						
OQUA (v9)	0.554**	1.000					
OFLEX (v10)	0.311**	0.452**	1.000				
OCAP (v11)	0.308**	0.416**	0.648**	1.000			
OLBR (v12)	0.348**	0.451**	0.577**	0.619**	1.000		
ORME (v13)	0.357**	0.438**	0.512**	0.523**	0.707**	1.000	
OREI (v14)	0.393**	0.475**	0.423**	0.396**	0.487**	0.611**	1.000
OHESY (v15)	0.372**	0.499**	0.474**	0.462**	0.546**	0.555**	0.783**
SSUP (v16)	0.260**	0.332**	0.357**	0.341**	0.332**	0.327**	0.269**
SCLI (v17)	0.416**	0.331**	0.259**	0.227**	0.299**	0.293**	0.282**
SCOM (v18)	0.360**	0.290**	0.232**	0.221**	0.274**	0.265**	0.249**
SINS (v19)	0.257**	0.255**	0.189**	0.159**	0.181**	0.234**	0.288**
SUNI (v20)	0.243**	0.176**	0.129**	0.093**	0.163**	0.245**	0.267**
SGMT (v21)	0.216**	0.147**	0.112**	0.108**	0.148**	0.195**	0.241**
SCON (v22)	0.364**	0.308**	0.243**	0.205**	0.271**	0.280**	0.298**
SJOU (v23)	0.346**	0.297**	0.241**	0.196**	0.268**	0.307**	0.320**
SPRO (v24)	0.276**	0.254**	0.232**	0.190**	0.268**	0.291**	0.315**
rrdinx_rat (v25)	0.117**	0.054**	-0.001	0	0.021	0.022	0.035
RTR (v26)	0.185**	0.193**	0.203**	0.174**	0.234**	0.231**	0.194**
SENTG (v27)	0.363**	0.315**	0.251**	0.215**	0.247**	0.255**	0.268**
turn_growth (v28)	-0.018	-0.035	-0.011	-0.023	-0.038*	-0.038*	-0.011
emp_growth (v29)	0.034	0.016	0.033	0.062**	0.043	0.035	0.015

Table 30 - Pearson's correlations table – part II

	v15	v16	v17	v18	v19	v20	v21
OHESY (v15)	1.000						
SSUP (v16)	0.304**	1.000					
SCLI (v17)	0.296**	0.382**	1.000				
SCOM (v18)	0.227**	0.345**	0.588**	1.000			
SINS (v19)	0.267**	0.246**	0.232**	0.291**	1.000		
SUNI (v20)	0.203**	0.168**	0.231**	0.255**	0.460**	1.000	
SGMT (v21)	0.175**	0.172**	0.192**	0.250**	0.440**	0.593**	1.000
SCON (v22)	0.293**	0.329**	0.369**	0.401**	0.314**	0.345**	0.295**
SJOU (v23)	0.304**	0.314**	0.358**	0.388**	0.333**	0.424**	0.367**
SPRO (v24)	0.302**	0.293**	0.329**	0.344**	0.389**	0.395**	0.437**
rrdinx_rat (v25)	0.038*	0.013	0.108**	0.055**	0.054**	0.123**	0.109**
RTR (v26)	0.214**	0.213**	0.231**	0.162**	0.115**	0.146**	0.039*
SENTG (v27)	0.263**	0.274**	0.329**	0.246**	0.212**	0.217**	0.157**
turn_growth (v28)	-0.042*	0.009	0.016	0	-0.004	0.005	0.005
emp_growth (v29)	0.023	0.048*	0.039	0.019	0.022	0.017	0.028

Table 31 - Pearson's correlations table – part III

	v22	v23	v24	v25
SCON (v22)	1.000			
SJOU (v23)	0.654**	1.000		
SPRO (v24)	0.513**	0.581**	1.000	
rrdinx_rat (v25)	0.062**	0.100**	0.055**	1.000
RTR (v26)	0.220**	0.235**	0.187**	0.050**
SENTG (v27)	0.244**	0.260**	0.179**	0.130**
turn_growth (v28)	-0.022	-0.006	-0.013	0.041*
emp_growth (v29)	0.012	0.003	0.009	0.057*

Table 32 - Pearson's correlations table – part IV

	v26	v27	v28	v29
RTR (v26)	1.000			
SENTG (v27)	0.193**	1.000		
turn_growth (v28)	-0.007	0.026	1.000	
emp_growth (v29)	0.082**	0.046*	0.112**	1.000

Table 33 - Pearson's correlations table – part V

After, the possible existence of common-method bias was checked, using an exploratory factor analysis of all variables of the model to generate one unique factor. This factor presented a total variance explained of 28.9%, much lower than the limit of 50%. A second test was also conducted, the CFA with a construct representing the common-method variance. Its common load was 0.32, representing a common variance of 10.2%. So, the analysis followed without considering common-method bias an important issue.

After applying the Z-core to all scalar variables to guarantee that no scale problems exist, the analysis followed with the EFA with a varimax rotation to reduce the constructs Innovation Performance and External R&D - Strategic Alliances. For the other two constructs, the decision was not to reduce the variables as they have three or less variables and a minimum of three should be kept (for Financial Performance it was not possible and it had only two proxies). The two constructs were successfully reduced for three variables using the scree-plot method. In the case of Innovation Performance, the EFA presented a KMO of 0.82 and the Bartlett's test of sphericity was significant ($p < 0.01$), indicating that the reduction was valid. The three factors had a cumulative variance of 62.5% of the original variables. For the External R&D - Strategic Alliances' EFA, the KMO was 0.84 and the Bartlett's test of sphericity was significant ($p < 0.01$), indicating that the reduction was also valid. The three factors had a cumulative variance of 67.7% of the original variables. Tables 34 and 35 present the results of the EFA after the varimax rotation, indicating the proxies that formed each of the factors (the ones that weighted 0.7 or higher in that factor).

Innovation Performance			
Variable	Factor 1	Factor 2	Factor 3
Introduction of prod. innov. (PRODINOV)		0.89	
Innov. degree prod. innov. (RADPRODINOV)		0.89	
% turnover prod. innov. (TURN)			
Introduction of proc. innov. (PROCINOV)			0.92
Innov. degree proc. innov. (RADPROCINOV)			0.90
Increase range of goods or services (ORANGE)			
Replace outdated products or processes (OREPL)			
Enter new markets or increase market share (ONMOMS)			
Improve quality of goods or services (OQUA)	0.70		
Improve flexibility producing goods or services (OFLEX)	0.73		
Increase capacity for producing goods or services (OCAP)	0.73		
Reduce labor costs per unit output (OLBR)	0.79		
Reduce material and energy costs per unit output (ORME)	0.78		
Reduce environmental impacts (OREI)	0.74		
Improve health or safety of your employees (OHESY)	0.76		

Table 34 - EFA – Varimax rotation (Innovation Performance)

External R&D - Strategic Alliances			
Variable	Factor 1	Factor 2	Factor 3
Suppliers (SSUP)			
Clients (SCLI)			0.83
Competitors (SCOM)			0.79
Consultants (SINS)	0.72		
Universities (SUNI)	0.80		
Government (SGMT)	0.82		
Conferences (SCON)		0.82	
Journals and publications (SJOU)		0.83	
Professional associations (SPRO)			

Table 35 - EFA – Varimax rotation (Strategic Alliances)

Factor 1 of innovation performance was formed by a summated-scales of Improve quality of goods or services (OQUA), Improve flexibility producing goods or services (OFLEX), Increase capacity for producing goods or services (OCAP), Reduce labor costs per unit output (OLBR), Reduce material and energy costs per unit output (ORME), Reduce environmental impacts (OREI) and Improve health or safety of your employees (OHESY), which are variables that measure the impact of the innovation for the firm. The other variables that represented innovation impact did not participate of other factors. For that reason, factor 1 was called *Innovations' Impacts* (INNOV_IMP).

Factor 2 was called *Product Innovation Introduction* (INTRO_PROD), as it was formed by the variables that indicates if product innovation was introduced (PRODINOV) and the degree of innovativeness of product innovation (RADPRODINOV). For a similar reason, Factor 3 was called *Process Innovation Introduction* (INTRO_PROC), as it was formed by the variables that indicates if process innovation was introduced (PROCINOV) and the degree of innovativeness of process innovation (RADPROCINOV). In the case of the construct External R&D - Strategic Alliances, factor 1 was formed by collaboration with consultants and private research centers (SINS), the Government (SGMT) and Universities (SUNI), being called *Alliances with Formal Institutions* (ALL_INST), factor 2 was formed by other external sources of information such as conferences (SCON) and journals (SJOU) being called *Alliances with the Academy* (ALL_ACAD), and factor 3 was formed by alliances with clients (SCLI) and competitors (SCOM) and was called *Alliances with the Market* (ALL_MKT).

The next step of the analysis was the full-sample's CFA considering only three constructs of the model, excluding Financial Performance. As Italian firms did not fill the employees' growth (emp_growth) indicator, the decision was not to use Financial Performance as a construct with two proxies (turnover growth and employees' growth), but to run two separate models, with the two variables alone in the place of a construct. For turn_growth, data from the 14 countries was used and for emp_growth, Italy was excluded. The following correlation of errors were added: *Alliances with Formal Institution* (ALL_INST) with *Alliances with the Market* (ALL_MKT) in the construct External R&D – Strategic Alliances, and *Innovations' Impacts* (INNOV_IMP) with *Process Innovation Introduction* (INTRO_PROC), in the construct Innovation Performance. Tables 36 and 37 shows respectively the results of the measurement model and the tests of discriminant validity.

All the standardized regression weights of the measurement model should be 0.7 or above to guarantee the reliability of the individual index. *Process Innovation Introduction* (INTRO_PROC), for Innovation Performance and Internal R&D spending/total turnover (rrdinx_rat) for Internal R&D – Absorptive

Capacity were below this value (0.37 and 0.24 respectively), but both variables were kept in the model as their regression weights are statistically significant ($p < 0.05$) and a minimum of three proxies for each construct should be kept to guarantee that the model is identifiable. The minimum for the average variance extracted – AVE (0.5) and the composite reliability – CR (0.7) were only achieved for External R&D – Strategic Alliances. However, as some authors consider that the AVE is a very conservative criterion for convergent validity (MALHOTRA; DASH, 2011) and that the researcher may decide to continue even with more than 50% of the variance of the construct explained by error, the analysis continued.

Variable	S.R.W.	t-test ($p < 0.05$)	Composite reliability (CR)	Average Variance Extracted (AVE)
INNOV_IMP	0.72	***	0.62	0.41
INTRO_PROD	0.75	***		
INTRO_PROC	0.37	***		
rrdinx_rat	0.24	***	0.52	0.35
RTR	0.75	***		
SENTG	0.67	***		
ALL_INST	0.83	***	0.81	0.67
ALL_MKT	0.84	***		
ALL_ACAD	0.78	***		

Table 36 - Results of the CFA

Discriminant validity was not achieved, as shown in Table 36, in which the main diagonal values, presenting the construct's AVEs, are in all cases lower than the squared estimated correlations between the constructs, showed in the off-diagonal elements. For nomological validity, significant covariances between constructs with low absolute values were expected. The covariance between Internal R&D – Absorptive Capacity and Innovation Performance was 1.00, between External R&D – Strategic Alliances and Innovation Performance was 0.98, and between Internal R&D – Absorptive Capacity and External R&D – Strategic Alliances was 0.88, all significant ($p < 0.05$) but high. Even with some validity issues, the analysis followed with the proposed model.

	IR&D	ER&D	IP
Internal R&D - Absorptive Capacity (IR&D)	**0.35**		
External R&D - Strategic Alliances (ER&D)	0.88	**0.67**	
Innovation Performance (IP)	1.00	0.98	**0.41**

Table 37 - Discriminant validity

Next, the structural model was tested using Bayesian estimation for the whole sample. The results of the analysis are summarized in Table 38. The model presents a fourth construct, ExtR&D x IntR&D, representing the moderation of absorptive capacity (IntR&D) and strategic alliances (ExtR&D), as previously explained. Figures 22 and 23 present the causal models for turn_growth and emp_growth respectively, with the standardized coefficients and the error terms.

All 14 Countries (n = 2,745)						
Relationship	FP - turn_growth			FP - emp_growth		
	S.R.W.	Sig.	Hypothesis test	S.R.W.	Sig.	Hypothesis test
Ext. R&D → IP	0.398	***	H1: Supported	0.400	***	H1: Supported
Int. R&D → IP	0.056	***	H2: Supported	0.051	***	H2: Supported
Ext R&D x Int R&D → IP	-0.027	-	H3: Rejected	-0.029	-	H3: Rejected
IP → FP	-0.009	-	H4: Rejected	-0.010	-	H4: Rejected

*** $p < 0.05$

Table 38 - Results of the SEM (all 14 countries)

Examining the standard regression weights of the relationships in Table 38 to analyse the hypotheses, H1and H2 are supported; and H3 and H4, rejected, both with turnover growth (turn_growth) and with employees' growth (emp_growth) as financial performance proxies. Both models presented very similar results, therefore the following analysis is valid for both, with any major differences being explained. The support of the first hypothesis suggests that the higher the level of external R&D of the manufacturing firm of these 14 countries of Europe, mainly accessed through strategic alliances, the higher its innovation performance. For turn_growth, the relation had a path coefficient of 0.398 and for emp_growth, of 0.400. ($p < 0.05$). ALL_MKT, representing alliances with partners from the market weights heavier in the construct External R&D – Strategic Alliances, indicating a higher importance of this type of partnership, followed by ALL_ACAD (see Figures 22 and 23).

Hypothesis 2 was also supported. The path coefficient between the constructs Internal R&D – Absorptive Capacity and Innovation Performance is 0.056 for turn_growth and 0.051 for emp_growth, both significant for $p < 0.05$. In this study's model, this construct was represented by internal R&D intensity (rrdinx_rat), training (RTR) and importance of internal knowledge sources for innovation (SENTG). The first proxy proved to be more important as internal source of R&D than the other two, according to the path coefficients (see Figures 22 and 23). The rejection of hypothesis 3 is not consistent with the absorptive capacity theory, which states that internal R&D is not only important as a source of knowledge to directly generate innovation, but also as a way to improve the absorptive capacity, which improves the effects of the strategic alliances on the innovation performance. H3 was rejected in both models (non-significant coefficients of -0.027 for turn_growth and of -0.029 for emp_growth with $p < 0.05$). It usually happens when the firms in the sample do not have a high level of absorptive capacity, fact generally related to countries in which the industry in not in an advanced innovative level and need to catch-up to the level of the world-leading countries. As the ANOVA showed that the three proxies of absorptive capacity present different levels among country groups, it was supposed to be found different results for each group. However, running the models separately for each group, the results are the same for H3, with non-significant relationships for all groups with exception of group 3, composed by Portugal and Spain, which presented a negative relationship (see Table 39). This could have been caused by a general modest level of innovation capabilities of the manufacturing firms in these countries, which are considered low or modest innovative countries compared to the rest of Europe (EUROPEAN UNION, 2016) and to the more innovative countries in the world (DUTTA et al., 2016). These modest level of innovation capabilities may provoke the absorptive capacity of the firms to be low, which causes a substitutive relationship between internal and external R&D (HAGEDOORN; WANG, 2012). The causal models for the six groups with turn_growth and emp_growth are presented in Figures 24 to 36.

A positive relationship between innovation performance and financial performance was expected, but not found, leading to the rejection of hypothesis 4. Non-significant relationships between innovation performance and turn_growth (-

0.09) and between innovation performance and emp_growth (-0.010) were found. Although the literature illustrates the existence of this positive relationship, it takes time for innovation to turn into an improvement in financial performance indicators. This research studied innovation introduced between 2008 and 2010 and the indicators of financial performance measured growth in this period, not allowing the effect to appear as it should, after the innovations introduced matured. The separate analysis per group also rejected H4 in most cases. The exception was group 3 (Portugal and Spain) for emp_growth and group 4 (Estonia and Lithuania) for turn_growth. The case of group 4 may be explained because the Baltic countries' growth was more negatively affected by the 2008 global crisis than the rest of Europe on average, followed by a very intense growth (STAEHR, 2015), that possibly were pushed by innovative firms. This suggests that an innovation strategy may position firms better to recover from country or global crises and to get advantage from the country's recovery. Portugal and Spain were also in an especially bad position after the 2008's crisis (LIN et al., 2013), but their economies did not present a recovery as fast as in the Baltic countries. The industry in these countries contracted during the crisis and the data shows that innovative firms had a better recovery, by growing faster to reach their approximate sizes before 2008 in terms of number of employees. However, an effect in turnover growth was not captured, as this indicator takes more time to recover.

Group 1 - Bulgaria and Romania (n = 425)						
Relationship	FP - turn_growth			FP - emp_growth		
	S.R.W.	Sig.	Hypothesis test	S.R.W.	Sig.	Hypothesis test
Ext. R&D → IP	0.412	***	H1: Supported	0.393	***	H1: Supported
Int. R&D → IP	0.310	***	H2: Supported	0.322	***	H2: Supported
Ext. R&DxInt R&D→IP	0.073	-	H3: Rejected	0.061	-	H3: Rejected
IP → FP	0.011	-	H4: Rejected	0.071	-	H4: Rejected
Group 2 - Italy (n = 731)						
Relationship	FP - turn_growth			FP - emp_growth		
	S.R.W.	Sig.	Hypothesis test	S.R.W.	Sig.	Hypothesis test
Ext. R&D → IP	0.148	***	H1: Supported	-	-	-
Int. R&D → IP	0.203	***	H2: Supported	-	-	-
Ext. R&DxInt R&D→IP	0.030	-	H3: Rejected	-	-	-
IP → FP	0.014	-	H4: Rejected	-	-	-

Group 3 - Portugal and Spain (n = 8,990)						
	FP - turn_growth			FP - emp_growth		
Relationship	S.R.W.	Sig.	Hypothesis test	S.R.W.	Sig.	Hypothesis test
Ext. R&D → IP	0.356	***	H1: Supported	0.356	***	H1: Supported
Int. R&D → IP	0.245	***	H2: Supported	0.245	***	H2: Supported
Ext. R&DxInt R&D→IP	-0.128	***	H3: Rejected	-0.131	***	H3: Rejected
IP → FP	-0.009	-	H4: Rejected	0.044	***	H4: Supported
Group 4 - Estonia and Lithuania (n = 470)						
	FP - turn_growth			FP - emp_growth		
Relationship	S.R.W.	Sig.	Hypothesis test	S.R.W.	Sig.	Hypothesis test
Ext. R&D → IP	0.229	***	H1: Supported	0.246	***	H1: Supported
Int. R&D → IP	0.149	***	H2: Supported	0.151	***	H2: Supported
Ext. R&DxInt R&D→IP	-0.014	-	H3: Rejected	0.012	-	H3: Rejected
IP → FP	0.059	***	H4: Supported	0.003	-	H4: Rejected
Group 5 - Croatia, Cyprus and Slovenia (n = 909)						
	FP - turn_growth			FP - emp_growth		
Relationship	S.R.W.	Sig.	Hypothesis test	S.R.W.	Sig.	Hypothesis test
Ext. R&D → IP	0.231	***	H1: Supported	0.242	***	H1: Supported
Int. R&D → IP	0.210	***	H2: Supported	0.188	***	H2: Supported
Ext. R&DxInt R&D→IP	-0.027	-	H3: Rejected	0.010	-	H3: Rejected
IP → FP	0.035	-	H4: Rejected	0.028	-	H4: Rejected
Group 6 - Czech Republic, Hungary and Slovakia (n = 1,657)						
	FP - turn_growth			FP - emp_growth		
Relationship	S.R.W.	Sig.	Hypothesis test	S.R.W.	Sig.	Hypothesis test
Ext. R&D → IP	0.258	***	H1: Supported	0.259	***	H1: Supported
Int. R&D → IP	0.177	***	H2: Supported	0.162	***	H2: Supported
Ext. R&DxInt R&D→IP	0.001	-	H3: Rejected	-0.014	-	H3: Rejected
IP → FP	0.001	-	H4: Rejected	0.009	-	H4: Rejected
Group 7 - Norway (n = 141)						
	FP - turn_growth			FP - emp_growth		
Relationship	S.R.W.	Sig.	Hypothesis test	S.R.W.	Sig.	Hypothesis test
Ext. R&D → IP	0.203	***	H1: Supported	0.253	***	H1: Supported
Int. R&D → IP	0.180	***	H2: Supported	0.190	***	H2: Supported
Ext. R&DxInt R&D→IP	0.036	-	H3: Rejected	0.043	-	H3: Rejected
IP → FP	0.009	-	H4: Rejected	0.029	-	H4: Rejected

*** $p < 0.05$

Table 39 - Results of the SEM (by group)

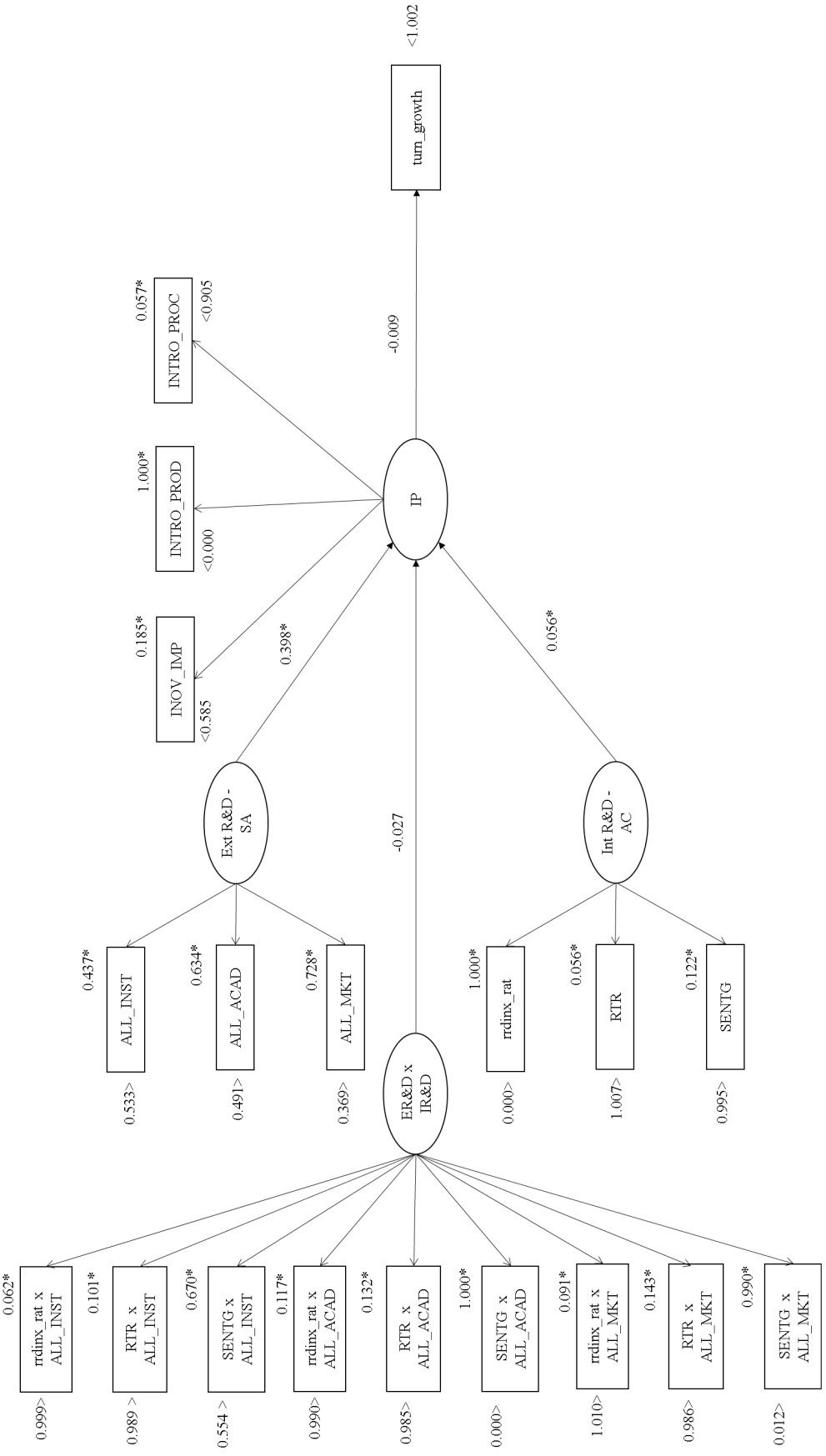


Figure 22 - Structural model (all 14 countries) - turn_growth

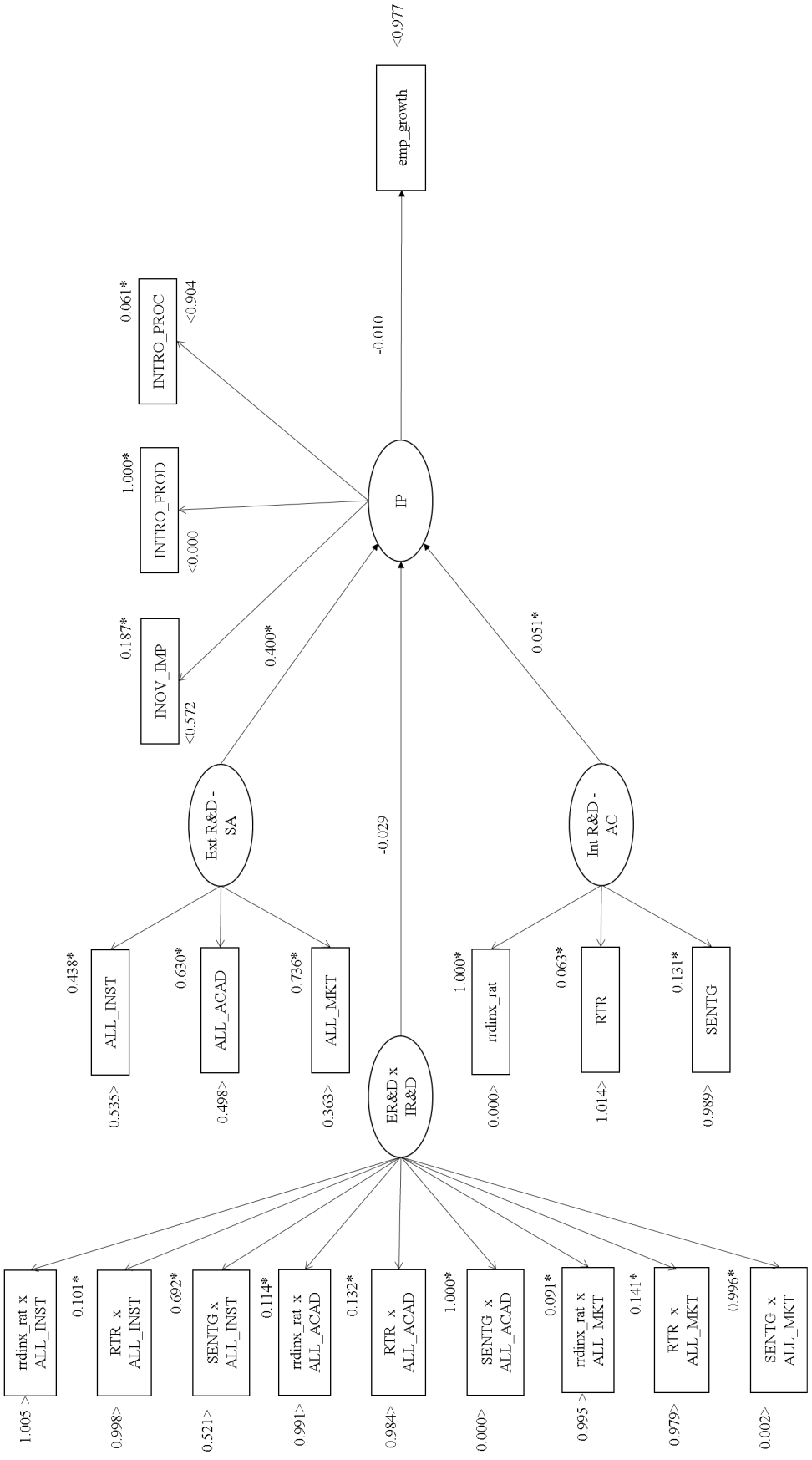
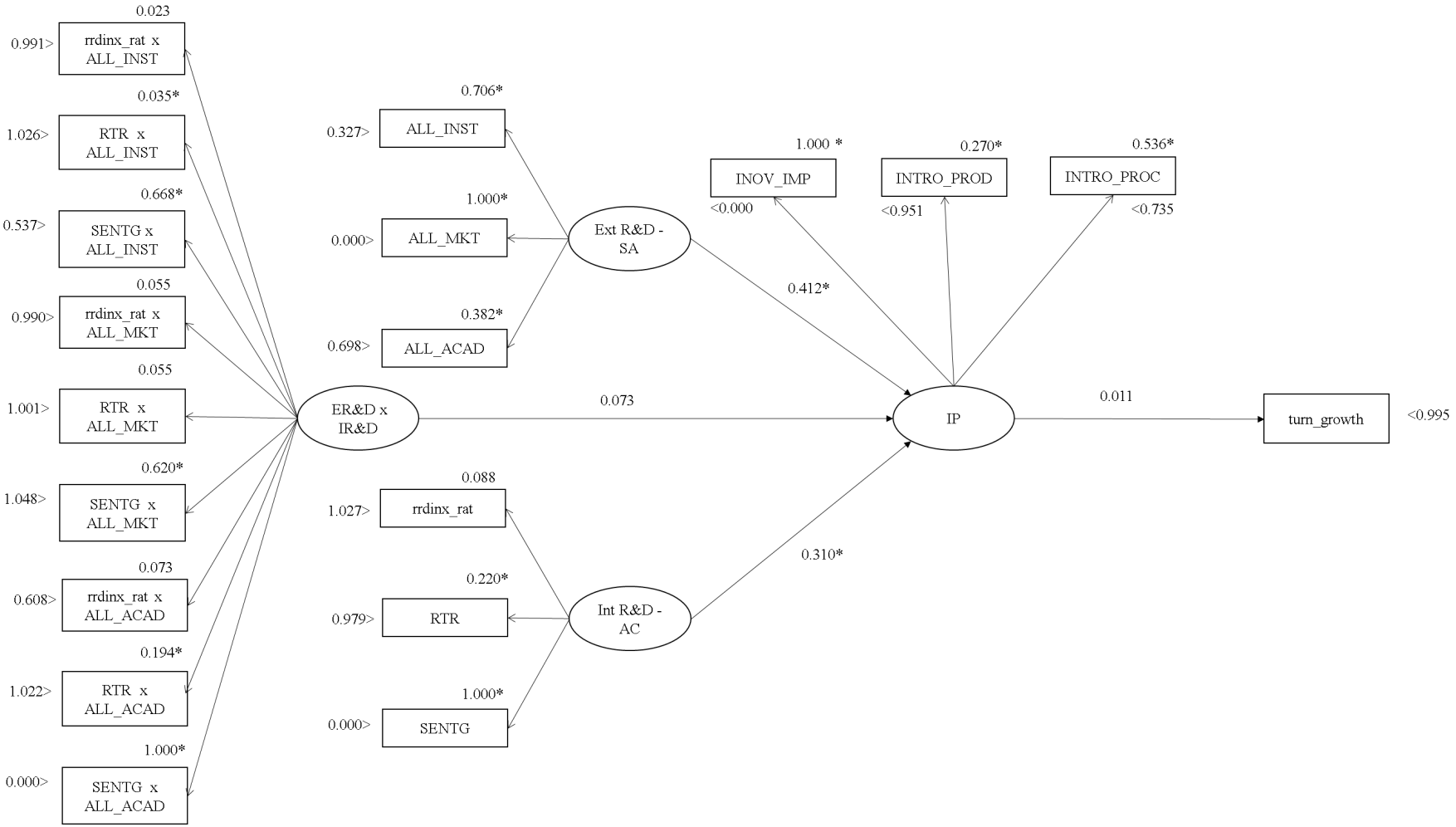


Figure 23 - Structural model (all 14 countries) - emp_growth

Figure 24 - Structural model (group 1) - turn_growth



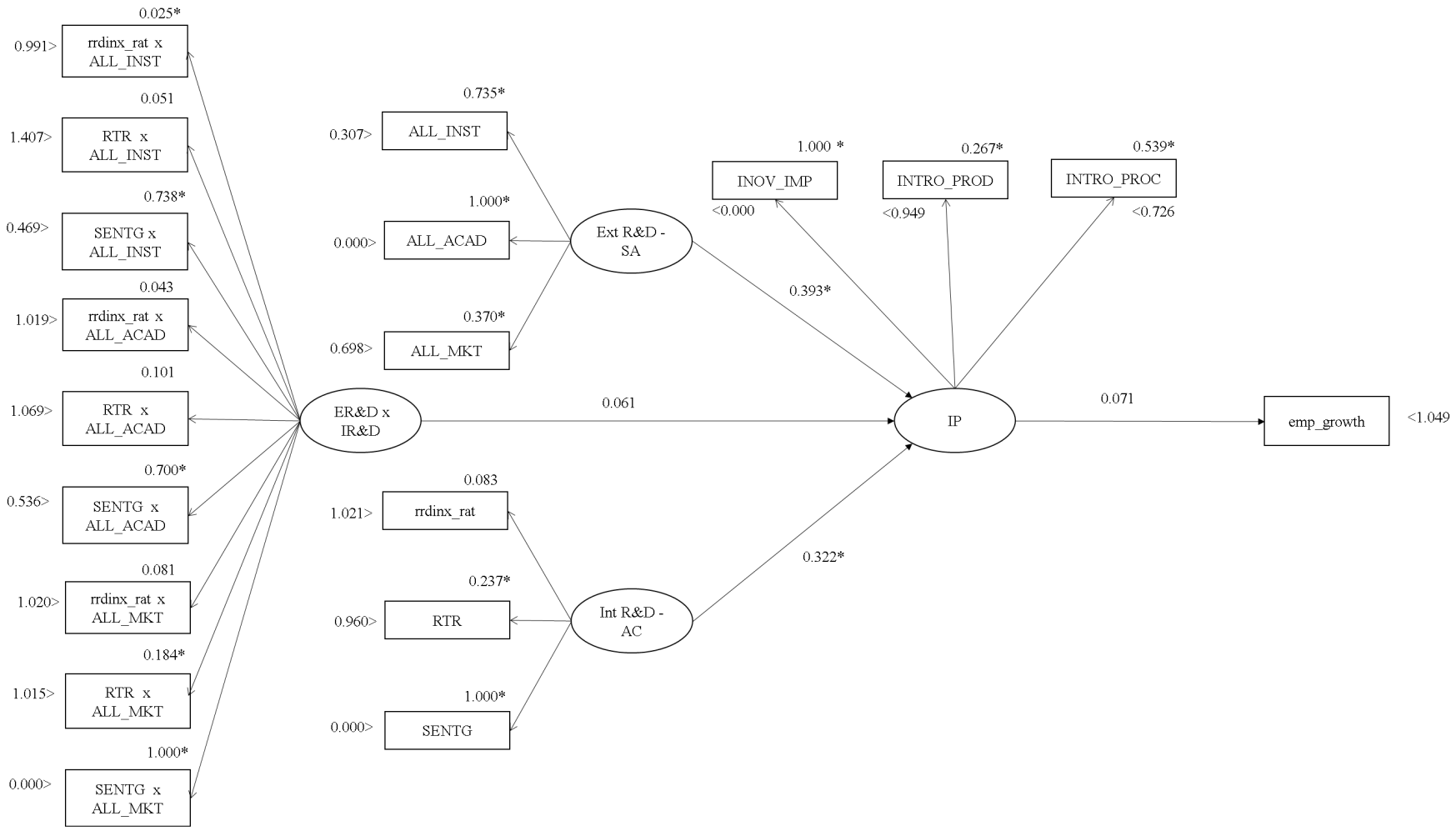


Figure 25 - Structural model (group 1) - emp_growth

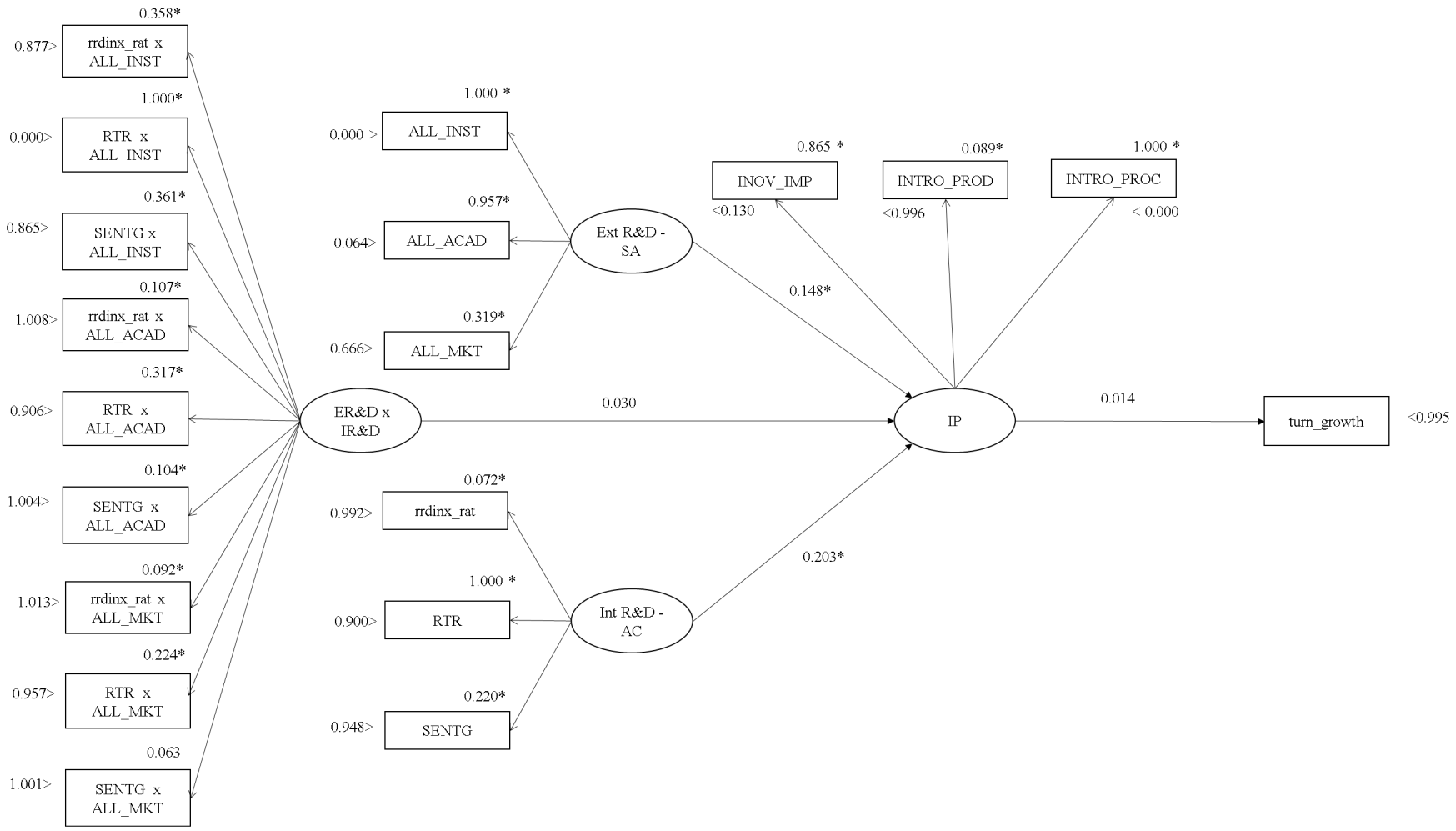


Figure 26 - Structural model (group 2) - turn_growth

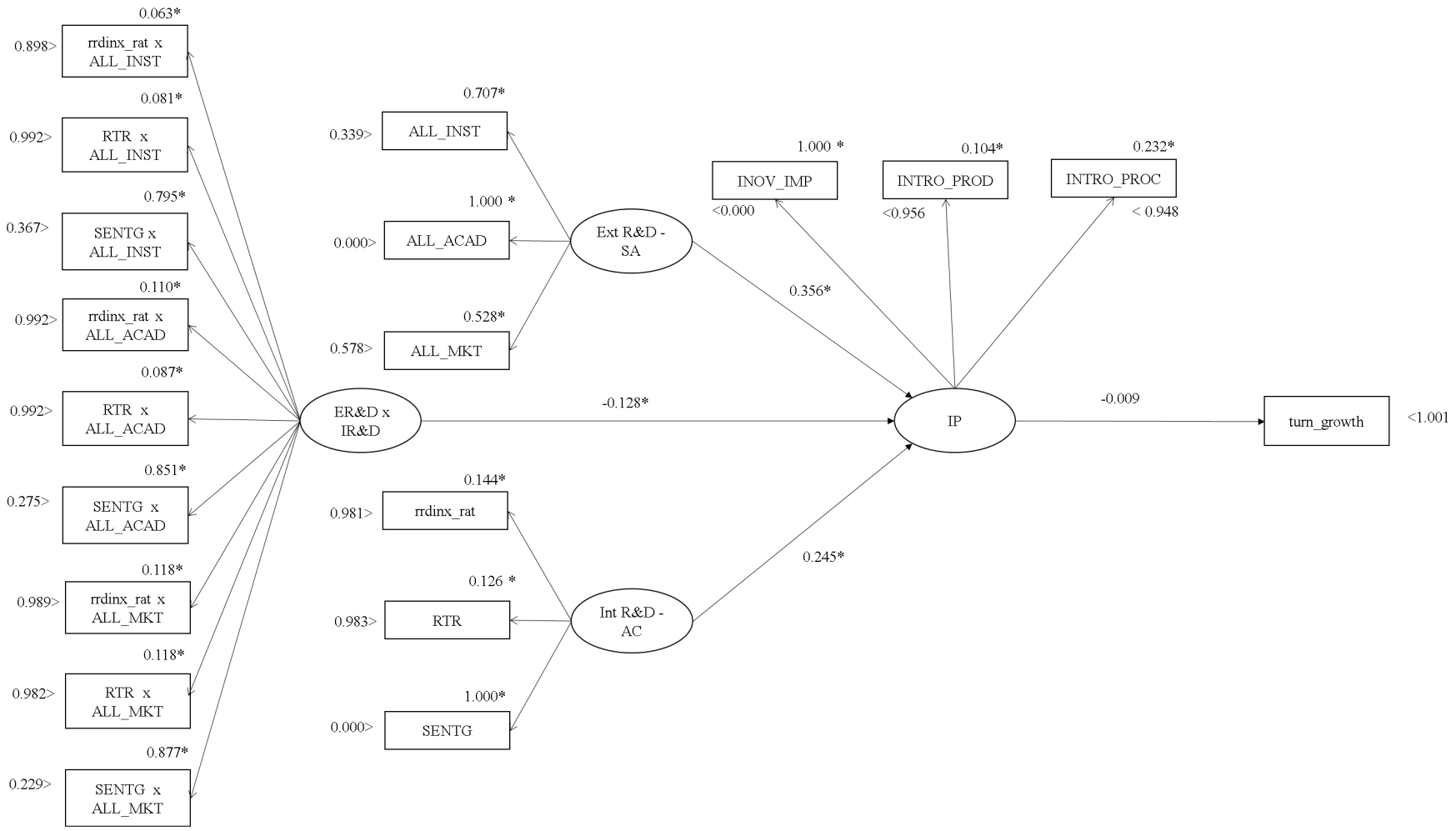
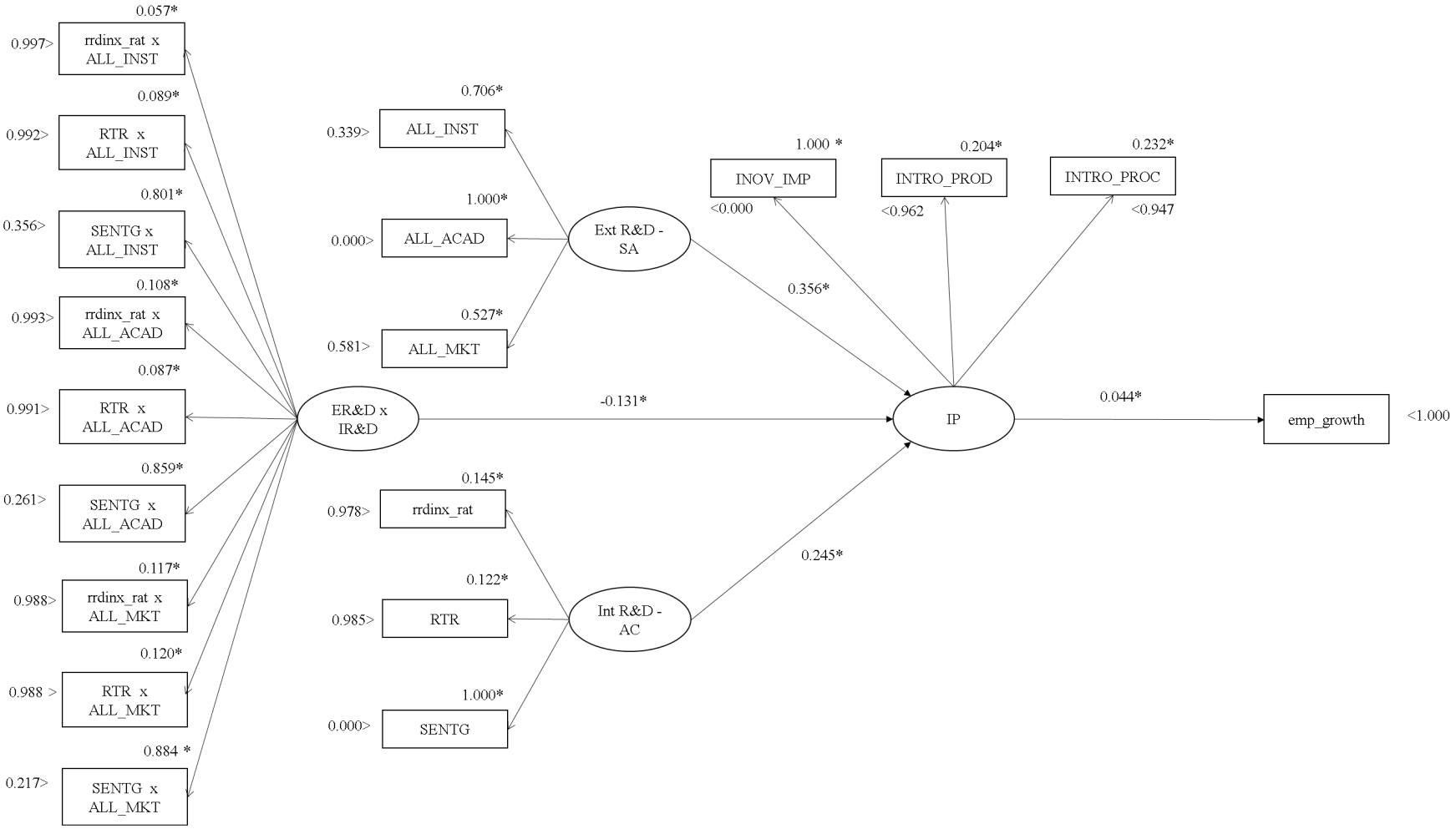


Figure 27 - Structural model (group 3) - turn_growth

Figure 28 - Structural model (group 3) - emp_growth



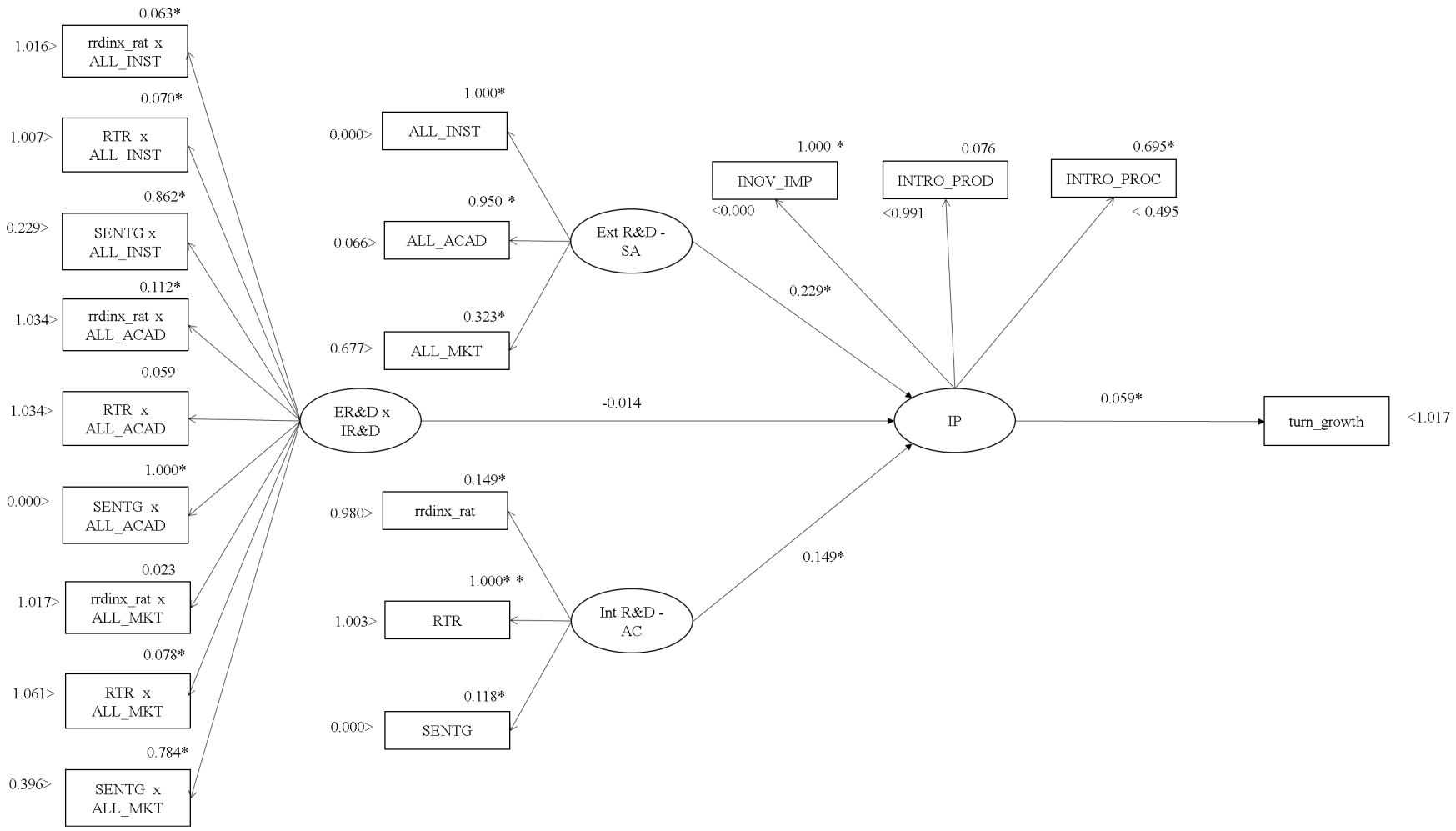


Figure 29 - Structural model (group 4) - turn_growth

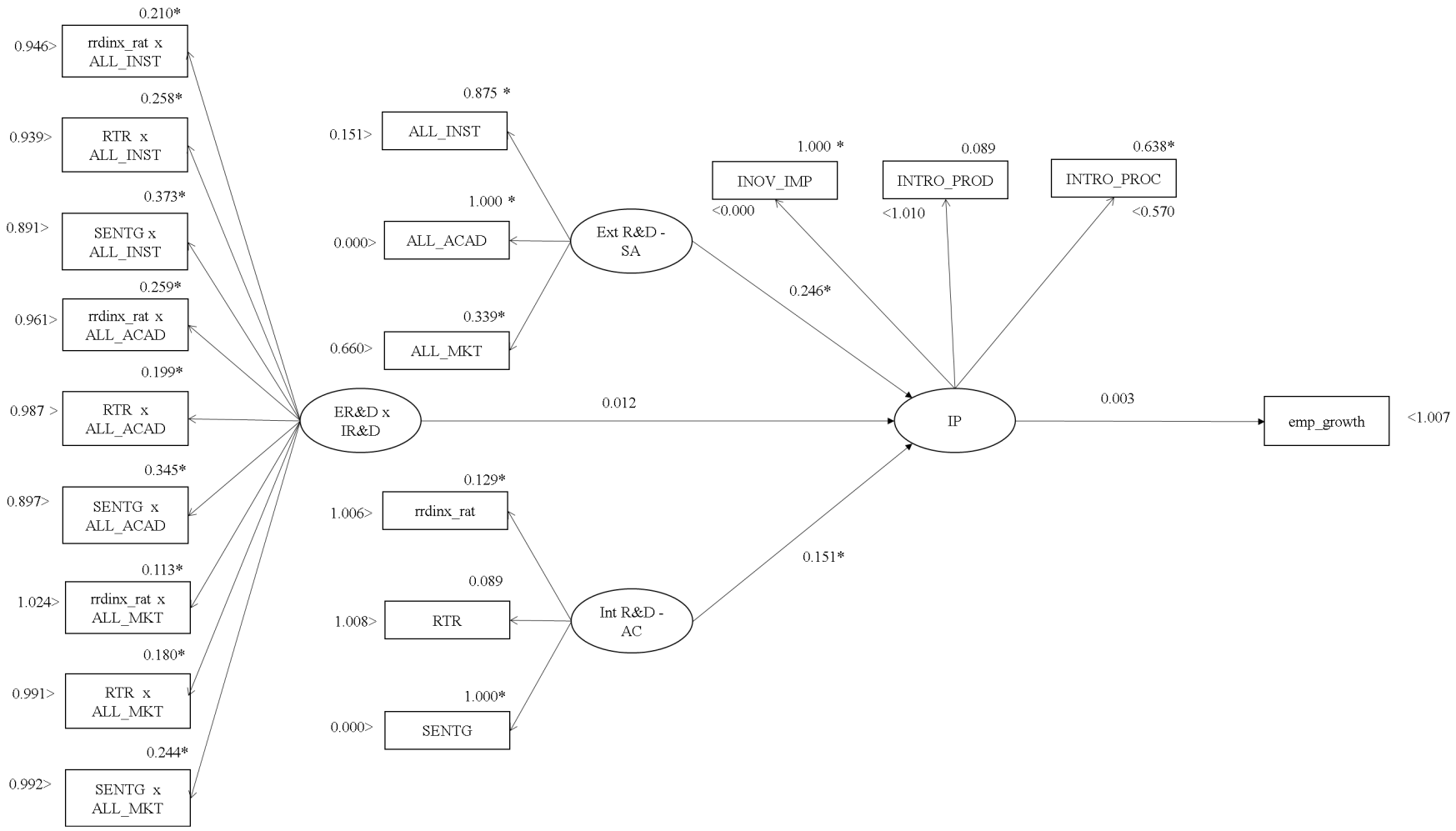


Figure 30 - Structural model (group 4) - emp_growth

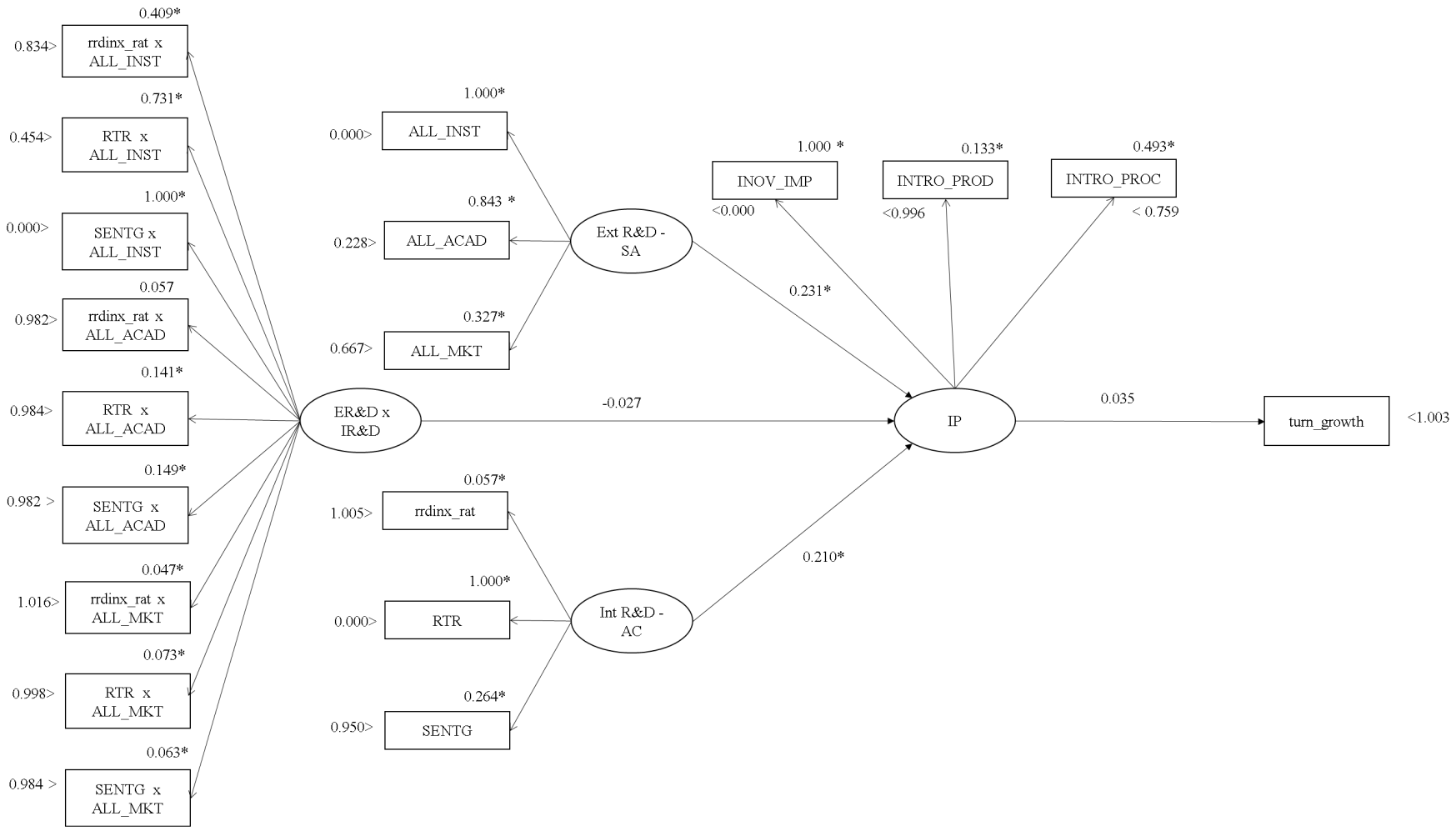


Figure 31 - Structural model (group 5) - turn_growth

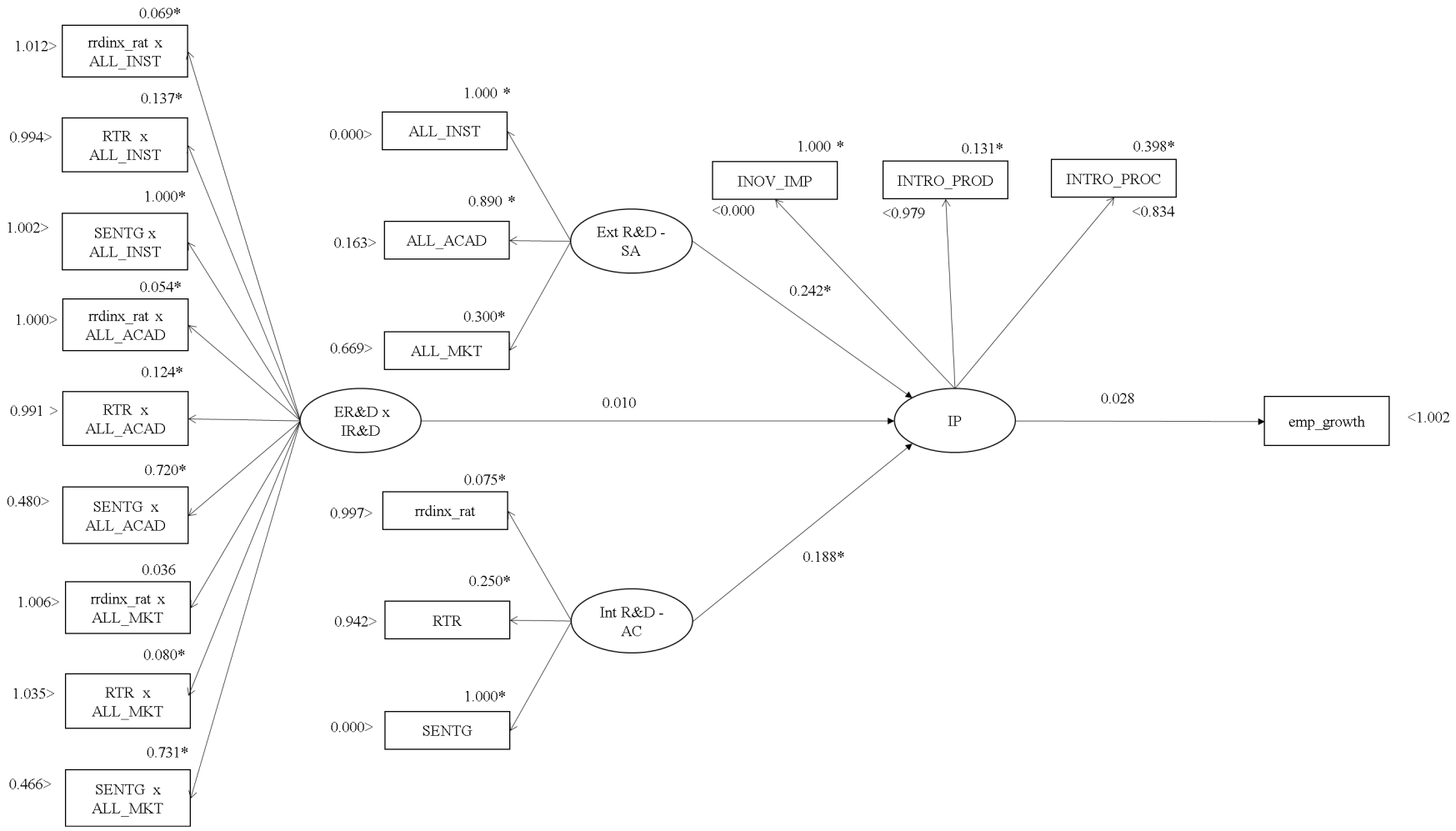


Figure 32 - Structural model (group 5) - emp_growth

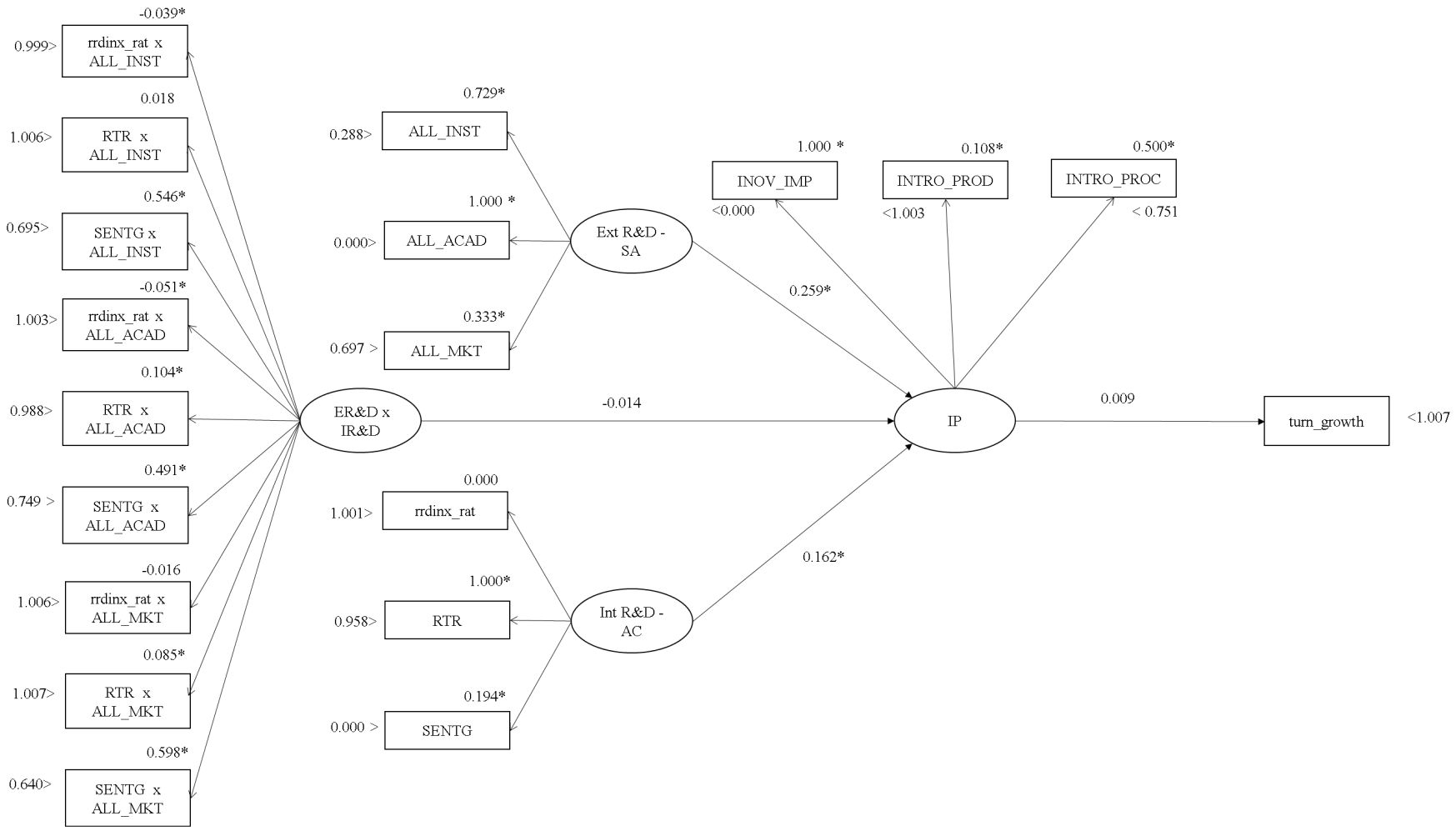


Figure 33 - Structural model (group 6) - turn_growth

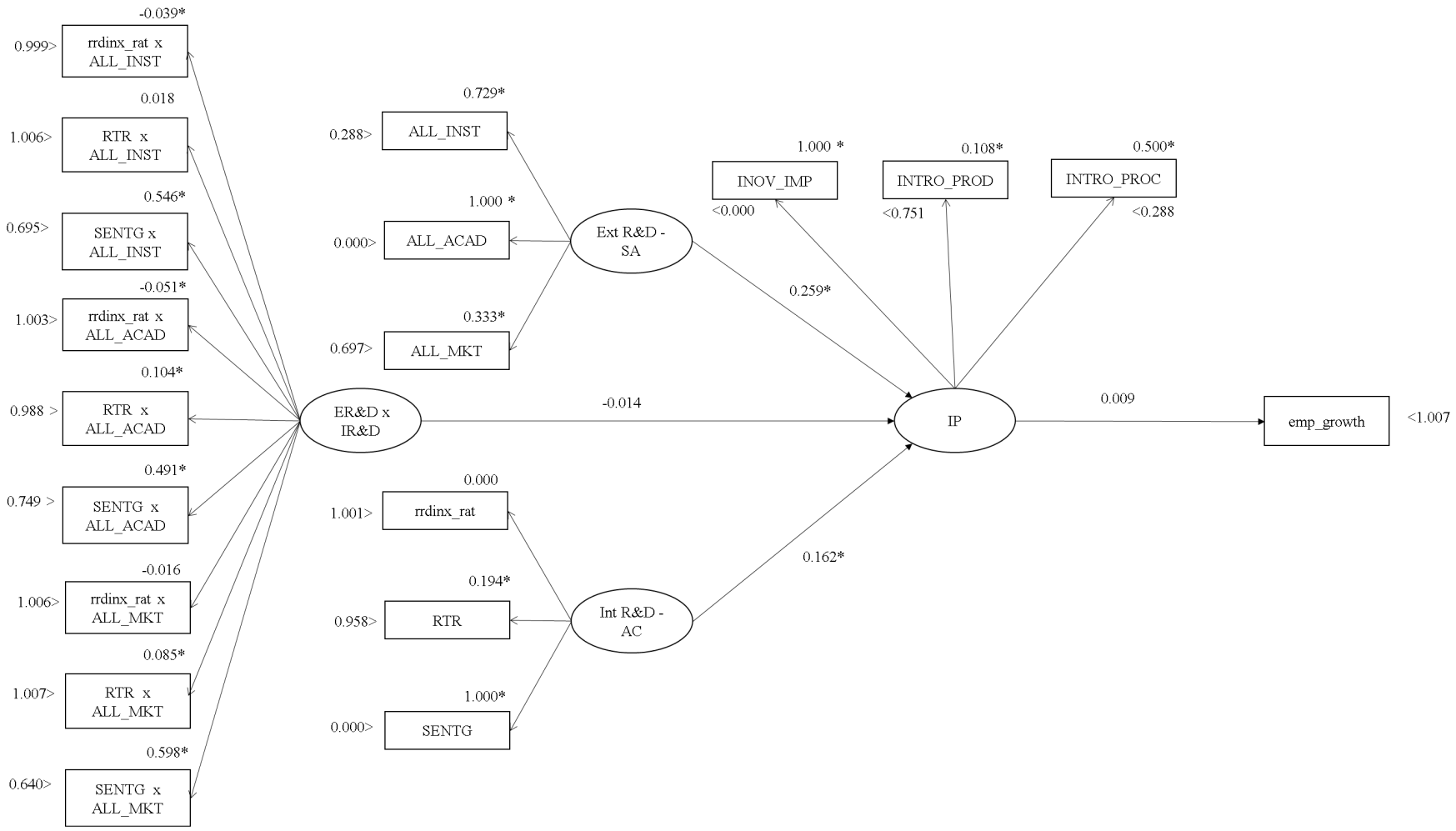


Figure 34 - Structural model (group 6) - emp_growth

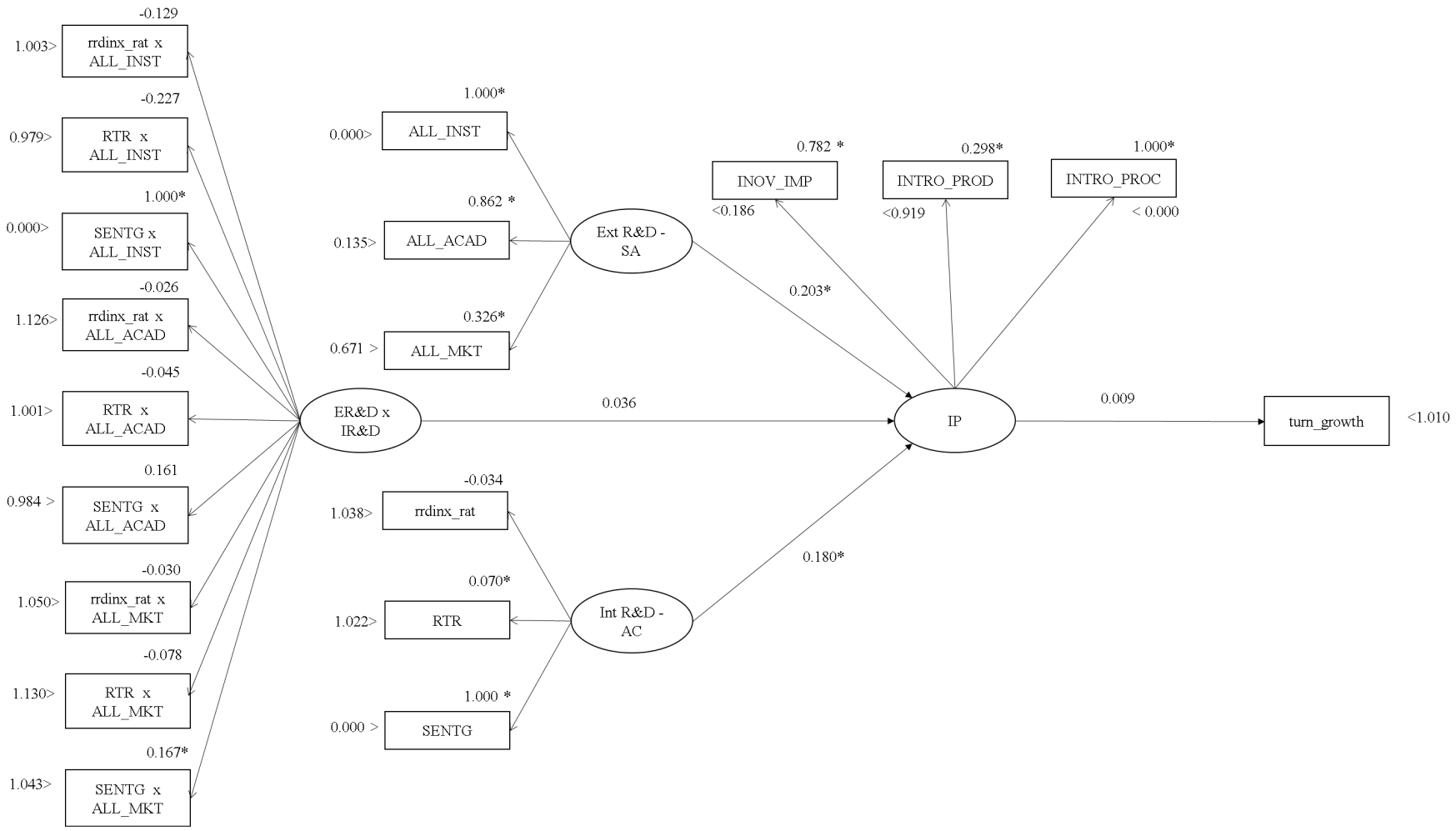


Figure 35 - Structural model (group 7) - turn_growth

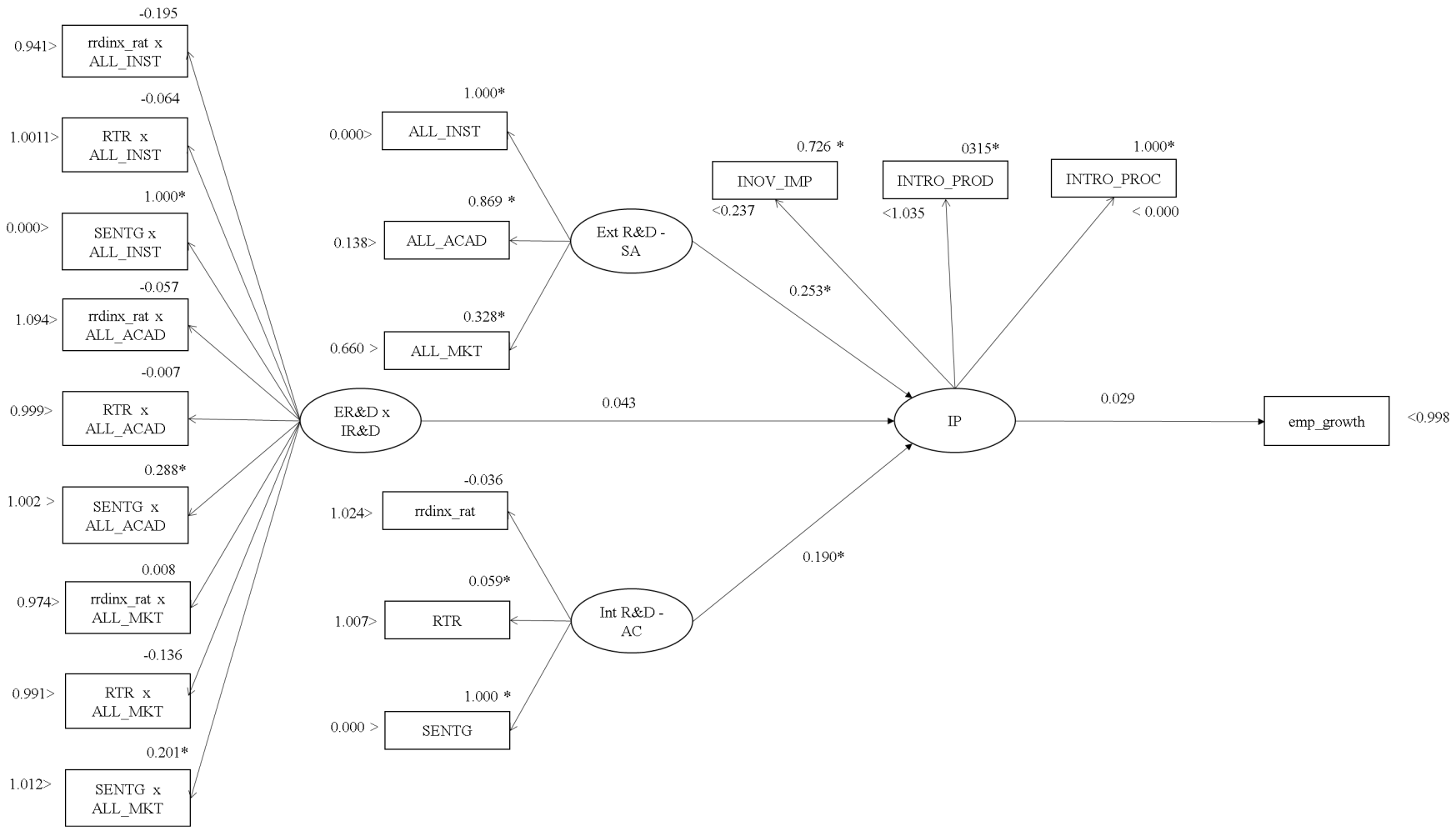


Figure 36 - Structural model (group 7) - emp_growth

4.3.
Comparative analysis: Brazil x selected European countries

After analyzing the two cases separately, a comparative analysis between the situation in the Brazilian and in the selected European countries' manufacturing firms was conducted. The models and surveys used in both contexts were very similar, however some differences exist that were taken into consideration when they were relevant to the analysis. The 14 European countries with data available do not represent the whole Europe. Some important countries such as UK, France, Germany, etc. could not be used in this work. However, the countries in the analysis may be used as a reference as they are part of Europe and are more developed in terms of innovation compared to Brazil, as they are positioned on average as 33rd in the 2016 GII (see Table 13) while Brazil was in the 69th, indicating that they have a friendlier environment for innovation than Brazil; therefore, allowing to use this comparison as an interesting reference to try to capture lessons for Brazilian firms and Government. The first difference between the models pointed here is that there is a difference of one year between the innovation surveys from Europe (CIS 2010) and Brazil (PINTEC 2011). However, this lag does not prevent the results from both surveys to be compared.

The comparison starts by bringing back the descriptive statistics of both contexts side-by-side, to explore the similarities and differences. The first variables analyzed were the proxies representing innovation performance, which are presented in Table 40. The first interesting difference that may be highlighted is that the success in the introduction of innovation is much higher in the selected European countries' sample. 95% of the total sample of selected European countries' manufacturing firms that conducted innovation activities in the period succeeded in developing at least one innovation while, in the case of Brazil, only 53%. This indicator showed that the selected European countries' firms are much more effective in their efforts to innovate than the Brazilians. Considering the different types of innovation, 39% Brazilian firms developed product innovation while 26%, process innovation. In the selected European countries, 74% of the firms introduced product innovation and 75%, process innovation. This difference in Brazil may have been provoked by a common view of Brazilian firms and of the Government that product innovation is more noble and more effective to

improve performance, which guarantees more funding for this type. Following the analysis, the degree of innovation, which indicates if the innovation is new to the firm, country, or to the world (which is equivalent to innovations new to the market) showed that the selected European countries' firms introduced more innovations with a higher degree of novelty. Brazilian firms scored 0.44 in product innovation and 1.01 in process innovation in a scale from 0 to 3 (see Table 39). The selected European countries' firms scored 0.75 for product innovation and 1.22 for process innovation in a scale from 0 to 2 (see Table 40). Comparing the scale of innovation impacts, the Brazilian survey presents 15 indicators (IN_IMP_1 to IN_IMP_15. See Table 14 for a description of the items) while the European survey presents 10 (ORANGE to OHESY. See Table 15 for a description of the items), ranging from 0 to 3. All the 10 items from Europe are comparable to items from Brazil. The indicators may clearly be identified in two groups: market impacts (IN_IMP_1 to IN_IMP_7 in the Brazilian survey; and ORANGE, OREPL, ONMOMS, OQUA, OFLEX and OCAP in the European survey); and cost-reduction impacts (IN_IMP_8 to IN_IMP_15 in the Brazilian survey; and OLBR, ORME, OREI and OHESY in the European survey). A closer look to the indicators do not allow to identify important indicators' or group of indicators' differences between the two samples that could be explained by environmental differences. In some cases, the Brazilian sample scored higher in comparable indexes (e.g. IN_IMP_3 versus OREPL), while in other cases, the selected European countries' sample scored higher (e.g. IN_IMP_11 versus ORME). On the other hand, in many cases the average is very close (e.g. IN_IMP_6 versus OCAP).

In the case of the construct External R&D – Strategic Alliances, the European part of the study did not analyze proxies that represented acquisition of knowledge, R&D or equipment, but only looked at variables that captured the importance of strategic alliances with different partner's types, in a range of 0 to 3. The selected European countries' manufacturing firms, on average, identify partnerships as more important to innovation than the Brazilians. As presented in Table 41, all types of partners are perceived as more important on average to the innovations' introduction in the selected European countries. The only exception is the partnership with the Government that, in the Brazilian survey was not

measured by importance, but as a dummy evaluating if the firm used governmental support for innovation or not. In the Brazilian sample, around 45% answered yes, which indicates a high importance. In the case of the selected European countries, the proxy measures the importance of Government as a partner, such as all the other variables, and had an average of 0.67, indicating a low importance. One interesting observation is that, for Brazilian firms, the importance of acquisitions of software and equipment are the proxies that scored higher in the construct, which may indicate that copying is an activity that prevails, compared to the creation of real novelties with the support of external partners, and is consistent with the previous finding that the degree of novelty of the innovation introduced by the selected European countries' sample is higher than the ones introduced by the Brazilian sample.

	Brazil (n = 2,810 firms)		14 European countries (n = 2,755 firms)	
Construct	Variable	Mean	Variable	Mean
Innovation Performance	INOVPROD	39%	PRODINOV	74%
	INOVPROC	26%	PROCINOV	75%
	INOV	53%	INOV	95%
	IPROD_GRAU	0.44	RADPRODINOV	0.75
	IPROD_RAD_IN	1.01		
	IPROC_GRAU	0.27	RADPROCINOV	1.22
	IPROC_RAD_IN	1.15		
	%_REC_IPROD	10%	TURN	12.6%
	IN_IMP_1	2.18	OQUA	2.25
	IN_IMP_2	1.89	ORANGE	2.17
	IN_IMP_3	2.17	OREPL	1.87
	IN_IMP_4	1.93	ONMOMS	2.09
	IN_IMP_5	1.78		
	IN_IMP_6	1.86	OCAP	1.83
	IN_IMP_7	1.74	OFLEX	1.86
	IN_IMP_8	1.50		
	IN_IMP_9	1.39	OLBR	1.73
	IN_IMP_10	0.96		
	IN_IMP_11	0.97	ORME	1.68
	IN_IMP_12	0.67		
	IN_IMP_13	1.29	OREI	1.64
	IN_IMP_14	1.53	OHESY	1.70
	IN_IMP_15	1.53		

Table 40 - Comparative descriptive statistics – Innovation Performance

In the case of the construct Internal R&D – Absorptive Capacity, the only comparable proxy is intensity of R&D expenses (training is not comparable as in Brazilian survey, its represented by percentage of revenues spent on R&D training and in the European survey, it is percentage of firms in the sample that promoted R&D training). R&D intensity is higher in the selected European countries' manufacturing firms, with 1.97%, while it is 1.7% in Brazil. The higher investment of the selected European countries' firms in internal R&D may have promoted a higher level of absorptive capacity in this group.

	Brazil (n = 2,810 firms)		14 European countries (n = 2,755 firms)	
Construct	Variable	Mean	Variable	Mean
External R&D - Strategic Alliances	IMP_ReD_EXT	0.50		
	IMP_KNOW_EXT	0.56		
	IMP_SOFT_EXT	1.08		
	IMP_EQ_EXT	1.96		
	AL_CLI	0.70	SCLI	1.66
	AL_SUP	0.77	SSUP	1.72
	AL_RIV	0.25	SCOM	1.24
	AL_CONSUL	0.39	SINS	1.07
	AL_UNIV	0.44	SUNI	0.75
	AL_CENTERS	0.34	SPRO	0.88
	AL_TEST_INST	0.48		
	SUP_GOV	0.45	SGMT	0.67
			SCON	1.26
			SJOU	1.07
			SPRO	0.88

Table 41 - Comparative descriptive statistics – External R&D

	Brazil (n = 2,810 firms)		14 European countries (n = 2,755 firms)	
Construct	Variable	Mean	Variable	Mean
Internal R&D - Absorptive Capacity	INT_ReD	1.70%	rrdinx_rat	1.97%
	TRAIN_EXP	0.08%	RTR	37%
	PERS_EDU	0.38		
			SENTG	2.22

Table 42 - Comparative descriptive statistics – Internal R&D

The last comparison possible to be made with the descriptive statistics is among the financial performance proxies. As the selected European countries' data for future financial performance were not available, the comparison presented

here is between the current financial performance proxies of Brazilian firms and the financial performance variables of the selected European countries' firms, excluding value-added growth, which was only present in the Brazilian data. In the case of Brazil, growth measures were of 2011, compared to 2010. In the selected European countries, they were from 2010, compared to 2008. Turnover growth was found to be higher in the Brazilian sample, with 36.2% versus 28.1% for the annual average in the selected European countries. In the case of number of employee's growth, the Brazilian sample averaged 9.7%, while the selected European countries' sample presented a decrease of 1% on the annual average. This may indicate that the selected European countries' manufacturing firms have more productivity than the Brazilian ones, as they grew in turnover with almost the same number of employees. However, in the case of financial performance, the one-year difference may have a big influence. Europe, for example, was recovering from the global 2008 crises, that hit specially some countries from the continent, such as the Iberian and the Baltic countries, and was not so severe in Brazil. The turnover growth, therefore, may reflect a better economic context in Brazil at the period.

	Brazil (n = 2,810 firms)		14 European countries (n = 2,755 firms)	
Construct	Variable	Mean	Variable	Mean
Financial Performance	2010_2011_TURN_GRW	36.2%	turn_growth (2 yrs.)	56.2% (28.1%yr.)
	2010_2011_VA_GRW	23.8%		
	2010_2011_EMP_GRW	9.7%	emp_growth (2 yrs)	-2.0% (-1.0% yr.)

Table 43 - Comparative descriptive statistics – Financial Performance

The analysis of the factors generated by the EFA for the constructs Innovation Performance and External R&D – Strategic Alliances (the only constructs that were reduced by the technique) presented interesting conclusions. Innovation performance proxies were reduced to four factors in the case of Brazil and three factors in the case of the selected European countries. In the Brazilian sample, Innovation Performance was formed by the following factors, as discussed in section 4.1:

1. *Innovations' Cost-Reduction Performance* (CR_PERF) → formed by IN_IMP_8, IN_IMP_9 and IN_IMP_11, that are variables that measured the

impact of the innovation in costs (in the case of these variables, production costs, labor costs and energy costs);

2. *Innovations' Market Performance* (IN_PERF) →. formed by IN_IMP_3 and IN_IMP_4, that represents the impact in keeping and increasing the firm's participation in the market;
3. *Product Innovation Introduction* (INTRO_PROD) → formed by the introduction or not of product innovation (INOVPROD) and by the innovativeness degree of the product innovation (IPROD_DEGREE);
4. *Process Innovation Introduction* (INTRO_PROC) → formed by the introduction or not of process innovation (INOVPROC).

In the selected European countries' sample, Innovation Performance was formed by the following factors, as discussed in section 4.2:

1. *Innovations' Impacts* (INNOV_IMP) → formed by OQUA, OFLEX, OCAP, OLBR, ORME, OREI and OHESY, which are variables that measured the impact of the innovation for the firm;
2. *Product Innovation Introduction* (INTRO_PROD) → formed by the variables that indicates if product innovation was introduced (PRODINOV) and the degree of innovativeness of product innovation (RADPRODINOV);
3. *Process Innovation Introduction* (INTRO_PROC) → formed by the variables that indicates if process innovation was introduced (PROCINOV) and the degree of innovativeness of process innovation (RADPROCINOV).

The presence of separate factors representing the introduction of product and process innovation in both the Brazilian and the selected European countries' samples was coherent with the expectations that both types may occur in different stages of the process of technological development, considering the main-stream theories based on developed countries, such as the model proposed by Utterback and Abernathy (1975), or theories developed based on developing countries, such as the one developed by Kim (1997). As different firms and industries are heterogeneous in terms of technological and innovation development, product and process innovation is not expected to happen conjointly always. Factors representing innovation impacts were different in both samples. In the selected European countries' sample, there was only one factor representing these impacts,

both if they are market or cost-reduction impacts. In Brazil, on the other hand, two separate factors for these two types of impacts could be identified. It was expected to exist separate factors as market impacts were supposed to be more related to product innovation and cost-reduction impacts, more related to process innovation. However, cost-reduction may help firms that have a cost-leadership strategy (PORTER, 1980) to improve its market position. And although it may not be as important to firms with a differentiation strategy, cost-reduction increases profitability, which boosts the firm's capacity to invest in growth in all dimensions. General investments in growth, such as investments in marketing efforts, or in increasing production may also affect the market dimension of the innovation impacts and this happens more effectively and fast in more mature and efficient firms. Firms in Europe should be in a more mature and efficient stage than Brazilian firms, which could justify these differences.

External R&D – Strategic Alliances proxies were reduced to only one factor in the case of Brazil and three factors in the case of the selected European countries. In the Brazilian sample, the unique factor was named *Strategic Alliances* (STR_ALL), which was formed by alliances with clients (AL_CLI), with suppliers (AL_SUP), with consulting firms (AL_CONSUL), with Universities (AL_UNIV), with professional capacitation and technical assistance centers (AL_CENTERS), and with test, trial and certification centers (AL_TEST_INST), as discussed in section 4.1. In the selected European countries' sample, External R&D – Strategic Alliances was formed by the following factors, as discussed in section 4.2:

1. *Alliances with Formal Institutions* (ALL_INST) → formed by collaboration with consultants and private research centers (SINS), the Government (SGMT) and Universities (SUNI);
2. *Alliances with the Academy* (ALL_ACAD) → formed by other external sources of information such as conferences (SCON) and journals (SJOU);
3. *Alliances with the Market* (ALL_MKT) → formed by alliances with clients (SCLI) and competitors (SCOM).

This difference may reflect a maturity difference in terms of strategic alliances' application between the two realities. As discussed in Section 2.5,

different types of partners promote different results in collaboration that depend on several aspects such as the characteristics of the firm and of the industry, the nature of the innovation, the appropriability regime, etc. Also, the U-shape relationship between partner diversity and innovation performance identified in several empirical studies and also discussed in Section 2.5 indicates that the tendency of firms to use all or many types of partnerships at the same time, as the unique factor in the Brazilian sample indicates Brazilian firms do, do not comply with the best practices. This may have been caused by a lower level of absorptive capacity of Brazilian manufacturing firms, that provokes a low capacity to identify efficiently the best partners to improve the innovation process. The selected European countries' firms in the sample seems to choose better one or few types of partners, based on the aspects discussed previously.

In the next step, the results of the SEM for Brazil and for the selected European countries are compared. Table 27 and Table 38 showed the results of the hypotheses' test from Brazil and from the selected European countries respectively. Table 39 presented the results for each of the selected European countries' groups separately, which in most of the cases were consistent with the results shown in Table 38. Hypothesis 1 was confirmed in both models. This indicates that External R&D from strategic alliances is positively related to the innovation performance of manufacturing firms in different environments, with different NSIs and diverse levels of innovation development. This fact is reinforced by the confirmation of this hypothesis for all the seven European groups of countries. In Brazil, most of the partnerships are viewed as similarly important for innovation development, which was demonstrated by the fact that the EFA reduced the construct External R&D to only one factor. In the selected European countries, all partnership types were considered important, with a higher incidence of the alliances with the market, followed by alliances with the academy and, last, alliances with formal institutions (respective regression weights are shown in Figures 22 and 23 and are consistent both with turn_growth and emp_growth representing financial performance). That affirmative is consistent with the open innovation concept, and with most of the literature presented in Section 2.5.

In contrast, the test of the relationship between internal R&D and innovation performance in hypothesis 2 presented different results on the two samples. It was confirmed in the selected European countries in general and in all separate groups and was rejected in Brazil. Both in Brazil and in the selected European countries, the regression weights of R&D intensity were higher than the other proxies in the internal R&D construct, indicating that it is more important in defining this concept than the other proxies. R&D intensity, as shown in Table 41, is higher in the selected European countries' sample than in Brazil (1.97% versus 1.70%) and this difference of 0.27% may have promoted a big difference in the direct effect of internal R&D in the innovation performance. Another issue that this result may be indicating is that the firms of the selected European countries' sample may be in a more evolved stage in the accumulation of innovative capabilities, which allows them to generate more significant incremental and radical innovations by their internal efforts and knowledge. As supposed, a lower level of innovative capabilities from the firms in the Brazilian sample forces them to focus on copying and making simple modifications on existing products and processes, or rely on the knowledge of more technological developed partners, which is reinforced by the confirmation of hypothesis 1.

Hypotheses 3, which tests moderation effect of the absorptive capacity (in this manuscript represented by the internal R&D construct) on the effectivity of the strategic alliances to increase innovation performance, was supported for Brazilian manufacturing firms and rejected for the selected European countries' firms. There are several possible reasons why this difference emerged. In the individual analysis of the selected European countries' sample, it was supposed that the absence of the moderation relationship could have been caused by a general modest level of innovation capability's level of the manufacturing firms in these countries, compared to most innovative countries in the world which are used in empirical studies that confirmed the absorptive capacity theory (e.g. COHEN; LEVINTHAL, 1990; DUSHNITSKY; LENOX, 2005a; HAGEDOORN; WANG, 2012). However, if the cause was that simple, the Brazilian sample would also present similar findings. But going deeper into the model results of the Brazilian case, presented in Figure 21, it may be shown that the only the factor of the absorptive capacity that had a significant moderation effect in the relationship

between strategic alliances and innovation performance was the level of education of the employees (PERS_EDU). Data about the level of education of employees were not available in the selected European countries' sample, reason why such proxy was not used in the European model. In Section 2.5, Figure 15 illustrated the two dimensions of absorptive capacity proposed by Kim (1997). The dimension intensity of efforts of the firms may be better represented by variables such as R&D intensity and R&D training efforts, which composed both the Brazilian and the European model. The dimension existing knowledge base may be somewhat represented by the level of education of employees, which was used only in the Brazilian model. The qualitative variable importance of internal R&D as a source of information (SENTG) is more qualitative than the others, being more subject to response bias, and do not reflect clearly any of the two dimensions independently. These observations led to the conclusion that, for environments (countries or industries) with firms of modest or low levels of innovation capability, the accumulated knowledge is more important than the level of effort of the firm, as it is a stronger source of differentiation between firms, which is caused by a higher heterogeneity of the level of accumulated capabilities among them than in firms of more innovative environments. If a variable such as education of employees was present in the European model, it is likely that hypothesis 3 would be confirmed. However, it is mandatory that firms continue to invest more on internal R&D as higher levels of this variable have a direct positive effect on innovation performance and increases the accumulated knowledge through time, which improves their absorptive capacity.

The comparative analysis of hypothesis 4 brought less valuable conclusions. This hypothesis was rejected in Brazil and in the selected European countries. In the selected European countries, the relationship between innovation and financial performance was not significant. In Brazil, however, it was negative. The possible reasons for this negative sign in Brazil was already discussed in section 4.1. Available Brazilian data allowed to test a more complete model, with current and future financial performance as separate constructs. Current financial performance was not lagged compared to the data of internal R&D, external R&D and innovation performance and no significant relationship regarding that construct was found (rejecting H5a and H5b, that were put in the model for controlling the

effects of the current financial performance). Future financial performance had a lag of two years that did not allow to identify the positive effects of the new products and services in the firm's growth, but allowed to capture the negative impact of the redirection of resources from marketing and sales to innovation activities and of the costs of collaboration management. No lagged financial performance data was available for the selected European countries' firms, which obligated to test H4 without any lag between financial performance and the other constructs and did not allow to capture any effect of innovation performance on financial performance, which is consistent with the rejection of H5b in the Brazilian model, that proposed an inversed direction of the relationship between these two constructs that was not confirmed.

5
Conclusions

5.1.
Summary of the study

The aim of this study was to identify how the choices and the effective usage of R&D sources act as antecedents of innovation and how innovation behaves as antecedent of an improvement in the financial performance of firms in different regions, considering that each region has its own specificities that may help to improve or hinder the positive relationships between these constructs. Particularly, the intention was to compare manufacturing firms from Brazil and from 14 selected countries of Europe, which, as shown in sections 1.1 and 4.3, are in different stages of innovative development, with the selected European countries being ahead.

In order to test the proposed research questions, a theoretical model was developed, through a deep literature review of the innovation and strategic management fields. The proposed model is composed by the constructs Internal R&D – Absorptive Capacity, External R&D - Strategic Alliances, Innovation Performance, Appropriability Regime, Current Financial Performance and Future Financial Performance, and contains the proposed proxies to operationalize its constructs. The hypotheses were tested separately for samples of manufacturing firms from Brazil and from the selected European countries with data from the surveys PINTEC 2011 and PIA 2009 to 2013 in the first case and from CIS 2010 in the second case, using the statistical methods Exploratory Factor Analysis and Structure Equation Modeling.

The analysis of a sample of 2,810 manufacturing firms from Brazil that conducted innovation activities (with success or not) from 2009 to 2011 from PINTEC 2011 survey allowed to find some interesting conclusions. Product innovation had a higher incidence than process innovation (38.50% vs. 26.30%)

and new products are responsible for, on average, 10% of the turnover of the firms. This higher incidence of product innovation may have emerged from a point of view of the Brazilian firms and of the Government that product innovation is more noble and more effective to improve performance. This common point of view of the Government and of the firms according the value of product and process innovation shows an agreement that indicates the dependence the firms have on the governmental incentives to innovate. Therefore, it may have motivated manufacturing firms to make less efforts to develop process innovation, that are usually responsible for improving the production process, which lower costs and may reflect faster in the financial performance than product innovation, that depends on marketing efforts to introduce the new product in the market and improve the firm's market-share and revenues. This may be one of the causes why it was not possible to identify a positive relationship between innovation performance and future financial performance in the Brazilian case. On the contrary, the observed effect was negative. The time-lag between the innovation performance indicators and the future financial performance indicators was only of two years (2011 to 2013) and was not enough to reflect the effect of new products or services in the performance. However, the performance may have been affected by the costs of management of the strategic alliances and by the redirection of resources from marketing and sales to innovation activities, such as internal R&D, which may have caused a decrease in the financial performance indicators in the short-term.

Strategic alliances, as the theory predicted, had a positive influence in the innovation performance. Internal R&D investments, such as R&D intensity and level of education of employees, on the other hand, did not affect innovation performance directly. However, it increased the positive effect of the strategic alliances on the innovation performance, mainly the proxy level of education of employees. The support of this hypothesis is in line with the absorptive capacity theory, and in the Brazilian manufacturing firms' case, the dimension of absorptive capacity that is more effective according to the empirical results is the one that needs least monetary investments. However, a continuous investment in internal R&D should be done as the level of technological capabilities of the Brazilian firms are still low. If they catch-up to the technological frontier, this

accumulation of internal R&D will tend to influence more the effect of the strategic alliances in the innovation outcomes (by an increase in the absorptive capacity), as well as, affect it directly.

The absence of a significant influence of Current Financial Performance on Future Financial Performance as well as on Innovation Performance indicates that Brazilian manufacturing firms are alternating in the industry leadership through time, with new entrants overcoming incumbents frequently. This may be an effect of innovations introduced previously to 2009 and reinforces the time-lag between the introduction of innovation and financial performance improvements. Innovation developed by new entrants may be a factor that may be influencing this leadership alternation.

The selected European countries' sample was composed by 2,745 manufacturing firms of 14 countries - Bulgaria, Cyprus, Czech Republic, Spain, Croatia, Portugal, Hungary, Slovenia, Norway, Lithuania, Romania, Italy, Slovakia and Estonia - which conducted innovation activities from 2008 to 2010 with successful introduction of innovation or not, based on the CIS 2010 survey and its analysis also drove to some interesting conclusions. Most of the firms that conducted innovation activities introduced at least one innovation in the period (95%), with similar levels of product and process innovation (74% vs. 75%) and new products participated on average with 12.6% of the organizations' turnover. This high level of innovation introduction shows that the innovation process is in a more advanced stage of efficiency in these European countries. The level of innovation introduction varies from 93% in Portugal and Spain to 100% in Norway. As the latter is the most innovative country of the list according to the Global Innovation Index, in the 22nd position (DUTTA et al., 2016), this result indicates that the other countries from this group have an opportunity to improve their innovation process to reach an efficiency of almost 100%.

External R&D from strategic alliances and internal R&D investments, such as R&D intensity and employees' training, had a positive influence on the innovation performance directly, as supposed by the theory. However, the moderation of Internal R&D on the relationship between External R&D and Innovation Performance was not found. As the countries of the study are moderate

or modest innovators in the European and global context, our findings are consistent with the results of Hagedoorn and Wang (2012), which suggested that internal and external R&D are substitutes at low levels of absorptive capacity. The manufacturing industry in these countries is not in a world-leading position in innovation and should invest more to accumulate innovative capabilities internally, by improving their investments in internal R&D and in capacitation of employees, in order to increase their absorptive capacity and the effectiveness of their collaboration efforts.

A positive effect of innovation performance on financial performance was not found either. This happened because the effects of innovation introduction on performance takes some time to show up. Financial performance indicators with an appropriate time-lag compared to the innovation performance indicators were not available, so the expected relationship could not be captured. However, there were exceptions. In Estonia and Lithuania, innovation performance influenced the immediate turnover growth, which is explained by the effect of 2008's crises, that promoted an abrupt decrease in the Baltic countries' economy, followed by an immediate intense recovery, possibly pushed by innovative firms. In Portugal and Spain, that were also strongly affected by the crisis, the employees' growth was positively influenced by the innovation performance, which may be an effect of downsized firms returning to their pre-crises' size.

The comparative analysis of the Brazilian and the selected European countries' samples presented interesting findings. It was clear that the firms from the selected European countries' sample had more success in the innovation introduction, with 95%, versus 53% of success in the Brazilian sample. This indicates that the innovation process of those is more effective than the process of the last one. It passes by the differences of choices and of effective uses of R&D sources, as well as the quality of the sources available. In the selected European countries' sample, internal R&D had a direct positive influence on the innovation performance of firms. This positive relationship was not found in the Brazilian sample, on the other hand. As the internal R&D construct relies more in the intensity of internal R&D expenses according to both models' results, the differences observed between the Brazilian and the selected European countries'

sample in this variable (1.70% versus 1.97%) may be in the root of this findings. On the other hand, the internal R&D construct was confirmed as moderating positively the effect of external R&D in the innovation performance of the Brazilian manufacturing firms, but this complementary relationship was not found in the selected European countries' case. It is very likely that this difference relies on modeling differences. The Brazilian model had a variable representing level of education of employees as a proxy of the internal R&D construct, which guarantees that the existing knowledge dimension of the absorptive capacity of the firms was represented in addition to the intensity of efforts dimension, which was represented by the other two proxies. Level of education was the only internal R&D variable that had a significant moderation effect in the relationship between the external R&D variables and the construct innovation performance. In the European model, the three proxies of the construct internal R&D represents the intensity of efforts dimension. This indicates that in countries that are not in the cutting-edge of the innovation development, which is the case of Brazil and most of those from our selected European countries' sample, the accumulated knowledge is more important than the level of efforts to the absorptive capacity of the firm, allowing them to turn external R&D into successful innovation. However, a continuous increasing in internal R&D investments is mandatory if these countries want to catch-up to the world-leading innovative countries.

The effect of innovation performance on financial performance was hard to be identified in this study. The time-lag between innovation introduction and the observed growth, which is in several dimensions our proxy of financial performance, was only two years in the Brazilian sample and barely non-existent in the selected European countries' sample. The two-year's lag in the Brazilian case did not allow us to identify a positive relationship, but on the contrary, could capture an initial negative effect caused by the redirecting of resources from marketing and sales to innovation activities. Product innovation prevails in Brazil, while product and process innovation occurs at similar levels in the selected European countries. As process innovation may give a positive financial return faster than product innovation, as it helps to decrease costs, the existence of extensive process innovation may had help the selected European countries' firms in our sample to compensate the short-term negative effects of product innovation.

5.2. Theoretical contributions

This study contributes to the academic knowledge of the innovation and strategic management field in several aspects. As highlighted previously, the extensive literature review allowed to propose a theoretical model integrating both fields. There was an important research gap consisting in integrating in a theoretical model the already explored relationships between the antecedents of innovation and innovation performance with the financial performance of firms, which was intended to be covered by this study. The model built on the open innovation theory (CHESBROUGH, 2003) and on the absorptive capacity theory (COHEN; LEVINTHAL, 1989, 1990) to explain the relationships between internal and external R&D sources and proposed their complementarity as antecedents of the innovation performance. The open innovation concept proposed that internal and external knowledge and resources should be considered by a firm conjointly in order to improve its capacity to innovate. In turn, the absorptive capacity theory propagated that internal R&D efforts and accumulation improve the firms' absorptive capacity, which helps them to get advantage from knowledge and resources of external partners to generate innovation. Conjointly with these relationships the model suggested that innovation capabilities accumulated by the firm, which are directly linked to the capacity to produce a satisfactory innovation performance, improves the financial performance, specially growth, which agreed with the findings of several empirical studies (e.g. DU et al., 2014; FAEMS et al., 2010; TOMLINSON, 2010; YAMAKAWA et al.,2011).

The empirical tests of the proposed model in Brazil and in 14 European countries contributed to the theory as it compares realities of moderate and low innovative countries. This comparison is not common in the main stream literature, which covers advanced innovative countries, and even in alternative streams that cover catching-up countries such as Korea and China. Novel results, which contradicts the main stream theories of innovation management were supposed to be found. As predicted, the results of this research contradict the main stream literature and supports the alternative stream, which proposes that the innovative capabilities accumulation occurs in a different way in catching-up

countries (KIM, 1997; CHOUNG et al., 2014; FIGUEIREDO, 2003; 2016). However, this study explored some novel relationships that differentiates catching-up countries by their innovative level, namely low and moderate. Brazil is a developing country in a not very favorable position in the most recent GII (69th position) and was considered a low innovator, whereas the selected European countries studied are in the 33rd position on average and may be considered moderate innovators. These European countries are not among the most innovative in the world, although are much more innovative than Brazil, according to the GII. The empirical tests also evaluated the environmental differences, which are highlighted by several authors, including the ones that wrote about the NSIs and its importance for the firms' innovative success (e.g. NELSON, 1993; PATEL; PAVITT, 1994). A deeper consideration to the secondary goals of the study, presented in section 1.1, helps to clarify more the academic contributions of the empirical tests.

i) *Determine the relationship between strategic alliances and innovation performance (especially product and process innovation), regardless of financial performance, in manufacturing firms.*

The empirical tests confirmed that strategic alliances are an important source of external knowledge and R&D to generate innovation, according to the main stream literature of innovation management and to several empirical studies (e.g. BELUSSI et al., 2010; FAEMS et al., 2010; RITALA et al., 2015). Both in the Brazilian and in the selected European countries' sample, this relationship was confirmed, which indicates that it is probably valid in more developed and also in catching-up countries. The fact that in the selected European countries' test, the difference in the importance of the diverse types of partner was more recognized by the firms than in the case of Brazilian manufacturing firms, which tended to apply different partnerships conjointly, indicates that the more innovative countries choose more carefully its partners, which is more consistent with the authors that found that different partners promote different results and that a very wide alliance portfolio, with many different partner types, is related to a decrease of the innovation performance (e.g. DUYSTERS; LOKSHIN, 2011).

ii) *Determine the relationship between innovation performance (especially product and process innovation) and financial performance in manufacturing firms.*

The empirical tests indicated that short-term financial performance tends to decrease with the increase of product innovation performance. Although this results contrast with the mainstream theory, which stated that there is a positive relationship between innovation and financial performance, it makes sense as this positive relationship is supposed to happen with a large time-lag, that could not be considered in our empirical settings by the absence of available data. The negative sign of the relationship between these two constructs may have been caused by the prevalence of product innovation in the Brazilian sample, while for the selected European countries' sample, in which there an equilibrium between product and process innovation, the effect of innovation in financial performance was not significant. It may indicate that process innovation is more effective for promoting an increase in short-term performance, equilibrating the negative effects of product innovation.

iii) *Determine the importance of internal knowledge sources for innovation performance (especially product and process innovation) directly and as a moderator of the relationship between strategic alliances and innovation in manufacturing firms. The firm's absorptive capacity is supposed to be of great importance in increasing its innovation capacity through alliances.*

The support of the hypothesis that internal R&D have a positive influence on innovation performance for the European sample and not for the Brazilian sample indicates that this relationship is more prevalent in more innovative countries. In less innovative countries, the theories of firms that do not have well-developed innovation capabilities (e.g. KIM, 1997) seem to work better. This conclusion started with the assumption that manufacturing firms of the European countries in the sample have more well-developed innovation capabilities than the Brazilian firms. But it also considered the empirical observation that the selected European countries' firms of the sample invest more in internal R&D on average than the Brazilian firms of the sample. In the case of the moderation of the absorptive capacity, represented by the construct internal R&D, on the positive

influence of strategic alliances, represented by the construct external R&D, on innovation performance, preconized by the absorptive capacity theory, the empirical evidence indicated that only the dimension existing knowledge (represented by the proxy level of education) of Kim (1997), is effective in moderate or low innovative environments. The dimension intensity of efforts (represented, for instance, by R&D intensity) is probably only effective in more developed countries, in which most of the firms have the necessary innovation capabilities accumulated. Although the selected European countries that are focused in this study are more innovative than Brazil, they are not among the most innovative of Europe and of the world and the innovation capability accumulation of its manufacturing firms is still not in the necessary stage to allow observing the absorptive capacity's dimension intensity of efforts acting effectively.

These findings, besides indicating that firms in countries that are modest and moderate innovators usually have only some dimensions of absorptive capacity developed, as opposed to firms in developed, which have all dimensions developed, bring some clues on how to operationalize the absorptive capacity construct more effectively, which is a big challenge for the academy. The results indicated that the absorptive capacity construct is most probably formative, instead of reflexive. The proxies R&D intensity, level of education of employees, etc. do not reflect the level of absorptive capacity of the firm but form it conjointly with other factors. For this reason, composing the absorptive capacity construct with some proxies and ignoring others (see Table 11 for a more extensive list of proxies) may weaken the modeling and the results.

iv) *Determine the similarities and differences among the countries studied according to the manufacturing firm's choices regarding strategic alliances and internal knowledge sources and in its effects on innovation (especially product and process innovation) and financial performance. This dissertation focuses specially on the differences among Brazil and some selected European countries.*

The differences in the choices and usage of internal and external R&D in the different environments, namely in Brazil and in the 14 European countries focused in this study, were perceived in the test of both models and were

described in the analysis of the three previous secondary goals to identify the theoretical contributions. It was clear that the separate results of the 14 European countries are much closer among each other than with Brazil. This indicates the validity of the theories about the importance of environmental factors, specifically country factors (e.g. AUSTIN, 2002), and the studies that recognize the influence of the NSI on the innovation process and performance of national firms (e.g. NELSON, 1993; PATEL; PAVITT, 1994). It also validates the theories that propose that the innovation process is different in developed and developing economies (KIM, 1997; CHOUNG et al., 2014; FIGUEIREDO, 2003; 2016), and reaffirms the relevance of indexes such as the GII (DUTTA et al., 2016) and the Innovation Union Scoreboard (EUROPEAN UNION, 2016).

5.3. Managerial implications

As stated in the introduction of this study and confirmed by the GII and other public information sources, the environment in Brazil is inhospitable for innovation, imposing a big challenge for firms that want to innovate in general. It may have contributed to the development of a "mongrel complex" (WIKIPEDIA, 2017b) in the Brazilian firms, which consists in a belief that they are not capable to develop world-leading innovations, causing a low investment in internal R&D, and a high level of licensing and copying. As licensing and copying does not impact the process in a high degree as the development of more radical innovations, process innovation has been neglected, as the empirical evidences showed. This challenge provoked by the Brazilian NSI was overcome by some firms and industries, such as Embraer, in the aviation industry (FIGUEIREDO et al., 2008), Natura in the cosmetics industry (ADES et al., 2013), and several firms in the pulp and paper industry (FIGUEIREDO, 2016), proving that even in its challenging environment, it is possible to catch-up to the innovation frontier and at the same time generate satisfactory financial performance. The main general lesson is that, in catching-up countries such as Brazil, the Government and the industry players should work together with a consistent strategy to overcome all the environmental issues and make the industry and its firms to become world-leading innovators. This work adds several contributions for practitioners,

specifically managers of manufacturing firms and areas from the Government responsible for formulating policies to incentive innovation as the empirical tests of its model in Brazil and in the selected European countries presented differences in the choice and application of R&D strategies and in the innovation focus that brought different performance results.

The first suggestion for manufacturing firm's managers is that Brazilian organizations should invest more internal R&D, improving their percentage of revenues invested. This action may promote a faster catch-up for the Brazilian firms, allowing them to generate more innovation directly from its own efforts while accumulating innovation capabilities and absorptive capacity. In terms of strategic alliances, firms should choose better its types of partners, giving preference to market partners, such as clients and competitors, although not neglecting the partnerships with Universities and Research Institutes in basic and applied research, but without amplifying too much the number of partners' types, which promotes a decrease in the innovation performance. For both firms and formulators of governmental policies, an important lesson is that process innovation must not be neglected. Governmental programs that are today more focused on product innovation should also incentive process innovation, as well as firms should put more efforts in innovation of this type to achieve more short-term financial return derived from innovation, as process innovation usually brings faster financial results than product innovation.

For both manufacturing firms of Brazil and of the 14 European countries of our sample, which presented moderate or low levels of innovative capabilities and absorptive capacity, and are trying to improve their innovation performance, this study demonstrated that, if the main goal is an immediate improvement in innovation performance levels, they should focus on either internal or external R&D. However, if the main goal is the long-term, beginning to strengthen their internal R&D is effective to improve the firms' absorptive capacity while achieving a satisfactory innovation outcome. This strategy will allow them to adopt more complex strategies, balancing internal and external R&D, effectively in the future, when the absorptive capacity level becomes high.

5.4. Limitations of the study

This study contains several limitations concerning the method and the research itself. The main limitation of the method adopted in this research was that the differences among Brazil and the selected European countries could not be tested statistically as their data could not be merged. Another limitation regarding the method was the absence of panel data of financial performance indicators for the selected European countries' firms and the small time-lag between innovation performance and financial performance in the case of Brazil, which did not allow to capture mid and long-term effects between these two constructs. Yet, another limitation of this type was that the operationalization of the constructs proposed in the theoretical model were limited to the data available in the surveys used, and different adaptations had to be made for the Brazilian and the European measurement models. The construct Appropriability Regime was not used in both regions and the construct Current Financial Performance, in the European case, among other changes previously described. The last limitation of the method related here is that PINTEC and CIS database have some qualitative questions based on fillings and experiences of the respondents, which could create a bias in the analysis.

Regarding the research itself, a limitation was that, from Europe, only 14 countries (Italy, Bulgaria, Cyprus, Czech Republic, Spain, Croatia, Portugal, Hungary, Slovenia, Norway, Lithuania, Romania, Slovakia and Estonia) participated of the study due to the availability of data. Only these countries were selected because they were the only ones that allow Eurostat to deliver the CIS 2010 database by CD-ROM, with exception of Italy. However, the author had previous access to the Italian data, as explained before. Germany's data were also included in the CD-ROM, however, there were no data from strategic alliances and, for that reason, Germany was not included. Resource limitations hindered the possibility to go personally to the Eurostat safety datacenter in Luxembourg, where more countries' data could be accessed. This limitation, together with the fact that the study only considered manufacturing firms, may have made the study regional and industry-specific.

Other limitation is that the construct Appropriability Regime was not used in both regions' models because of the lack of data available in CIS 2010 and PINTEC 2011. However, the construct and its referred hypothesis were kept in the theoretical model as it contributes to the model's explanatory power and may serve as basis for future studies, such as some of the ones proposed in the next section.

Another important limitation is that the there were some differences between the models caused by differences in the surveys and in the data available. In the case of the Brazilian model, the constructs Current and Future Financial Performance had three proxies each. In the European case, two models using one variable representing financial performance on each were used, insead of one model with a latent variable representing this construct. Some of the other constructs presented proxies' differences (e.g. level of education of employees is a proxy for Internal R&D in the Brazilian model and is not present in the European model). Another difference is that the CIS survey was conducted one year before the PINTEC survey. Altough this differences are relevant, the study and the comparison of both models are still valid and very interesting as the surveys and the models have much more similarities than differences that allow an effective comparative analysis. The most important difference between the application of the model in both contexts that should be highlighted is that the time-lag between innovation performance and financial performance is two years in the case of Brazil and non-existent in the case of Europe, because of absence of lagged data in the last case. The empirical analyses presented a negative relationship between both constructs in the case of Brazil and a non-significant relationship in the case of the selected European countries and some comments and conclusions made by the comparison of this two cases to try to explain this difference may be weaker by this time-lag difference. This lack of data also did not allow the use of the construct Current Financial Performance in the European model.

Other limitation that should be remarked is that consessions were made on the internal validity and discriminant validity of the contructs in both the Brazilian and in the European models because of the low level of some validity's indicators, as shown in sections 4.1 and 4.2. However, a complex model such the one presented in this study, sometimes demands flexibilizations in these indicators. By

last, our main goal, that was to learn lessons from more innovative countries to help to improve the innvoation capacity of Brazilian firms, was limited as some important European countries such as Germany, France and UK, and some of the most innovative countries such as Sweden, Finland, Denmark and Holland (EUROPEAN UNION, 2016) are out of the analysis.

5.5. Recommendations for future studies

Although this study contributed to explore the influence of internal and external R&D on innovation and financial performance in Brazil and in several European countries, it was only a starting point and several research opportunities present for the future, and the limitations section gave some hints about some of them. A first opportunity that arises is to study other European countries that participated of the CIS survey and could not be included in this research, such as the biggest economies of the continent (e.g. Germany, France, UK) and some of the most innovative countries (e.g. Sweden, Denmark, Finland, Holland) and others. Adding these European countries may enable to compare developed countries in which the main stream theories of innovation should fit better with Brazil and less developed European economies, in which the innovation theories must be adapted to the reality of catching-up countries, and try to identify the reasons why these differences happen.

One additional possibility to extend the research is running the model for other countries that applied surveys similar to CIS and PINTEC. Several countries in all continents and at different innovative stages are in this situation, such as Argentine, Belarus, China, Colombia, Dominican Republic, Ecuador, Lesotho, Malaysia, Palestine, Paraguay, Philippines, Serbia, Tunisia, Uganda, Ukraine, Russia, South Africa, New Zeeland, Canada, South Korea, Turkey, Switzerland, Mexico, Chile, Uruguay, etc.

Another opportunity is running the model for firms of different industrial sectors. As only manufacturing firms were used, the service sectors, the extractive sectors and so forth were not considered and possibly would present different results that could generate interesting conclusions. Other possibility is merging

several CIS and PINTEC surveys to create a panel dataset to improve the capacity to analyze the causal relationships with longer time-lags among the constructs. Antecedents such as internal and external R&D could be from one time-frame, innovation performance from another and financial performance from another one. CIS started to be applied in 1992 and has eight versions nowadays (CIS 2012). PINTEC has been applied since 2000 and the last one (PINTEC 2014) is the sixth version of the survey. The surveys had changes through time and a longer time-frame includes more complexity as some historical events may have influenced the events and should be considered. However, with this type of panel database, possibly the positive influence of innovation performance in financial performance could be captured, for example using a five-years' or a ten-years' time-lag. It also would allow to differentiate current and future financial performance in the European model. Also considering possibilities with other versions of the survey, both CIS 2012 and PINTEC 2014 contain questions that represents the appropriability mechanisms, which would allow to include the construct Appropriability Regime from the theoretical model in the empirical analysis

A last suggestion is to use data from different surveys that investigated innovation activities, such as the Business Environment and Enterprise Performance Survey – BEEPS, conducted by the World Bank jointly with the European Bank for Reconstruction and Development (EUROPEAN BANK FOR RECONSTRUCTION AND DEVELOPMENT, 2016). This survey investigated several phenomena related to innovation activities and to financial performance in the firm-level, besides having information about the characteristics of firms of transition countries of Eastern Europe, Asia and Africa based on the year 2011.

6
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