Relationship between marketing innovation and other innovation types: an empirical analysis of Portuguese firms

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Declaração

Declaro que o presente documento é um trabalho original da minha autoria e que cumpre todos os requisitos do Código de Conduta e Boas Práticas da Universidade de Lisboa.

Declaration

I declare that this document is an original work of my own authorship and that it fulfills all the requirements of the Code of Conduct and Good Practices of the Universidade de Lisboa.

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Abstract

Marketing innovations are a source of competitive advantages for companies. However, to obtain these advantages, is important to understand the relationship they have with the different types of innovations, such as product innovation, process innovation and organizational innovation. This study addresses the concept of marketing innovation and tries to understand its relationship with other types of innovation. Through the literature review carried out, it was possible to identify that there is a potential complementary relationship between marketing innovation, and its subtypes, and product, process, and organizational innovations. Afterwards, were defined research hypotheses, that were verified through a logistic regression model, logit, and using data related to the innovation of Portuguese companies from the Community Innovation Survey 2016 (CIS 2016), for the period between 2014 and 2016. The results show that marketing innovation has a positive effect on all other types of innovations. Regarding the subtypes of marketing innovation, product design innovation, promotional innovation, placement innovation and pricing innovation, these have been found to have a positive effect on both technological innovations and organizational innovations.

Keywords: Marketing innovation; non-technological innovation; technological innovation; CIS

Resumo

Inovações de marketing são uma fonte de vantagens competitivas para as empresas. No entanto, para se obterem essas vantagens, deve-se compreender qual a relação que estas possuem com os diferentes tipos de inovação (produto, processo e organizacional). Este trabalho aborda o conceito de inovação de marketing e tenta perceber a sua relação com os outros tipos de inovação. Através da revisão de literatura foi possível identificar que existe uma potencial relação complementar entre inovação de marketing, e os seus subtipos, e as inovações de produto, processo e organizacional. Desta forma, foram definidas hipóteses de investigação que foram verificadas através de um modelo de regressão logística logit e com recurso a dados relativos à inovação de empresas Portuguesas provenientes do Inquérito Comunitário à Inovação 2016 (CIS 2016), referentes ao período entre 2014 e 2016. Os resultados mostram que as inovações de marketing têm um efeito positivo em todos os outros tipos de inovações. Em relação aos subtipos de inovação de marketing, inovação de design de produto, inovação promocional, inovação de canais de distribuição e inovação de preços, foi verificado estes têm um efeito positivo tanto em inovações tecnológicas como em inovações organizacionais.

Palavras chave: Inovação de marketing; inovação não tecnológica; inovação tecnológica; CIS

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1. Introduction

This first chapter consists of a brief description that will allow to understand the context in which this study is inserted, the motivations that led to its realization, the main objectives to be achieved.

The following study consists in a master dissertation in Industrial Engineering and Management and is focused on marketing innovation and its relationship with the different types of innovations (product, process and organizational) defined by third edition of OECD's Oslo Manual.

Marketing innovation can be defined as the changes that happens in terms of product design or packaging, placement, promotion, or pricing (OECD, 2005). Even though it has been neglecting from the literature (Medrano-Sáez & Olarte-Pascual, 2016), marketing innovation has a great importance for a firm to get competitive advantages (Ren et al., 2010). As Drucker said, only marketing and innovation are responsible for the creation of value, all the rest are costs (Drucker, 1954). Nevertheless, in order to take full advantage from the benefits of marketing innovation, it is important to understand its relationship with the other types of innovations (product, process and organizational).

Marketing innovation's interactions with the other types of innovations has not been widely explored in literature (Schubert, 2010) and therefore, there is not a consensus between the authors who studied it, with some of them defending that they are substitutes of other types of innovations and others that they are complements (Kijek, 2013; Medrano-Sáez & Olarte-Pascual, 2016).

1.1 Problem Definition

Schumpeter, the pioneer of the modern concept of innovation, defined innovation as the development of new products, new raw materials, new processes, new sales methods and opening new markets and is the main responsible for major economic changes. If a company wants to remain in the market, it must innovate (Śledzik, 2013; Fagerberg 2009). More recently, the concept of innovation was extended to marketing, that is showed to be a driver for the other types of innovations, helping companies to increase their sales and reduce their costs.

The study of innovation has gained relevance in recent years due to its positive effects on firms. The interest from researchers on innovation has growth and therefore there is a lot of empirical studies (Thornhill, 2006; Bowonder et al., 2010). However, those studies focus mainly on the effects of technological innovations on firm's performance (Medrano-Sáez & Olarte-Pascual, 2016) or the relationship between them, neglecting the study of marketing innovation and with the different types of innovations (Rebane, 2018; Schubert, 2010).

In order to understand how to obtain competitive advantages through marketing innovation, it is important to study how it relates with the different types of innovation in order to understand why

companies behave differently in the adoption of the different innovation strategies and why the results and performance are different between them (Rebane, 2018; Joueid & Coenders, 2018). Many authors studied the relationship between marketing innovation and the other types of innovations. This is the case of Bartoloni & Baussola (2015), Medrano-Sáez & Olarte-Pascual (2016), Joueid & Coenders (2018), Geldes et al. (2017), Soltani et al. (2015), Rebane (2018), Kijek (2013), Schubert (2010), Gunday et al. (2011), González-Blanco et al. (2018) and Grimpe et al. (2017). It should be taken into account that that there is not a linearization when establish the relations between innovations, what means that they can vary across countries, sectors and over time (Rebane, 2018; Ferreira & Marques, 2013; Mothe & Thi, 2012). This aspect can make it difficult to understand the relationship between marketing innovation and the other types of innovations.

In Portugal there are some studies on innovation. Most of them use the Community Innovation Survey, however they are mainly focused on technological innovation. For instance, Pinto et al. (2019), by using four waves from CIS (2006, 2008, 2010 and 2012), studied how the 2007 economic recession affected product and process innovation, while Pires et al. (2008) identified and compared technological innovation determinants for manufacturing and services sector. The research focused on marketing innovation using Portuguese data is scant. Some exceptions are Moreira et al. (2012) and Ferreira & Marques (2013). The former analyzed the determinants of marketing innovation and the latter studied the impact that non-technological innovation (organizational and marketing) have on technological innovation (product and process).

Given the lack of empirical studies the main objective of this dissertation is to understand the relationship between marketing innovation (and all its subtypes) and other types of innovation for Portuguese companies, by using data from the Community Innovation Survey (CIS), for the periods between 2014 and 2016. In this way, it will be possible to contribute to the scarce existing literature, so that this study can serve as a starting point for other future studies, since, in order to understand this phenomenon, it is necessary to carry out several recurrent studies, for different countries, time periods and sectors.

1.2 Structure

The structure of this dissertation is presented as follows:

2 - Literature Review

This chapter is composed by six main topics where: the concept of innovation is briefly described; it is explained the main types of innovation, with more emphasis to marketing innovation; are identified the determinants of innovation, that are responsible for a firm's decision whether innovate or not; based on literature, the relationship between marketing innovation and the other types of innovation is studied; are highlighted the main conclusions from the collected papers; and, taking into account the empirical studies, research hypotheses are formulated.

3 – Data and Methodology

This chapter has three main topics where is: described the Community Innovation Survey (CIS), that consists in the data that will be used in this study; defined and explained the dependent and independent variables that will be used in the model; and described and built the model that will used in this study.

4 – Results

This chapter presents the descriptive statistics of the variables used, the correlation between the dependent variables, a brief description of the outputs presented by STATA and finally the presentation of the results.

5 – Conclusions

This chapter presents the main conclusions, limitations and recommendations for future studies.

2. Literature Review

In this chapter it will be defined more in-depth the basic concepts of innovation, product innovation, process innovation, organizational innovation, and marketing innovation. It will also be defined the innovation determinants and based on collected papers, the relationship between marketing innovation and the different types of relationship will be studied and the hypotheses will be formulated.

2.1 Innovation, the process to transform ideas

Studies regard innovation have gained more relevance in the last years due to their positive effects on companies' performance (Thornhill, 2006; Bowonder et al., 2010).

It is believed that the firsts definitions of innovation were defined in the 1880s, however the literature point to Schumpeter as the main pioneer in the innovation field. For Schumpeter (1934), innovation is what causes major changes in the structure of industries and is the major cause of economic changes. As such, to obtain greater profits, companies should innovate. Schumpeter defined innovation as the development of new products, new raw materials, new processes, new sales methods and opening of new markets (Śledzik, 2013; Fagerberg 2009).

More recently, some authors defend that innovation is the set of tools and strategies responsible for the transformation of knowledge, that can be new or existent, into new products, services or processes (Hauser et al., 2006; Kusiak, 2009; Popa et al. 2010) and is the main responsible for improvements in customer satisfaction, through the increase of products quality and decrease of prices (Hauser et al., 2006).

Innovation should not be confused with creation, which consists of the process of generating new ideas, but innovation implies implementing these ideas to create or improve something (Ilić et al., 2014).

The third edition of OECD's Oslo Manual came with a more general definition, describing innovation as the "implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations." (OECD, 2005, p 49)

Even though the main studies focus mainly on the effects of innovations in private companies, innovation can also occur in a context of sectors that are not market oriented, that is, the public sector (OECD 2005, Bloch 2013; Potts 2010). Public sector is composed by activities financed by public revenues and unlike innovation in the private sector, where innovation is used as a differentiating element in a competitive market, innovation in public sector consists in a kind of monopoly where companies, that are not motivated by profits, try to satisfy its only client, the government (Bloch 2013; Potts 2010; Cankar 2013). However, according to the OECD Oslo Manual, this concept is not widely explored, as there is not sufficient data on how its innovation

processes work. According to the OECD, the study of this type of innovation could give rise to a new manual focused only on the public sector.

According to Oslo Manual there are four different types of innovations: product innovation, process innovation, organizational innovation, and marketing innovation.

Product and process Innovations can be defined as technological innovations, that consist in innovations responsible for the development of new technologies. In other hand organizational innovation and marketing innovations belong to non-technological innovations, that consists in the alteration of business activities through the introduction of new business methods (Schmidt & Rammer, 2007; Mothe & Thi, 2010, 2012). These different types of innovations have different impacts on the company and as such it is important to know how those different types of innovations should be implemented. This way, a framework was developed by OECD and shows the interactions between the different types of innovation within a company, the relationships other companies, the institutional context and market demand. In figure 1 it is represented the framework developed by OECD.

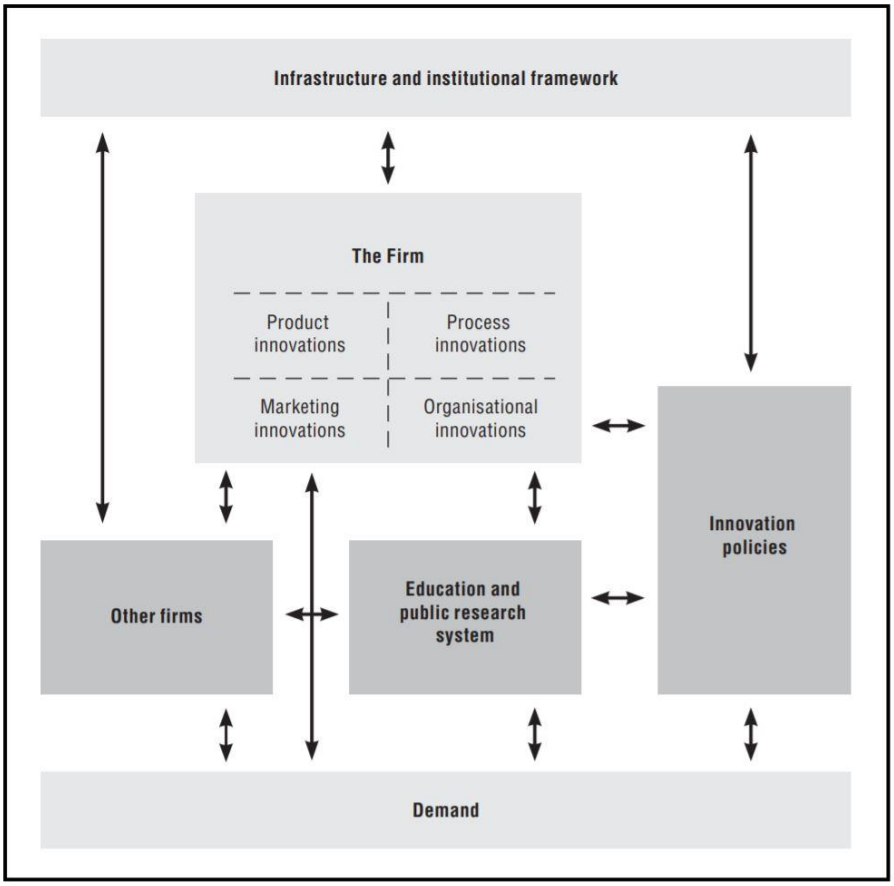

Figure 1: OECD innovation framework (OECD, 2005)

2.2 Types of innovation

2.2.1 Product innovation

Product innovation consists in the total or partial change of the main characteristics and functionalities of a product or service, in order to improve it. This implies create a brand-new product, by changing its main components or raw materials, or change the way an existent product is used. It should be considered that, even though design is part of the process of new products' development, they should not be considered products' innovations if they do not change products' main functionalities or characteristics. On the other hand, service innovations consist in changing or improving how the services are done, by creating a whole new service or increasing the efficiency, accuracy, or speed of an existent one. The changes in terms of product/service innovations can be done by applying new technologies or just by combining different and existent technologies (OECD, 2005).

2.2.2 Process innovation

Process Innovation consists in the introduction of a new, or an improved, production method or logistic channel in order to reduce costs or increase quality related to production and transportation processes. This may imply changing the equipment, software, or techniques for the main activities but also for ancillary support activities like purchasing, accounting, computing, and maintenance (OECD, 2005).

2.2.3 Organizational innovation

An organizational innovation is the introduction of a new organizational method in order to reduce administrative costs, increase productivity (by improve workplace satisfaction) and reduce supply costs. There are three main types of new organizational methods:

- Innovations business practices: introduction of new techniques to improve the flow of knowledge within a company.
- Innovations in workplace organization: introduction of new techniques for decision-making and distribution of responsibilities. This implies changes in centralization or decentralization of hierarchies and decision-making process.
- Innovations in external relations: creating or changing relationships with other organizations (public or private). This implies new types of relationships with other organizations directly or indirectly related to the company's activity. However, those relationships do not include Mergers or acquisition of other firms (OECD, 2005).

2.2.4 Marketing innovation

One of the first definitions of marketing innovation in the literature came in 1960 by Levitt who defined marketing innovation as the introduction of new marketing methods, without specify in what consisted those methods. In 1997, Kim and Mauborgne came with a more complete definition, arguing that marketing innovation could occur in terms of: i) the physical product; ii) all services related to the product's maintenance, distribution and after sales; and, iii) deliver of the product (all the logistic channels responsible to deliver the product to the customer) (Moreira et al., 2012).

The third edition of the OECD's Oslo Manual came out with a more consensual definition, by saying that marketing innovation consists in changes or improvements in terms of product's design or packaging, placement, promotion, or pricing. Many authors, such as Higgins (1995), Ilić et al. (2014), Joueid & Coenders (2018), Shergill & Nargundkar (2005) and Gunday et al. (2011), complemented this and defined marketing innovation as the set of strategies responsible to introduce any change in one of the basic tools of marketing, i.e. the four components of marketing mix (product, price, promotion and placement).

More recently, Bloch & Bugge (2013) introduced a new concept in the field of innovation. Unlike other authors who studied marketing innovation in a context of private sector, Bloch & Bugge 2013 studied the effects of marketing innovation in the public sector and redefined it for communication innovation. This type of innovation only considers the promotion of goods or services and innovative methods that aim to influence the behavior of others. For Bloch & Bugge (2013), public sector organizations do not operate in a competitive market, however promotion is still important. Therefore, they define three classes of communication innovations:

- New methods of promoting the organization or its services.
- New methods to influence the behavior of user.
- First time commercialization of goods or services.

Table 1 - Definitions of marketing innovation in literature

Author	*Definition*
Levitt 1960	Introduction of new marketing methods
Kim and Mauborgne (1997)	Innovation in terms of product, service or product deliver
Higgins 1995	The application of a new marketing method that implies significant improvements in any element of the marketing mix – product, promotion, price, distribution
Chen (2006)	The development of new marketing tools and methods
OECD 2005	The application of a new marketing method for a product or service accounting for significant alterations to any of the following elements: product design or packaging, placement, promotion or price establishing criteria
Vorhies & Harker (1999)	Market research, price establishing strategy, market segmentation, promotions, sales channels and marketing information systems.
Bhaskaran (2006)	Marketing innovation is a type of incremental innovation[1]
Ren et al. (2010)	A way to achieve a sustainable competitive advantage
Bloch and Bugge 2013	Communication innovation is the implementation of a new method of promoting the organization or its services and goods, or new methods to influence the behavior of individuals or others. These must differ significantly from existing communication methods in your organization

Source: Adapted from Medrano-Sáez & Olarte-Pascual (2012)

[1] Incremental innovation consists in continuous improvements of processes, technology, products or services (Windrum & García-Goñi, 2008).

Many authors (Higgins, 1995; Bartoloni & Baussola, 2015; Ren et al. 2010; Rammer et al., 2008; Soltani et al., 2015; Medrano-Sáez & Olarte-Pascual, 2012; Szymańska, 2012; Bhaskaran, 2006; Gunday et al., 2011) are consensual when they state that marketing innovation is the set of tools and strategies that allows firms to obtain competitive advantages, permitting them to differentiate from the competition, attract customers and consequently increase their profits (Bartoloni & Baussola, 2015). In Chinese companies' context, Ren et al. (2010) carried out a theoretical study that showed that companies can obtain a long-term sustainable competitive advantage through the implementation of marketing innovations. However, they indicate that if companies take a conservative approach, that is, if they focus only on products innovations in a way that they ignore totally marketing innovations, they will not be able to take benefits from a competitive environment, which is dynamic and in constant change. Consequently, they do not obtain a sustainable competitive advantage. This idea is complemented by Higgins (1995), that says that any marketing strategy will not help a company to increase its sales if it is not perceived by the customers and marketing innovation is responsible to allow the customers to perceive these strategies.

Some papers highlight the importance of marketing innovation as the only tool for SMEs survival, since they are less costly to implement and allow to reach good results in terms of company's performance (Rammer et al., 2008; Soltani et al., 2015; Medrano-Sáez & Olarte-Pascual, 2012). Bhaskaran (2006) states that SMEs only can get those competitive advantages through this type of innovation, since they are incremental innovations that can be adopted quickly and are independent on companies' knowledges and skills.

Marketing innovations are also important for establishing strong bonds between companies and customers, by satisfying the customer's needs in the best way possible. This consequently will maximize the potential profit taken by each customer and allow customers to become loyal and promoters of the organization. Marketing innovations also allow the creation of new markets, penetration into existent markets, what leads to an increase of the number of sales (Ilić et al., 2014; Gunday et al., 2011). In Polish tourism sector, Szymańska (2012) claimed that, both travel agencies and hotels, have benefited from the introduction of marketing innovations as, for large part of these companies, they brought an increase in profits.

2.2.5 Subtypes of Marketing Innovation

There is a general agreement when defining marketing innovation as the innovation of one, or more, element of the marketing mix (Higgins, 1995; Ilić et al., 2014; Joueid and Coenders, 2018; Shergill & Nargundkar, 2005). The Community Innovation Survey (CIS), that is responsible for collecting data regarding European companies' innovation, also categorized marketing innovation in four different subtypes. Table 2 shows the subtypes of marketing innovation and the definitions according to CIS.

Table 2: Definition of the different types of Marketing Innovation according to the Community Innovation Survey

Marketing Innovation	**Definition according to CIS**
Product Design Innovation	Significant changes to the aesthetic design or packaging of a good or service
Pricing Strategy Innovation	New methods of pricing goods or services
Placement Innovation	New methods for product placement or sales channels
Promotional methods Innovation	New media or techniques for product promotion

Product design Innovation

Product design innovation occur when the changes are made in terms of product packaging, form, or appearance, without change the product's main functionalities. Changes at packaging level aim to improve the protection of the product and helps to facilitate its identification and storage, while changes in terms of form or appearance allow companies to differentiate their product, by making it more appealing, and also increase company's products scope, what allows targeting new markets segments and consequently leads to sales increasing (OECD 2005; Zastempowski & Przybylska, 2017; Ilić et. al., 2014).

Differences between Product Design Innovation and Product Innovation:

Note that this type of innovations is not the same as product innovations, since the objective of product innovation is to improve the product performance what implies the total or partial change of its composition and functionality. There are product and marketing innovations at the same time whenever changes in the functionality of an existent product imply changes in its appearance or packaging, or vice versa (OECD 2005).

Pricing strategy Innovation

OECD defines pricing innovation as the application of a new pricing strategy for a specific good or service in each market. This strategy consists essentially in the determination of a new value for the price that, according to the economic assumptions, results from the equilibrium of the supply and demand. However, setting different prices for different types of clients, i.e., price discrimination should not be considered a Pricing Strategy Innovation. Some pricing innovations

are, for instance, discounts (price or quantity) or online pricing[2] (OECD 2005; Śląskiej, 2017; Ilić et. al., 2014).

Placement Innovation:

Placement Innovation consists in the introduction of new sales channels, i.e., new methods to sell a product or service to the customer. The introduction of franchising, direct sales or exclusive retail sales are examples of Placement Innovations.

Differences between Placement Innovation and Process Innovation:

This type of innovation should not be confused with process innovation, although both deal with product flows, these types of innovation differ from each other. Process innovation, in addition to the introduction of new production techniques, is essentially focused on logistics channels[3], that is, distribution and innovation channels while placement innovations focus only on sales channels without any change in the method in which products are distributed. It is possible that process innovation and marketing innovation occur simultaneously if an innovation is introduced in the distribution channels that also imply a change in the sales channels, or vice versa (OECD 2005).

Promotional methods Innovation:

Innovation of promotional methods is the application of new communication techniques, that facilitate the exchange of information between consumers and companies, so that the flow of products and services between consumers and companies is greater. This is done by promoting the goods or services of a company through various means such as films or TV, celebrities, social networks, or branding[4] (Ilić et al, 2014; OECD 2005).

[2] When the price of the product varies with product features that were selected online.
[3] Product transportation, storage, and handling.
[4] Introduction of a new brand symbol to consumers perceive the product or service differently so that a company enters in a new market or leads an existent one.

2.3 Non-technological Innovation and Technological Innovation drivers

The success, or failure, of innovative strategies is dependent on the determinants. The determinants are internal or external factors that influence the decision to innovate or not. Internal factors determine how the organization moves forward, as an autonomous organizational entity and in response to its external environment. External factors are those that the source is from the outside of the company and usually are not controlled, i.e. the external company environment. (Prokop & Stejskal, 2019).

Many authors agree when they mention that there are several factors that are transversal to all types of innovation, regarding the decision of a firm to introduce innovations or not. This is the case of the competitive environment that a company faces, its internal characteristics and characteristics associated with its employees (Schmidt & Rammer, 2007; Becheikh et al., 2006).

There are other factors that affect whether a firm innovates or not. This is the case of technological activities, where, according to Silva et al. (2014) they are shown to increase the probability of a firm to innovate technologically. However, Carvalho et al. (2013), through data from the Portuguese CIS 4, proved empirically that the introduction of technological activities also increased the propensity of non-technological innovations, namely organizational innovation in specific. This vision is shared by Schmidt & Rammer (2007), that defend the drivers of technological innovations and non-technological innovations are the same.

Table 3 is presented the innovation determinants, based mainly on the study of Schmidt & Rammer (2007), but also on Carvalho et al. (2013) and Silva et al. (2014)

Table 3: Innovation drivers (Adapted from Schmidt & Rammer, 2007)

Category	***Driver***
Competitive environment an enterprise face	-Competitors' behavior is hard to foresee -General demand development is hard to foresee -Threat of entry of new competitors -Short technology cycles -Short product-life cycles -Own products are easily substitutable with those of competitors
Firm's characteristics	-Exports/Internalization -Degree of diversification, measured with through firms' products (share of sales with the largest product/service group) and number of customers (share of turnover with the three most important customers). -Firm belongs to a group of firms
Enterprise's employees	-Number of employees -Share of high-skilled labor -Labor productivity
Technological Activities	-Innovation expenditure on activities related to product and process innovations as a share of turnover -Innovation co-operation with external partners -Intramural (in-house) R&D activities -External R&D activities -Acquisition of machinery, equipment and software -Acquisition of other external knowledge -Training for product and process innovations -Market introduction of product innovations -Other preparations, e.g. procedures and technological preparation to implement new or significantly improved products and processes that are not covered elsewhere

2.4 Relationships between marketing innovation and the other innovation types

There is a relationship between the different types of innovations (Damanpour et al., 1989) and it is important to study this relationship in order to understand how innovation strategies vary in different companies and also why their performance is not steady, even in similar companies. This way, it will be possible to take full advantage from the implementation of innovations strategies and consequently help a company to become more efficient (Joueid & Coenders, 2018).

Even though there is a lack of studies in the relationship between marketing innovation and other types of innovation (Rebane, 2018; Schubert 2010), the existing literature is divided. Some authors defend that marketing innovation allows replacing other types of innovation, others say that they behave as complements (Medrano-Sáez & Olarte-Pascual, 2016; Kijek 2013).

Some authors claim that marketing innovations lead firms to the same result as technological innovation, and therefore, for them, they act as substitutes. Rammer et al. (2008), for German companies in general, and Grimpe et al. (2017), in the context of Germany SMEs, refer that smaller companies that do not invest in internal R&D are more likely to introduce marketing innovations since this type of innovation implies lower costs and allow companies to have the same results as technological innovations. In Victoria (Australia) SMEs seafood retailer's context, Bhaskaran (2006) also defends that smaller companies are more willing to invest in new marketing methods since they do not represent high investments but still, they are a source of competitive advantages that allow smaller firms to compete with greater firms, since its implementation is a driver of both sales' growth and profitability. Grimpe et al. (2017) complement this idea, by saying that a company does not benefit from the implementation of a dual innovation strategy, i.e., that it is not positive to implement both marketing innovations and technological innovations simultaneously, since there is a disynergetic effect between both them, due to complexity of the innovation, what do not allow to take the maximum benefit of each individual innovation.

On the other hand, several authors claim that there is a complementary relationship between non-technological innovation (marketing and organizational innovations) and technological innovation (product and process innovations), and that this relationship extend to marketing innovations. In the context of software companies in Finland, Ali-Yrkkö & Martikainen (2008) showed that the combination of both non-technological and technological innovation was a growth driver for companies. Schmidt & Rammer (2007) also noticed that firms that the implementation of both types of innovation simultaneously allow firms to increase sales, through marketing novelties, and reduce costs. Ali-Yrkkö & Martikainen (2008) and Schmidt & Rammer (2007) argue that those benefits only occur when both technological and non- technological innovations are implemented. For Ali-Yrkkö & Martikainen (2008), this occurs because there is a complementary relationship both types of innovation. Ferreira & Marques (2013) findings for Portuguese enterprises also demonstrated this complementarity, however they found that this relationship is stronger on

services companies, what suggest that the effects of non-technological innovation on technological innovation vary according to the sector in which the company operates.

According to Schubert (2010), for most researchers in management literature, the right approach is to consider that the relationship between marketing innovation and technological innovation is complementary. González-Blanco et al. (2018) emphasizes this idea, by saying that in an era that companies are customer-oriented, marketing resources make it possible to determine what the customer wants in advance, allowing to reduce the failure rate in the commercialization of new products. Similarly, promotion strategies allow to increase companies' sales. Additionally, a new pricing policy (pricing innovations) may require a company to implement process innovations to lower production costs. Therefore, for González-Blanco et al. (2018) is intuitive that the relationships between marketing innovation and product innovation and marketing innovation and process innovations is complementary.

Following the complementary approach explained above, some empirical studies highlight this behavior between innovations. For instance, using data from Luxembourg companies between 2004 and 2006, Mothe & Thi (2010) studied the effects that non-technological innovations have on technological innovations performance and verified the complementarity effect between different types of marketing innovation (product design, pricing and promotion innovations) and technological innovation. However, they stated that this complementary relationship between both types of innovation do not lead to a greater innovative performance (measured by percentage of sales of new products) necessarily. In the tobacco industry, Lewis & Wackowski (2006) found that the huge success, in terms of sales, of Camel, Salem and Kool flavored cigarettes was exclusively due to the fact that this new type of cigarettes (product innovation) was supported by an innovative packaging method (marketing innovation). On the other hand, Kijek (2013) tried to prove complementarity by studying the relationship between technological innovations and marketing innovations (and its subtypes) for manufacturing enterprises in Poland and showed that product innovation and marketing innovation (and its subtypes) have a positive relationship. However, when Kijek (2013) studied the relationship between process innovation and marketing innovation, he found that both have a negative relationship, suggesting that both behave as potential substitutes. To Kijek (2013) this may be justified due to the fact that some marketing innovations have the same purpose as process innovations. Kijek (2013) said that some changes in placement can, sometimes, imply changes in logistics channels. Even though this conclusion of Kijek (2013) is in contrast with most of the authors that defend complementarity, Rebane (2018) points out to the fact that absolute truths do not exist when studying relationships between innovations, meaning that complementary might vary among different countries, sectors and overtime.

The literature on the relationship between marketing innovations and organizational innovations is scarce and there is not much of empirical evidence. The few papers that studied this relationship are divided. On the one hand, Soltani et al. (2015), in the context of small food industry in Iran, showed that marketing innovation and organizational innovations are

complementary. Similarly, Gunday et al. (2011) also verified this complementarity for manufacturing firms in Turkey. On the contrary, González-Blanco et al. (2018) concluded that both types of innovations act almost like as substitutes. However, Damanpour et al. (1989) say that there is a relationship between the different types of innovation, and Ballot et al. (2015) refer that different types of innovation should be implemented simultaneously, it is possible to expect that, potentially, there is a complementary relationship between marketing innovation and organizational innovation (Soltani et. al, 2015).

2.5 Empirical Evidence

The following studies can be consulted in the Appendix, where the main points of the collected studies are summarized.

Several authors defend the complementarity relationship between marketing innovation and the other types of innovations, most of the collected papers had different motivations to carry out their studies, although they converge at one point. Schubert (2010); Mothe & Thi (2010, 2012); Bartoloni & Baussola (2015); Medrano-Sáez & Olarte-Pascual (2016); Joueid & Coenders (2018); Geldes et al., 2017; Soltani et al. (2015); Rebane (2018); Kijek (2013), González-Blanco et al. (2018), Schubert (2010), Gunday et al. (2011) and Aksoy (2017) agree that marketing innovation and the other types of innovations somehow have a positive relationship.

There are more papers focused on the relationship of marketing innovation and product innovation, when comparing to process innovation or organizational innovation. The reason for that is that the success of new products is directly related with marketing methods. Therefore, marketing innovations shape products innovations (Gunday et al., 2011; González-Blanco et al., 2018; Kijek, 2013). González-Blanco et al. (2018) studied the Spanish service sector and highlighted this relationship by proving that there is a positive relationship between marketing innovation and product innovation. This is in line with Mothe & Thi (2010, 2012), Joueid & Coenders (2018) Bartoloni & Baussola (2015), Kijek (2013), Rebane (2018), Schubert (2010), Gunday et al. (2011) and Aksoy (2017) findings.

On the other hand, regarding the other type of technological innovation, process innovation, there are fewer studies that focus on the relationship between marketing innovation and process innovation. Even though many authors defend that non-technological innovations, in general, benefit both types of technological innovations (Ali-Yrkkö & Martikainen, 2008; Schmidt & Rammer, 2007; Ferreira & Marques, 2013), when extend those studies to marketing innovation domain, only Medrano-Sáez & Olarte-Pascual (2016), in a context of Spanish companies, Soltani et al. (2015), for Iran's small companies, Schubert (2010) for German companies and Mothe & Thi (2010), for Luxembourg companies, studied and verified that marketing innovation is positively related with process innovations.

The literature on the relationship between non-technological innovations has not been much explored. Even though there are not many papers that focus on the possible positive relationship between marketing innovation and organizational innovation, Medrano-Sáez & Olarte-Pascual (2016) and Soltani et al. (2015) could get some satisfactory results. They stated that both have a cause-effect relationship. In a similar way, Gunday et al. (2011) refer that organizational innovation is a driver of marketing innovation, reinforcing the signs of a possible positive link between both types of innovations.

It should be highlighted that the results across papers are not uniform. For example, regarding the relationship between marketing innovations and process innovation, Kijek (2013) findings for Polish manufacturing firms are different from other papers that studied different countries, sectors and time intervals and used different approaches, models, and databases. Some papers also point to the differences of results between sectors. In the context of Estonian companies, Rebane (2018), who studied the relationship between marketing innovation and product innovation, has only succeeded in proving their positive behavior in the services sector. Rebane explains that this relationship is stronger in the service industry because incremental innovations and marketing activities are more important to the company's performance in service sector than in the manufacturing industry. This is in line with Mothe & Thi (2012) findings, that marketing innovation has greater impact on products innovations in service sector rather than manufacturing sector. This shows that the relationships positive relationships evidenced by empirical studies should not be generalized as they may vary according to countries, sectors of activity and time (Rebane, 2018; Ferreira & Marques, 2013).

If the studies regarding marketing innovations are limited, the studies that highlight the different types of marketing innovations are even limited. Only Medrano-Sáez & Olarte-Pascual (2016), Mothe & Thi (2012) and Kijek (2013) used the four different types of marketing innovation defined by Oslo Manual as variables. On the one hand, Medrano-Sáez & Olarte-Pascual (2016), could prove a full positive relationship between the subtypes of marketing innovation and organizational innovations, but not for technological innovations, where only product design innovations affected positively technological innovations. On other hand, Kijek could prove this positive relationship only for product innovation but not for process innovation. Finally, Mothe & Thi (2010) only studied and showed that two of the four different types of marketing innovation (product design and placement innovations) increase the propensity to innovate.

Although the different types of marketing innovation are not widely explored in the empirical field, is important to understand how they affect the other types of innovations. Mothe & Thi (2012) stated that the impact of marketing innovation on product innovation was different across sectors because that different types of marketing innovation have on product innovation. According to Mothe & Thi (2012), design and promotion innovations are more relevant to product innovations while placement innovations are more relevant to services innovations.

Medrano-Sáez & Olarte-Pascual (2016), in a context of 2008 economic crisis, also found that the propensity to introduce any one of the different types of marketing innovation across the different

sectors is not the same. According to them, Spanish manufacturing firms tend to innovate more in design and packaging while service firms tend to innovate more in placement, promotion, and pricing. This means that, statistically, there are differences in the probability of a firm to implement marketing innovations.

In terms of databases used, not all the collected empirical studies utilize necessarily the CIS. This is the case of Medrano-Sáez & Olarte-Pascual (2016) and González-Blanco et al. (2018) that resorted to PITEC (Spanish Technological Innovation Panel), that consists in a CIS type database, developed by the Spanish National Statistics Institute (INE) alongside with the Spanish Foundation for Science and Technology (FECYT) and the Foundation for Technical Innovation (COTEC) and which consists of collecting data on innovation activities for Spanish companies. Other studies used own databases, for example, Ali-Yrkkö & Martikainen (2008) studied Finnish software companies by merging data from OSKARI questionnaire and Statistics Finland, while Soltani et al. (2015) used a Census Sampling Method to collect data for Iranian companies.

Considering the empirical studies collected, it is possible to make some observations regarding the similarities of some papers. However, it must be borne in mind that studies can vary from country to country, sector to sector and over time (Rebane, 2018) and therefore the results obtained can be different from the collected papers.

2.6 Hypotheses development

The following hypotheses are shown in figure 2.

Considering the studies of Mothe & Thi (2010, 2012), Joueid & Coenders (2018), Bartoloni & Baussola (2015), Kijek (2013), Rebane (2018), Schubert (2010) and Gunday et al. (2011) that refer that there is a positive effect of marketing innovation and product innovations, and taking into account the information of Kijek (2013), Rebane (2018) and Mothe & Thi (2012) that say that the results may vary from one sector to another, the following hypotheses were defined:

H1: Marketing innovation is positively related with product innovation

H2: Marketing innovation is positively related with service innovation

Soltani et al. (2015), Schubert (2010) and Mothe and Thi (2010) studies allow to expect that there is a positive relationship between marketing innovation and process innovation. Therefore, the following hypothesis was defined:

H3: Marketing innovation is positively related with process innovation

Regarding the study of the relationship between marketing innovation and organizational innovations, the number of empirical studies is much smaller when comparing to the other types of innovation. However, taking into account the studies of Medrano-Sáez & Olarte-Pascual (2016), Soltani (2015) and Gunday et al. (2011), that suggest that there is a potential positive relationship between both types of innovation, the following hypothesis was defined:

H4: Marketing innovation is positively related with organizational innovation

The number of empirical studies that analyze the relation that the four different types of marketing innovation, defined by OECD, have on the other types of innovation is limited. But even though there is not much empirical evidence to support the idea that there is a possible positive relationship between different types of marketing innovation and other types of innovation (technological and organizational), it would be interesting to study how they are related. This way it will be possible to obtain a clearer view and help to fill this gap in the lack of studies on the impact that different types of marketing innovation have on other types of innovation. Thus, taking into account the studies carried by Medrano-Sáez & Olarte-Pascual (2016), Mothe & Thi (2012) and Kijek (2013), that used the different types of marketing innovation as variables, the following hypotheses were defined:

H5: Product design Innovation is positive related with technological and non-technological innovations

H5A: Product Design Innovation is positively related with Technological Innovation

H5B: Product Design Innovation is positively related with Organizational Innovation

H6: Promotional methods Innovation is positive related with technological and non-technological innovations

H6A: Promotional methods Innovation is positively related with Technological Innovation

H6B: Promotional methods Innovation is positively related with Organizational Innovation

H7: Placement Innovation is positive related with technological and non-technological innovations

H7A: Placement Innovation is positively related with Technological Innovation

H7B: Placement Innovation is positively related with Organizational Innovation

H8: Pricing Strategy Innovation is positive related with technological and non-technological innovations

H8A: Pricing Strategy Innovation is positively related with Technological Innovation

H8B: Pricing Strategy Innovation is positively related with Organizational Innovation

	Hypothesis	Dependent variable	Independent variable	Model
Technological innovations	H1	Product innovation	Marketing innovation	Logistic Regression
	H2	Service innovation		
	H3	Process innovation		
Non-technological innovations	H4	Organizational innovation		
Technological + non-technological	H5	Technological and non-technological innovations	Product design innovation	
	H5A	Technological innovations		
	H5B	Non-technological innovations		
	H6	Technological and non-technological innovations	Promotional methods innovation	
	H6A	Technological innovations		
	H6B	Non-technological innovations		
	H7	Technological and non-technological innovations	Placement innovation	
	H7A	Technological innovations		
	H7B	Non-technological innovations		
	H8	Technological and non-technological innovations	Pricing strategy innovation	
	H8A	Technological innovations		
	H8B	Non-technological innovations		

Figure 2: Hypotheses to be tested (Adapted from Moreira et al., 2012)

3. Data and Methodology

In this chapter, the sample data from the Community Innovation Survey 2016 is characterized, which is used to estimate the models, the dependent and independent variables are defined, and the methodology of the logit models is presented.

3.1 Data

To verify the hypothesis defined in the literature review, regarding the relationship between marketing innovation and the other types of innovation (product, process and organizational), it is used data from the CIS for Portuguese companies in the period between 2014-2016 (CIS 2016). CIS is taken every 2 years and is the main statistical survey on innovation for companies. It is mandatory and anonymous for EU Member States and follows the orientations of Eurostat and is based on the tools and guidelines provided by the OECD's Oslo Manual (OCDE, 2005; DGEEC, 2016).

The questions presented in the CIS questionnaire may change over the years if there is a need to improve the quality of the data or to solve problems related with the interpretation of the data. This was the case of CIS 1, which presented subjective questions and did not include many of the recommendations stipulated and defined by the OECD such as the number of technological innovations introduced. This made that many companies were supposedly innovative when they were not. However, the biggest changes in terms of concepts and definitions occurred from CIS 4 (for the periods between 2002 and 2004), in which the ambiguity problems related to the authorship of the innovation and the role of R&D, were solved. The domain of innovations was also extended and sections for non-technological innovations (marketing innovation and organizational innovation) were included in the questionnaire. The questionnaire can be different from country to country since they have the autonomy to add questions to the standard CIS. All changes to the CIS questionnaires are coordinated by Eurostat (Arundel & Smith).

Portugal participated for the first time in this survey for the periods between 1991 and 1992, which corresponds to the first edition of the CIS. Since then, Portugal has participated in all editions (DGEEC, 2016).

Sample Characterization

The data for this study is exclusively from Portuguese companies and it refers to the period between 2014 and 2016 and it was obtained through CIS 2016. According to DGEEC (2016), for the construction of this sample, were validated 6775 responses in 8934 firms, which corresponds to a response rate of 75.8%.

Innovation in Portuguese firms:

Figure 3 allows to observe that, according to the data from CIS, in the period between 2014 and 2016, 69,43% of the firms were innovative. This means that from the 6775 firms, 4704 introduced any type of innovation. Of these innovative firms, 39,57% (2681 firms) introduced marketing innovations, 35,82% (2472 firms) organizational innovations, and 60,43% (4094 firms) any type of technological innovation.

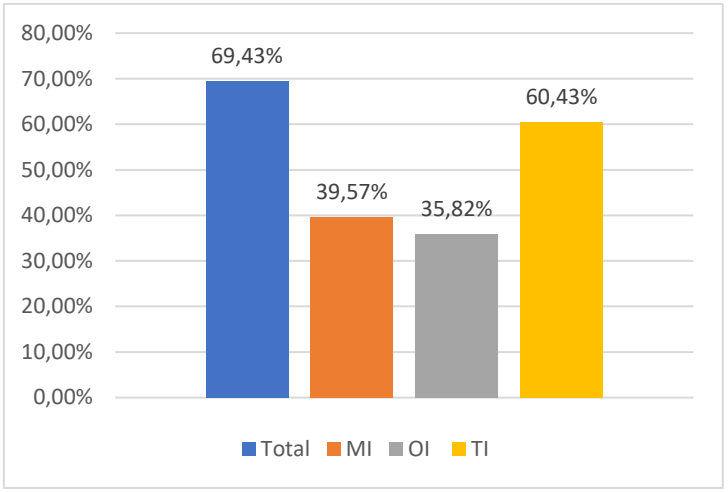

Figure 3: Distribution of innovations (CIS 2016)

Marketing innovation in Portuguese firms:

Focusing in the 2681 firms that introduced marketing innovations, figure 4 shows that 68,82% (1845 firms) of them introduced “promotion innovation”, what makes it the most implemented one. The less implemented one was “placement innovation”, with 33,94% (910 firms).

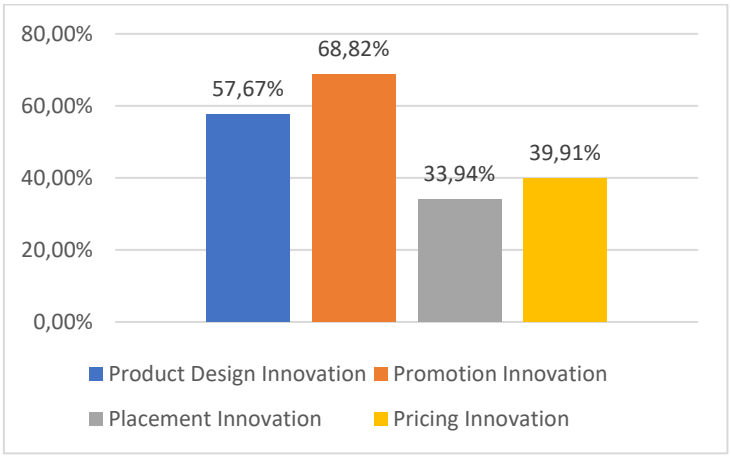

Figure 4: Distribution of marketing innovation subtypes (CIS 2016)

Portuguese firms tend to implement a low number of marketing innovations simultaneously. From the firms that introduced marketing innovations (figure 5), 41,1% (1102) introduced only one type of marketing innovation, 29,54% (792) two types, 17,27% (463) three types and 12,09% (324) implemented all different types of marketing innovations.

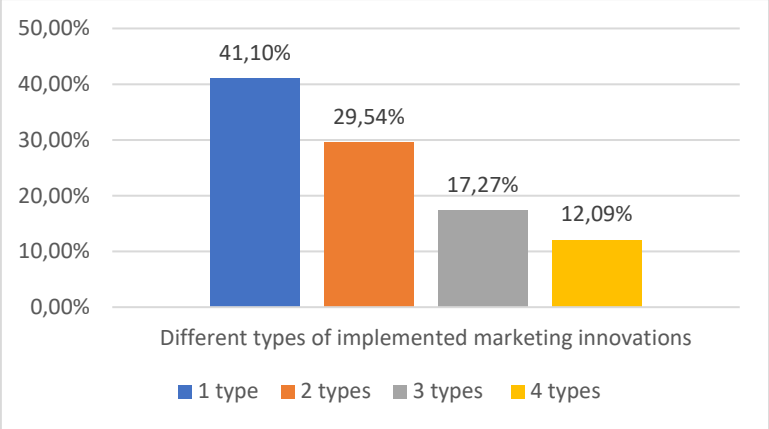

Figure 5: Implemented subtypes of marketing innovations (CIS 2016)

Innovative Portuguese firms by activity sector:

The sample from Portuguese CIS 2016 is not directly divided into service or industry sectors, but rather by a division by economic activities, CAE[5], proposed by the Portuguese National Statistics Institute (INE). Nevertheless, according to DGEEC (2016), firms with CAE number between 05 and 43 belong to the industry sector, while firms with CAE number between 46 to 86 belong to services sector.

Figure 6 shows the distribution of the companies in this sample by the different sectors of activity. From the 6775 companies, 3,732 (55,08%) operate in industry sector while the remain 3,043 (44,92%) operate in services sector. The data provided by CIS, presented in figure 7, in addition allow to observe that, for the period between 2014 and 2016, the companies that operated in service sector were more innovative, in proportion, than firms that operate in industry sector. The companies from this sector also introduced more non-technological innovations (marketing and organizational) while companies from the industry sector introduced more technological innovations.

[5] Classificação Portuguesa das Atividades Económicas, Revisão 3, in www.ine.pt/ine_novidades/semin/cae/CAE_REV_3.pdf

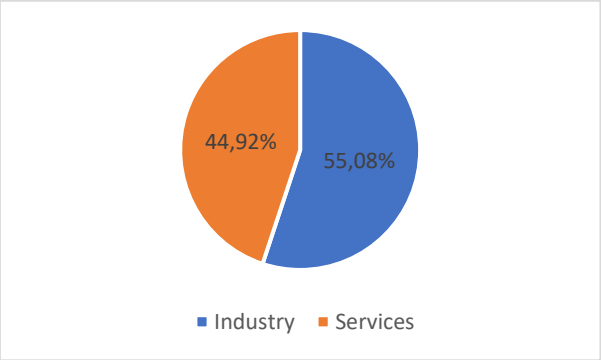

Figure 6: Distribution of companies across activity sectors (CIS 2016)

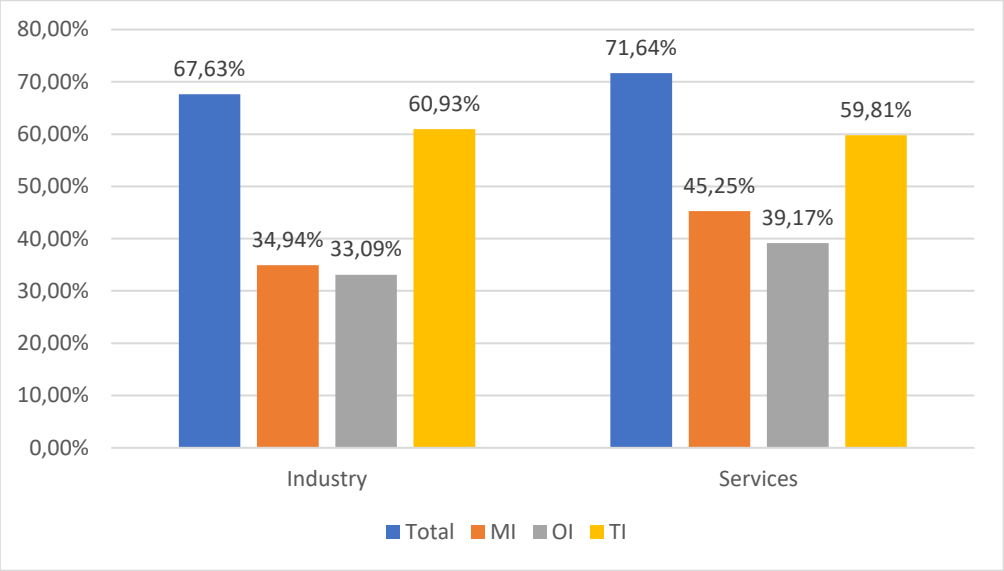

Figure 7: Distribution of the different types of innovation in industry and services sectors (CIS 2016)

Innovative Portuguese firms by size:

Regarding the size of the company, figure 8 presents the distribution of company sizes in Portugal. Figure 9 presents the distribution of the different types of innovation according to firm's size and is possible to observe that, between 2014 and 2016, 82,54% of the firms with 250 employees or more introduced any type of innovation against 73,76% for firms with 50 to 249 employees and 65,99% for firms with 10 to 49 employees. This also happens to the different types of innovation (marketing, organizational and technological). Hence, in percentage, the larger Portuguese firms are, the more they tend to be innovative. This is in line with Medrano-Sáez & Olarte-Pascual (2016), Mothe & Thi (2012) and Schimdt and Rammer (2007) findings.

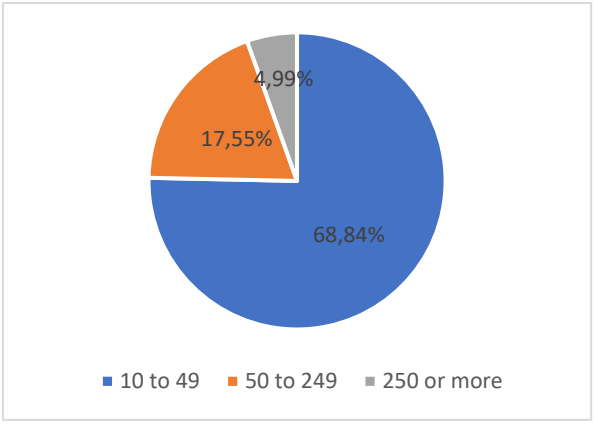

Figure 8: Distribution of company sizes (CIS 2016)

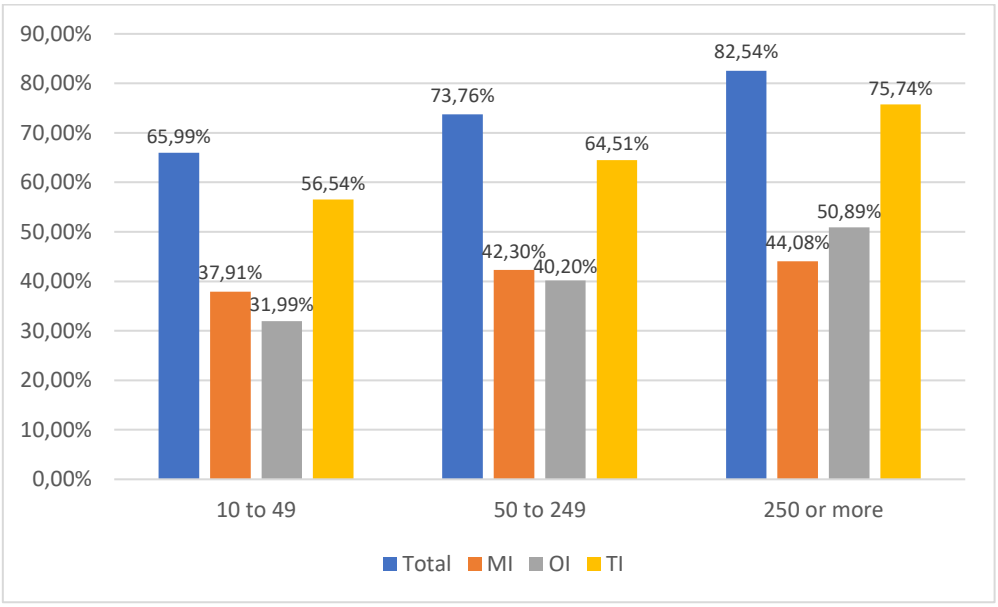

Figure 9: Distribution of the different types of innovation according to firm's size (CIS 2016)

Innovative Portuguese firms by location:

When focus on the prevalence of innovations according to regions (see figure 10), it is possible to observe that, overall, Azores was the most innovating region. 72,7% of the Azores firms introduced any one of the different types of innovation. In terms of technological innovations, the Center was the most innovative region, with 61,8% of the firms introducing technological innovations. In terms of non-technological innovations, Algarve was the most innovative region in marketing (46,8%) while Lisbon in organizational innovation (36,8%).

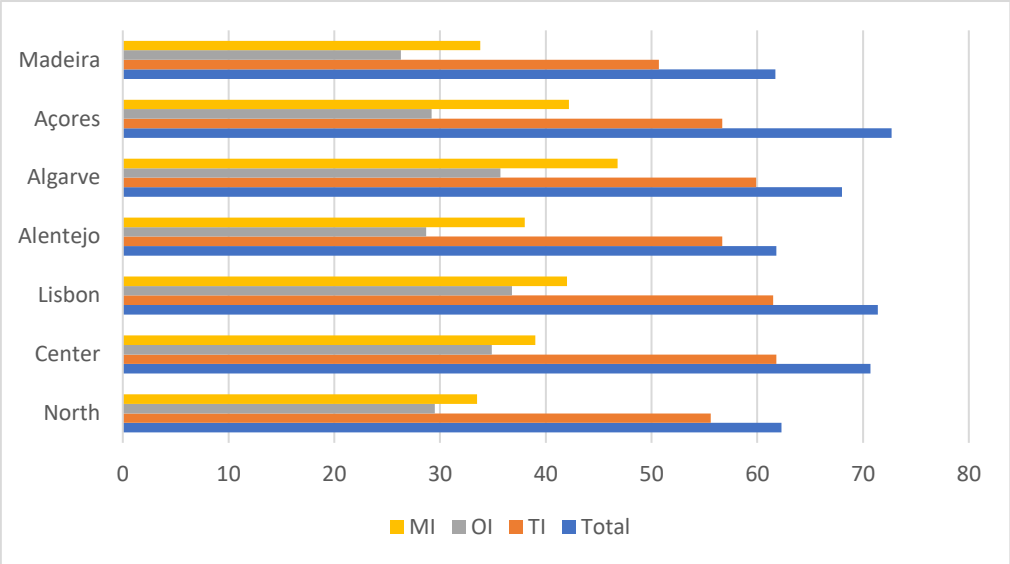

Figure 10: Distribution of the different types of innovation according to regions (Adapted from DGEEC, 2016)

3.2 Variables

The variables were defined according to CIS 2016 questionnaire and were divided in two main groups. Dependent variables and independent variables.

3.2.1 Dependent Variables

It was defined five dependent variables. The first three variables refer to technological innovations (product and process innovation) while the last one refers to non-technological innovation (organizational innovation). To test hypothesis 2, it was necessary to separate service innovation from product Innovation. All dependent variables are dummy and take the value “1” if the referred innovation is implemented and “0” otherwise.

Table 4: List of dependent variables

Dependent Variables	Description
pd_i	Implemented product innovation (Dummy)
sv_i	Implemented service innovation (Dummy)
pr_i	Implemented process innovation (Dummy)
ti	Implemented technological innovation (Dummy)
og_i	Implemented organizational innovation (Dummy)

3.2.2 Independent and control variables

Table 5: List of independent and control variables

Independent Variables	Description
Marketing Innovations	
mi	Implemented Marketing Innovation (No = 0; Yes =1)
mktdgp	Implemented Product Design Innovation (No = 0; Yes =1)
mktpdp	Implemented Promotional Innovation (No = 0; Yes =1)
mktpdl	Implemented Placement Innovation (No = 0; Yes =1)
mktpri	Implemented Pricing Innovation (No = 0; Yes =1)
Control Variables	
Competitive environment	
Sector	Activity sector where a firm operates (Industry, CAE 05 to 43; Services, CAE 46 to 86)
marloc	Operates in the Local Market (No = 0; Yes =1)
marnat	Operates in the National Market (No = 0; Yes =1)
mareur	Operates in the EU Market (No = 0; Yes =1)
maroth	Operates in Other Countries (No = 0; Yes =1)
hcomph	Market competition as a barrier to innovate (Not important=0; Low=1; Medium=2; High=3)
Firm's characteristics	
gp	Part of a group (No = 0; Yes =1)
size_small	Small size firm (From 10 to 49) (No = 0; Yes =1)
size_medium	Medium size firm (50 to 249 employees) (No = 0; Yes =1)
size_large	Large Small size firm (More than 249 employees) (No = 0; Yes =1)
rev	Company Average Revenue (log (revenue))
newmkt	New Product to Market (No = 0; Yes =1)
newfrm	New Product to Company (No = 0; Yes =1)
turnmar (%)	Percentage of New products to market in turnover (%)
turnin (%)	Percentage of New products to company in turnover (%)
Enterprise's employees	
empud	Share of employees with higher education (%)
Technological Activities	
Co (tech)	Cooperation with other firms (No = 0; Yes =1)
innovation_exp (tech)	Total innovation expenditure (log (innovation expenditures))
rrdin (tech)	In-house R&D (No = 0; Yes =1)
rrdex (tech)	Acquisition of external R&D (No = 0; Yes =1)
rmac (tech)	Acquisition of machinery, equipment, software, and buildings (No = 0; Yes =1)
roek (tech)	Acquisition of other external knowledge existent in other organizations (No = 0; Yes =1)
rtr (tech)	Training for product or process innovation (No = 0; Yes =1)
rmar (tech)	Activities to introduce products or services innovations in the market (No = 0; Yes =1)
rdsg (tech)	Internal or external design activities for goods or services (No = 0; Yes =1)
rpre (tech)	Other internal or external activities to implement new or significantly improved products or processes (No = 0; Yes =1)

Marketing Innovation

It was defined five binary variables regarding marketing innovation. The variable “MI” was defined for marketing innovation in general while the other four variables (MI_DSG, MI_PRM, MI_PLC, MI_Prc) were defined for the different subtypes of marketing innovation defined by the third edition of OECD’s Oslo Manual. They have the value “1” if they were implemented or “0” otherwise.

Competitive environment

According to Schmidt & Rammer (2007) and Medrano-Sáez & Olarte-Pascual (2016) the competitive environment that a company faces has a great impact on the decision to innovate. Some authors defend that the lower the market concentration, more a firm is willing to innovate. However, several authors also said that in a highly concentrated market, some companies can be motivated to introduce innovations to compete in the market. Therefore, considering the information provided by CIS 2016, it was defined one variable related to the market concentration (Mkt_Comp) and four variables that describe the type of the market where the company operates, namely, Local (Local_M), National (Nat_M), Europe (EU_M) or other countries (Oth_M).

It was also defined a variable that differentiate the activity sector, due to the fact that, according to Barata & Fontainha (2017) and Medrano-Sáez & Olarte-Pascual (2012) findings, the level of innovation is not uniform across sectors, meaning that some market sectors might be more innovative than others.

Firm’s characteristics

The internal characteristics of a company can influence the competitive environment in which it is inserted and as such they also influence the decision of a company to introduce innovations or not (Schmidt & Rammer; 2007). According to Medrano-Sáez & Olarte-Pascual (2016), a company that belongs to a group of companies (GR), is more likely to introduce innovations. This is complemented by Schubert (2010), Barata & Fontainha (2017), Prokop & Stejskal (2019) and Mothe & Thi (2012), who state that the size of the company (Size) is positively related to the introduction of innovations, that is, the larger the size, the greater the company innovates. It is expected that the number of sales, that can be measured through firm’s average revenue (REV), can increase the propensity of a company to innovate. Geldes et al. (2017) stated that the higher the number of a company sales, the higher the implementation and performance of innovations.

According to Schimdt & Rammer (2007), the degree of product diversification is another characteristic that may influence companies' innovation activities. Theoretically, the greater the company's product diversification, the greater the incentive for a firm to implement product and marketing innovations. For this reason, it was defined four variables to measure products’

diversification. If a company introduced a new product on the market, then the variable “NP_MK” takes on the value "1" and "0" otherwise. On the other hand, if a company introduced an already existent product on the market but new to the company, then the variable “NP_CP” assumes the value “1” and 0 otherwise. The values of the variables “Share_NP_MK” and “Share_NP_CP” correspond respectively to the percentages of products that are new to the market and new to the company. They are expressed in percentage of company's turnover.

Enterprises Employees

The enterprise’s employees are also related to the decision to introduce innovations or not. The number of employees is directly related to the propensity to introduce innovations, since the greater the number of employees, the greater the impact that innovations will have on the company. This way, the company has more incentive to invest in innovations (Schimdt & Rammer, 2007). For this reason, it was defined the variable “Num_Emp”, which consists in the average number of company’s employees.

In addition to the number of employees, their training also affects the probability of a company to introduce innovations. The greater the share of qualified employees, the greater the chances for a company to obtaining external knowledge and thus applying it in its innovation processes, since they can be quite complex (Schmidt & Rammer, 2007; Pippel, 2014; Schubert, 2010). Considering this information, it was defined the variable “Edu_Emp”, which captures the share of employees with higher education.

Technological Activities:

Although it seems quite intuitive that the variables related to technological activities are exclusively linked to technological innovations (Silva et al., 2014), Schimdt & Rammer (2007) and Carvalho et al. (2013) found that these are also positively related to non-technological innovations. It was defined nine variables related to technological activities.

Mothe & Thi (2010), Aboal & Garda (2015), Medrano-Sáez & Olarte-Pascual (2012) and Schmidt & Rammer (2007) stated that the introduction of innovations is directly related to the capacity to carry out R&D activities internally and externally. For this reason, it was defined the variable “In_R & D”, that assumes the value “1” if R&D activities are carried out within the company and “0” otherwise, and the variable “Ext_R & D”, that is equal to “1” if the company acquires external R&D and “0” otherwise. For Schimdt & Rammer (2007), Geldes et al. (2017) and Soltani et al. (2015) cooperating firms tend to be more innovative than non-cooperating firms. For this reason, it was defined the variable CO, that takes the value “1” if the firm cooperated with other companies and “0” otherwise.

In addition to these variables, it was defined six more variables (Acq_Fixed_Capital, Acq_Ext_Knowledge, Training_Act, Market_Act, Desing_Act, Other_Act) related to the technological activities carried out by the company and which assume the value "1" if the company has carried any one of them, internally or externally, or "0" otherwise.

Still on technological activities, the variable "Innovation_Exp" was defined, which consists in the log of the total expenditures in innovation. This is justified by the fact that, according to Mothe & Thi (2010), the performance of innovations is higher for firms that invest in both internal and external R&D. This is in line with Aboal & Garda (2015) and Schimdt and Rammer (2007), that stated that the more innovative is a company the more it has to invest.

3.3 Model

When a dependent variable is of dichotomous nature, that is, it can only assume two values (0.1), then it should be used a specialized binary regression model (Probit or Logit). The logistic regression model Logit is suitable for studying the relationship between the probability of a binary response and explanatory variables (Trueck & Rachev, 2008; Hosmer & Lemeshow, Peng & So, 2002; Pang et. al, 2019). For this reason, the logit model was chosen, since it is intended to study the relationship between the probability of occurrence of a binary variable, that is associated with a type of innovation (technological and organizational), and a binary variable related to the introduction of marketing innovation.

According to Trueck and Rachev (2008), both binary models (probit and logit) come from the same probability function. For both probit and logit, the right side of the following equation results from a transformation of a normal linear regression model:

$$Y = f\left(\beta_0 + \sum_{i=1}^{n} \beta_i x_i\right) \quad (1)$$

The only difference is that in the logit model the distribution is logistic and in the probit model the distribution is normal.

In the Logit logistic regression model, through the weighting of the contribution of independent variables, a Y score is given, in the form of the probability of a positive outcome, that is, P (Y = 1 | x_1, ..., x_k). Let Y_i be the answer of company i regarding the result of the explanatory variables x_{1i}, ..., x_{ki}, in this case described by:

$$Y_i = \begin{cases} 1, \text{if company i implemented any type of innovation (Technological or Organizational)} \\ 0, \ otherwise \end{cases}$$

Then, using logistic regression, the probability of the implementation of any type of innovation, in general, is given by (Trueck & Rachev, 2008):

$$P(Y = 1|x_1, \dots, x_k) = f(x_1, \dots, x_k) = f\left(\beta_0 + \sum_{i=1}^{n} \beta_i x_i\right) \quad (2)$$

In order to guarantee that 0≤P(Y = 1 | x1, ..., xk)≤1, is necessary that the transformation f in equation 2 allows to transform the basic linear regression model into an interval between 0 and 1. This is possible if f is a logistic distribution. Applying a logistic transformation, the following equation is obtained (Trueck & Rachev, 2008; Hosmer & Lemeshow, Peng & So, 2002):

$$P(Y = 1|x_1, \dots, x_k) = \frac{e^{\beta_0 + \sum_{i=1}^{n} \beta_i x_i}}{1 + e^{\beta_0 + \sum_{i=1}^{n} \beta_i x_i}} \quad (3)$$

Where P (Y = 1 | x_1, ..., x_k) can be a value between 0 and 1 and the coefficients β can assume any value between -inf and +inf. The parameter β_0 is a constant value independent from the dependent variables and the parameter β_i is the estimated weights of the variable x_i, since the coefficients of slope explain the how a unit change in x affects the probability function of Y.

Bearing in mind that the logit function is given by $logit\ (x) = log\left(\frac{x}{1-x}\right)$, then, the logit model in generalized form can be defined as (Trueck & Rachev, 2008, Hosmer & Lemeshow, Peng & So, 2002):

$$logit\left(P(Y = 1|x_1, \dots, x_k)\right) = log\left(\frac{P(Y = 1|x_1, \dots, x_k)}{1 - P(Y = 1|x_1, \dots, x_k)}\right) = \beta_0 + \sum_{i=1}^{n} \beta_i x_i \quad (4)$$

For the determination of the parameters of the model, which allow to measure the impact that each independent variable has over the dependent variable, it can be used the maximum likelihood method.

According to Pang et al. (2019) the maximum likelihood estimation is given by:

$$L = \prod_{i=1}^{m} P_i^{Y_i}(1 - P_i)^{1-Y_i} \quad (5)$$

, with, $Y = \begin{cases} 1, \text{ with probability } P_i \\ 0, \text{ with probability } 1\text{-}P_i \end{cases}$

This means that ln(L) is given by:

$$\ln(L) = \sum_{i=1}^{n} [y_i * \ln(P_i) + (1 - Y_i) * ln(1 - P_i)] \quad (6)$$

Then, the coefficients can be determined by solving the following equation system:

$$\begin{cases} \frac{\delta \ln(L)}{\delta \beta_0} = 0 \\ \quad \ldots \\ \frac{\delta \ln(L)}{\delta \beta_n} = 0 \end{cases} \quad (7)$$

Following the models build by Geldes et al. (2017) and Mothe & Thi (2010, 2012), where different control variables were grouped in vectors, it was defined three different groups of control variables:

- A first set of variables is defined by the vector V_1 and is related with the competitive environment an enterprise face. As referred previously, it encompasses the variables "Local_M", "Nat_M", "EU_M", "Oth_M" and "Mkt_Comp"
- It was defined a vector V_2 that is related with the firm's characteristics. This vector includes the variables "GR", "Size", "REV", "NP_MK", "NP_Cp", "Share_NP_MK" and "Share_NP_CP".
- A third vector, V_3, describes the enterprise's employees and is composed by the variables "Num_Emp" and "Edu_Emp".
- The last vector, V_4 is related with the technological activities performed by a firm. This vector encompasses the variables "Innovation_Exp", "In_R&D", "Ext_R&D", "Acq_Fixed_Capital", "Acq_Ext_Knowledge", "Training_Act", "Market_Act", "Desing_Act" and "Other_Act".

The relationship between marketing innovation (and its subtypes) and the other types of innovation will be studied by using the steps of logistic regression (Logit), that were defined above. Following an approach similar to Geldes et al. (2017), the equations that allow to study these relationships are given by:

$$Logit\ (PD\_I) = \beta_1 MI + \beta_2 V_1 + \beta_3 V_2 + \beta_4 V_3 + \beta_5 V_4 + \varepsilon \quad (8)$$

$$Logit\ (SV\_I) = \beta_1 MI + \beta_2 V_1 + \beta_3 V_2 + \beta_4 V_3 + \beta_5 V_4 + \varepsilon \quad (9)$$

$$Logit\ (PR\_I) = \beta_1 MI + \beta_2 V_1 + \beta_3 V_2 + \beta_4 V_3 + \beta_5 V_4 + \varepsilon \quad (10)$$

$$Logit\ (OG\_I) = \beta_1 MI + \beta_2 V_1 + \beta_3 V_2 + \beta_4 V_3 + \beta_5 V_4 + \varepsilon \quad (11)$$

$$Logit\ (TI) = \beta_{1a}MKTDGP + \beta_{1b}MKTPDP + \beta_{1c}MKTPDL + \beta_{1d}MKTPRI + \beta_2 V_1 + \beta_3 V_2 + \beta_4 V_3 + \beta_5 V_4 + \varepsilon \quad (12)$$

$$Logit\ (OG\_I) = \beta_{1a}MKTDGP + \beta_{1b}MKTPDP + \beta_{1c}MKTPDL + \beta_{1d}MKTPRI + \beta_2 V_1 + \beta_3 V_2 + \beta_4 V_3 + \beta_5 V_4 + \varepsilon \quad (13)$$

Where:

- PD_I, SV_I, PR_I, OG_I, TI and MI are the binary variables that represent respectively the introduction of product innovation, service innovation, process innovation, organizational innovation, technological innovation and marketing innovation by a firm;
- V_i represents the vectors of control variables;
- β_i represents the dependent and control variables coefficient;
- ε represents the associated error.

4. Results

4.1 Descriptive statistics

In table 6 is presented the descriptive statistics for all variables[6] that are going to be used in the logistic regression models. It is presented their mean, standard deviation, and the minimum and maximum values that they can take. The number of total observations of all variables is 6766. This number is different from the total sample size (6775) since the variable revenue had less observations due to missing values, i.e., companies that did not answer the referring questions and logistic regression only considers the minimum observations for the analysis. Most of the variables used in this analysis are dichotomous, meaning that they can only take “1” or “0”. The only exceptions are made for the categorical control variable, employee education, that varies from 0 to 6, and for the continuous control variable, revenue, that varies from 5,403 to 22,066 and has a mean and a standard deviation of 14,872 and 1,667 respectively.

[6] There were issues in the estimation of some models on STATA, due to conflicts caused by some non-observations between control and independent variables. This happened because, according to CIS, some control variables related with firm’s characteristics (newmkt, newfrm, turnmar and turnin) required that a firm, had previously introduced a product innovation while some variables related with firm’s technological activities (Co, innovation_exp, rrdin, rrdex, rmac, roek, rtr, rmar, rdsg and rpre) required technological innovations. Therefore, they could not be used as control variables for all types of innovation, hence it was decided to remove them from the analysis.

Table 6 - Descriptive statistics for each variable

	Variable	Mean	Std. Dev.	Min value	Max value
Dependent variables	Product innovation	0,3352	0,4721	0	1
	Service innovation	0,2765	0,4473	0	1
	Process innovation	0,4952	0,5000	0	1
	Organizational innovation	0,3582	0,4795	0	1
	Technological Innovation	0,6043	0,4890	0	1
Independent variables	Marketing innovation	0,3957	0,4890	0	1
	Product design innovation	0,2282	0,4197	0	1
	Promotion innovation	0,2723	0,4452	0	1
	Placement innovation	0,1343	0,3410	0	1
	Pricing innovation	0,1579	0,3647	0	1
Control variables	Sector	0,4492	0,4974	0	1
	Local market	0,8677	0,3388	0	1
	National market	0,8117	0,3910	0	1
	EU market	0,6154	0,4865	0	1
	Other countries	0,4531	0,4978	0	1
	Group	0,2685	0,4432	0	1
	Small size	0,6884	0,4632	0	1
	Medium size	0,1755	0,3804	0	1
	Large size	0,0499	0,2177	0	1
	Revenue	14,8716	1,6665	5,4027	22,0660
	Employees education	2,4125	1,8299	0	6
	Number of observations:	6,766			

Cross-tabulations are a useful descriptive statistic on the relationship between categorical variables. To perform logistic regressions, dependent and independent variables must interact between them. These tables record the frequencies of companies that have the specific characteristics described in the cells of the table. Therefore, it was performed cross tabulations between dependent and independent variables. Tables 7, 8, 9 and 10 provide information about the incidence of marketing innovation in the other types of innovations. Between 2014 and 2016, from all Portuguese companies surveyed, 1446 implemented marketing innovations and implemented product innovations. This value is higher than firms that implemented only marketing innovation and not product innovations (1235) and firms that implemented only product innovations but not marketing innovations (825). This observation is similar for the 1626 firms that implemented both marketing and organizational innovations and for the 1934 firms that implemented marketing innovations alongside process innovations. The only exception is for service innovations where the number of firms that introduced marketing innovations and not service innovations (1475) is higher than the firms that introduced both simultaneously (1206).

Table 7: Cross-tabulation between marketing innovation in product innovation

		Product innovation		
		0	1	Total
Marketing innovation	0	3269	825	4,094
	1	1235	1446	2,681
	Total	4504	2271	6,775

Table 8: Cross-tabulation between marketing innovation and service innovation

		Service innovation		
		0	1	Total
Marketing innovation	0	3,427	667	4094
	1	1475	1206	2681
	Total	4902	1873	6775

Table 9: Cross-tabulation between marketing innovation and process innovation

		Process innovation		
		0	1	Total
Marketing innovation	0	2673	1421	4094
	1	747	1,934	2681
	Total	3420	3355	6775

Table 10: Cross-tabulation between marketing innovation and organizational innovation

		Organizational innovation		
		0	1	Total
Marketing innovation	0	3293	801	4094
	1	1055	1626	2861
	Total	4348	2427	6775

4.2 Correlation between independent variables

Logistic regression does not have a lot of assumptions. For example, it is not necessary that independent variables follow a specific distribution. However, collinearity should be avoided. This means that independent variables should not have a high correlation between them since that could cause problems related with the estimation. Due to the independent variables' nature, where most of them are categorical, it was decided to use Spearman's correlation. Each coefficient varies from 0 to 1, where 0 means complete lack of collinearity and 1 complete collinearity. Correlation coefficients above 50% (or less than -50%) should start to indicate multicollinearity between two variables (Mukaka, 2012; Favero, 2019; Bewick et al. ,2005).

The correlation coefficient matrix is presented in table B, in appendix, and shows that, overall, there is not a high collinearity between the independent variables, in exception to variables related to firm's size and revenue, where the correlation between small size and medium size and small size and revenues is greater than 60%. Therefore, in order to avoid infringing multicollinearity assumption, it was decided to remove the variable small size from the analysis.

4.3 Logistic regression results

Six groups of models were developed to test the eight research hypotheses.

The first four groups of models (models 1 to 8) are composed by every two models and are regarding the first four hypothesis (H1, H2, H3 and H4), where is studied the effects that marketing innovation (independent variable) has in product, service, process and organizational innovation (dependent variables). The methodology is equal for these four sets. The first logistic regression model has only the dependent variable and the control variables whereas the second includes the independent variable.

It was also developed two sets of models (models 9 to 18), that are composed by every 5 models and test the remain hypothesis. The first set is related with the impacts that the different subtypes of marketing innovation (independent variables) have in technological innovation (dependent variables), what correspond to the hypothesis H5A, H6A, H7A and H8A, and the second set is related with the impacts that the different subtypes of marketing innovation have on non-technological innovation. The methodology is also equal for both sets. In first four models was included only one type of marketing innovation and in the last model all were included.

Before the analysis to logistic regression results, is important to explain the STATA's statistical outputs. These are the average marginal effects, p-values, overall p-values, pseudo R^2 and % of correctly classified.

Average marginal effects:

The following logistic regressions results only show the independent variables average marginal effects (and their standard errors) since the analysis of the coefficients (that can be consulted in the appendix) can only indicate the direction of the sign. This means that only shows if the relationship between the dependent and independent variables is either positive or negative, but not in a quantitative way. The average marginal effects thus allow to quantify the magnitude of this relationship and indicate the change that the independent variable causes in the probability of the dependent variable be equal to 1. If the independent variable is continuous, the marginal effect means the impact that the increment of 1 unit has in the probability of the dependent variable, if it is categorical then it means the impact that the change from one category to another has on the dependent variable's probability (Norton et al., 2019).

P-values:

To test the significance level of each independent variable's estimated coefficient, STATA uses the chi-square test, in which a chi-square value is determined by the Wald test, based on variable's coefficient and standard error:

$$Wald\ \chi^2 = \frac{Coefficient}{SE \times Coefficient}$$

Then, that value is compared with the χ2 distribution for one degree of freedom, from which a p value is then taken.

- If the p-value is greater than a certain limit value, α (STATA defines 3 levels of significance: 0.01***, 0.05** and 0.1*), it is said that the coefficient is not statistically significant and the null hypothesis is failed to reject (in a logistic regression, failing to reject the null hypothesis means that there is no relationship between the dependent and independent variable and therefore the estimated coefficient value is null).

- If the p-value is less than α, it means that there is a probability less than α % that the null model is correct, and therefore the null hypothesis is rejected. This means that the coefficient is not zero and consequently there is a relationship between dependent and independent variable.

(Goodman, 1993; Bewick et al., 2005)

Overall P-value:

The overall p-value of the model is a measure of model's goodness of fit and tests all the coefficients simultaneously for the joint null hypothesis, where is assumed that all the regression coefficients are zero (except the constant value). The process to obtain the model p-value is very similar to the one to obtain de p-value for each coefficient, the only difference is that STATA uses the likelihood ratio test, that is based in the difference between the logs of the model's likelihood without the predictor (L_{null}) and the and the likelihood with the predictor ($L_{parameters}$):

$$LR\chi^2 = 2\ln(likelihood\ ratio) = -2 \times \ln\left(\frac{L_{null}}{L_{parameters}}\right) = -2 \times \ln(L_{null} - L_{parameters})$$

The model p-value is then obtained by comparing the LR χ2 value (for the number of degrees of freedom equal to the difference between regression categories and parameters) with a χ2 distribution.

If is statistically significant, then it can be assumed that at least one of the estimated coefficients is different from 0 and therefore the estimated model is valid, since it is better that the null model (Goodman, 1993; Bewick et al. ,2005).

Pseudo R^2:

To test model's goodness of fit in OLS (ordinary least squares) regression, it is used a R2, that explains the variability of the dependent variables, how better is a model with predictors when comparing to the null model and the correlation between predicted values and real values. R^2 varies from 0 to 1 and larger values indicates that the model is well fitted. Due to logistic regression's nature, where the models are estimated using the maximum likelihood iterative method, is not possible to determine a R^2. However, in order to evaluate model's goodness of fit, some pseudo R^2 were developed. These, although similar to OLS regressions R^2, should not be interpreted in the same way, since different pseudo R^2 can give rise to different values (Long, 2001).

The pseudo R^2 presented is McFadden's, also known as "likelihood-ratio index" and compares the null model without parameters and the model with all the parameters. It is defined as:

$$R^2McF = 1 - \frac{ln(L_{parameters})}{\ln(L_{null})}$$

Considering that $\mathrm{LR}\chi^2 = -2 \times \ln(L_{null} - L_{parameters})$, Pituch & Stevens (2016) suggest the following change in McFadden's R^2 equation:

$$R^2McF = 1 - \frac{ln(L_1)}{\ln(L_0)} = \frac{\ln(L_0) - ln(L_1)}{\ln(L_0)} = \frac{\mathrm{LR}\chi^2}{-2 \times \ln(L_0)}$$

This way, McFadden's pseudo R2 can be interpreted as the improvement that the estimated model has when comparing to the null model. Although McFadden (1977) states that a well fitted model presents R^2 values between 0.2-0.4, Pituch & Stevens (2016) defend that it cannot be generalized since these values depend on the context.

% of correctly classified:

Following an approach similar to Medrano-Sáez & Olarte-Pascual (2012, 2016) and Moreira et al. (2012), it was also determined the percentage of correctly classified predictions, that allows to determine the overall model's capacity to predict the outcome, as function of model's sensitivity (correctly classified true positives) and specificity (correctly classified true negatives). STATA allows to obtain the percentage of correctly classified by adjusting both sensitivity and specificity,

therefore, it was selected a percentage where both are maximized, since true positives are just as important as true negatives.

In table 11 is presented the average marginal effects obtained by logistic regression regarding the impacts of marketing innovation in the product, service, process, and organizational innovations. This corresponds to the research hypothesis H1, H2, H3 and H4.

The results of models 2, 4 and 6 suggest that there is a positive relationship between marketing innovation and all the three types of technological innovations. The introduction of, at least one type of marketing innovation increases in 28,1%, 22,9% and 32,6% the probability of a firm to introduce product, service, and process innovations, respectively. This positive relationship extends to non-technological innovations, where, in model 8, is possible to observe that, marketing innovation impacts positively (0.317) in the likelihood of organizational innovation. These results also show that marketing innovation has a higher impact in process innovation, when comparing with the other innovation types and a lower impact in service innovation. All these results were statistically significant, with a p-value inferior to 1.

In terms of goodness of fit, all models have overall p-values of 0, what allows to reject the joint null hypothesis and confirm that they are statistically significant. Even if not in McFadden's range (0.2-0.4), the chi-square test led to Pseudo R^2s greater than 0, around 10% (for the models with the independent variable) what indicates that, according to Pituch & Stevens (2016), these models are better at predicting the dependent variable than a null model. Also, when comparing to the models with only the control variables, is possible to verify that the introduction of the selected independent variables increased the model's prediction capacity, i.e., predict when dependent variable is 0 or 1, since the Pseudo-R^2 values and the correct prediction of outcomes (% Correctly classified) increased.

These models also allow to do an analysis to the innovation drivers, that were defined in the literature review. In terms of control variables, is possible to see that firm's operating sector and market, size and revenues have effects in the likelihood of introducing innovations. Apparently belonging to a group does not have impacts in the decision to introduce innovations, what contradicts the conclusions of Medrano-Sáez & Olarte-Pascual (2016). Lastly, the higher the employee's education, the higher the probability of a firm in introducing innovations.

The results of models 2, 4, 6 and 8 validate correspondingly the research hypotheses H1 (*Marketing innovation is positively related with product innovation*), H2 (*Marketing innovation is positively related with service innovation*), H3 (*Marketing innovation is positively related with process innovation*) and H4 (*Marketing innovation is positively related with organizational innovation*).

Table 11 – Average marginal effects of marketing innovation in the other types of innovation

	Product Innovation		Service Innovation		Process Innovation		Organizational Innovation	
Model	1	2	3	4	5	6	7	8
Variables								
Marketing innovation		0.281***		0.229***		0.326***		0.317***
		(0.009)		(0.009)		(0.009)		(0.008)
Sector	-0.784***	-0.173***	0.087***	0.076***	-0.091***	-0.107***	-0.007	-0.023*
	(0.063)	(0.011)	(0.012)	(0.011)	(0.013)	(0.012)	(0.013)	(0.012)
Local market	0.036	-0.018	0.042***	0.022	0.027	-0.001	0.011	-0.019
	(0.080)	(0.015)	(0.016)	(0.016)	(0.018)	(0.016)	(0.017)	(0.015)
National market	0.379***	0.046***	0.038**	0.014	0.039**	0.009	0.051***	0.016
	(0.083)	(0.016)	(0.016)	(0.015)	(0.017)	(0.016)	(0.017)	(0.015)
EU market	0.314***	0.054***	0.026*	0.019	0.068***	0.059***	0.043***	0.033**
	(0.072)	(0.014)	(0.014)	(0.013)	(0.015)	(0.014)	(0.015)	(0.014)
Other countries	0.572***	0.094***	0.011	-0.007	0.050***	0.024*	0.055***	0.029**
	(0.065)	(0.012)	(0.013)	(0.013)	(0.014)	(0.014)	(0.014)	(0.013)
Group	-0.060	0.001	0.007	0.017	-0.013	0.001	0.011	0.026*
	(0.073)	(0.014)	(0.014)	(0.013)	(0.016)	(0.015)	(0.015)	(0.014)
Medium size	-0.164**	-0.030**	0.011	0.012	-0.018	-0.013	0.006	0.009
	(0.077)	(0.015)	(0.015)	(0.015)	(0.017)	(0.016)	(0.016)	(0.015)
Large size	-0.098	-0.013	0.078***	0.085***	0.058*	0.065**	0.052*	0.063**
	(0.137)	(0.026)	(0.026)	(0.026)	(0.033)	(0.030)	(0.028)	(0.026)
Revenue	0.115***	0.018***	-0.010**	-0.015***	0.034***	0.028***	0.016***	0.009**
	(0.023)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.004)
Employees education	0.123***	0.012***	0.039***	0.029***	0.024***	0.010***	0.045***	0.030***
	(0.018)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)
Observations	6,766	6,766	6,766	6,766	6,766	6,766	6,766	6,766
% Correctly classified	62.67%	70.57%	60.20%	67.47%	59.06%	68.61%	60.79%	71.49%
Chi-squared	635.7	1373	385.7	897.6	370.7	1192	463.1	1435
p-value:	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pseudo-R^2:	0.0737	0.159	0.0484	0.113	0.0395	0.127	0.0525	0.163

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The impacts that the different subtypes of marketing innovation have on technological innovations are quantified in Table 12.

Through the analysis of these models is possible to verify that the inclusion of all subtypes of marketing innovations lead to an increase of technological innovation, being the results statistically significant. On the one hand the analysis of model 9 suggests that product design innovation has a positive impact (0.373) on technological innovation, on the other hand Model 10 indicates that the promotional innovation is positively associated (0.336) with technological innovation. Models 11 and 12 also confirm this positive relationship, indicating that the implementation of both placement and pricing innovations increases the probability of technological innovations in almost 40% and 36% respectively. This means that, when implemented separately, placement innovation (0.398) is the marketing innovation subtype that has higher impacts in technological innovations while promotional innovation (0.336) is the one that has lower effects.

Completely, model 13 shows that, the implementation of product design, promotional, placement and pricing innovations, at the same time, increases in 21.6%, 17.3%, 14.6% and 17.8% respectively, the probability of technological innovations, meaning that, when all subtypes are implemented at the same time, placement innovations (0.146) are not as relevant as when they are implemented individually. On the other hand, product design innovation (0.216) has higher effects in technological innovations. All these marginal effects were estimated for a significance level lower than 1% and therefore the null hypothesis is rejected.

In terms of control variables, the conclusions are the same for the previous models, making only one observation to the fact that size does not seem to have any significance in the decision to implement technological innovations, what goes against the findings of Schubert (2010), Barata & Fontainha (2017), Prokop & Stejskal (2019) and Mothe & Thi (2012).

The LR Chi-square test also led to models p-values of 0, what is an indicator that the models are well adjusted. The correctly classified percentage indicates that models 9, 10, 11 and 12 can predict the outcome (both true negatives and positives) in 65.43%, 65.98%, 64.1%, and 64.59% respectively. Finally, the Pseudo-R^2s in these models indicate that they are better than null models in predicting the outcome. Is also possible to verify that the inclusion of all types of marketing innovation simultaneously (model 18) increased model's fit (higher % correct predict and R^2).

Therefore, the results presented in table 12 allow to confirm the research hypotheses H5A (*Product Design Innovation is positively related with Technological Innovation*), H6A (*Promotional methods Innovation is positively related with Technological Innovation*), H7A (*Placement Innovation is positively related with Technological Innovation*) and H8A (*Pricing Strategy Innovation is positively related with Technological Innovation*).

Table 12 – Average marginal effects of different types marketing innovation on technological innovation

	Technological Innovation				
Model	9	10	11	12	13
Variables					
Product design innovation	0.373***				0.216***
	(0.016)				(0.018)
Promotional innovation		0.336***			0.173***
		(0.013)			(0.016)
Placement innovation			0.398***		0.146***
			(0.023)		(0.025)
Pricing innovation				0.361***	0.178***
				(0.019)	(0.021)
Sector	-0.062***	-0.085***	-0.084***	-0.082***	-0.085***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Local market	0.008	0.001	0.010	0.014	-0.005
	(0.016)	(0.016)	(0.017)	(0.017)	(0.016)
National market	0.035**	0.036**	0.046***	0.044***	0.025*
	(0.015)	(0.015)	(0.015)	(0.015)	(0.014)
EU market	0.046***	0.046***	0.055***	0.055***	0.046***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.013)
Other countries	0.059***	0.055***	0.070***	0.072***	0.049***
	(0.013)	(0.013)	(0.014)	(0.014)	(0.013)
Group	-0.002	-0.000	0.001	-0.004	0.006
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Medium size	-0.017	-0.024	-0.022	-0.015	-0.018
	(0.016)	(0.016)	(0.017)	(0.016)	(0.016)
Large size	0.047	0.022	0.033	0.051	0.040
	(0.032)	(0.032)	(0.032)	(0.032)	(0.030)
Revenue	0.024***	0.026***	0.024***	0.026***	0.022***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Employees education	0.028***	0.026***	0.034***	0.036***	0.023***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)
Observations	6,766	6,766	6,766	6,766	6,766
Correctly classified	65.43%	65.98%	64.01%	64.59%	69.92%
LR Chi-squared	1089	1084	877.6	908.0	1484
p-value:	0.0000	0.0000	0.0000	0.0000	0.0000
Pseudo-R:	0.120	0.119	0.0966	0.1000	0.163

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

In Table 13 is shown the relationship that product design innovation, promotional innovation, placement innovation and pricing innovations and have with organizational innovations.

Model 14 allows to verify that product design innovation impacts positively (0.254) in organizational innovation. Models 15, 16 and 17 show that this relationship extends to the other types of marketing innovation, where the introduction of promotional, placement and pricing innovation correspondingly lead to an increase in 0.307, 0.342 and 0.320 in the probability to introduce organizational innovations. This way, these results show that, when all marketing innovation subtypes are implemented separately, placement innovations (0.342) are the ones that contributes more for the implementation of organizational innovations, what somehow goes according to the trend shown in technological innovations. On the other hand, product design innovations (0.254) are the ones that have lower impacts.

In model 18, where all the four types of marketing innovation are included, is possible to see that their implementation simultaneously enhance organizational innovation in 7.3%, for product design innovation, 18.8% for promotional innovation, 12.8% for placement innovation and 16.1% for pricing innovation, meaning that promotional innovations (0.188) have the greatest impacts and product design innovations (0,073) the lowest.

All the results are statistically significant for a significance level lower than 0.01, and therefore is possible to reject the null hypothesis.

The presented models' (14, 15, 16, 17 and 18) fit, in table 13, are in line with the ones presented in table 12 (models 9 to 13), where the estimated models are better than the null model and the model where all independent variables are included present a better capacity to predict the outcome than the others.

These results allow to validate hypotheses 5B (*Product Design Innovation is positively related with Organizational Innovation),* 6B (*Promotional methods Innovation is positively related with Organizational*), 7B (*Placement Innovation is positively related with Organizational Innovation*) and 8B (*Pricing Strategy Innovation is positively related with Organizational Innovation*).

Table 13 – Average marginal effects of different types marketing innovation on organizational innovations

	Organizational Innovation				
Model	14	15	16	17	18
Variables					
Product design innovation	0.254***				0.073***
	(0.011)				(0.013)
Promotional innovation		0.307***			0.188***
		(0.009)			(0.012)
Placement innovation			0.342***		0.128***
			(0.014)		(0.017)
Pricing innovation				0.320***	0.161***
				(0.013)	(0.015)
Sector	-0.001	-0.027**	-0.027**	-0.025**	-0.035***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Local market	-0.003	-0.015	-0.005	-0.000	-0.021
	(0.016)	(0.016)	(0.016)	(0.016)	(0.015)
National market	0.030*	0.025	0.038**	0.037**	0.016
	(0.016)	(0.015)	(0.016)	(0.016)	(0.015)
EU market	0.035**	0.034**	0.044***	0.044***	0.037***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Other countries	0.039***	0.028**	0.046***	0.048***	0.026**
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Group	0.019	0.024*	0.025*	0.018	0.030**
	(0.014)	(0.014)	(0.014)	(0.014)	(0.013)
Medium size	0.008	0.001	0.005	0.013	0.007
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Large size	0.062**	0.039	0.047*	0.068**	0.052**
	(0.027)	(0.027)	(0.027)	(0.027)	(0.026)
Revenue	0.012***	0.012***	0.011**	0.014***	0.010**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Employees education	0.036***	0.031***	0.039***	0.043***	0.030***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Observations	6,766	6,766	6,766	6,766	6,766
Correctly classified	64.44%	67.37%	64.88%	65.44%	71.03%
LR Chi-squared	885.0	1198	959.0	976.2	1515
p-value:	0.0000	0.0000	0.0000	0.0000	0.0000
Pseudo-R:	0.100	0.136	0.109	0.111	0.172

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The obtained results from all hypothesis testing are summarized in table 13 below:

Table 14 - Summary of empirical results obtained from research hypotheses

Hypothesis	Results
H1: Marketing innovation is positively related with product innovation	Validated
H2: Marketing innovation is positively related with service innovation	Validated
H3: Marketing innovation is positively related with process innovation	Validated
H4: Marketing innovation is positively related with organizational innovation	Validated
H5A: Product Design Innovation is positively related with Technological Innovation	Validated
H5B: Product Design Innovation is positively related with Organizational Innovation	Validated
H6A: Promotional methods Innovation is positively related with Technological Innovation	Validated
H6B: Promotional methods Innovation is positively related with Organizational	Validated
H7A: Placement Innovation is positively related with Technological Innovation	Validated
H7B: Placement Innovation is positively related with Organizational Innovation	Validated
H8A: Pricing Strategy Innovation is positively related with Technological Innovation	Validated
H8B: Pricing Strategy Innovation is positively related with Organizational Innovation	Validated

5. Conclusions

Due to the positive impacts that marketing innovation have on firms, is important to study its relationship with the other types of innovations, in order to take advantage from it (Rebane, 2018; Joueid & Coenders, 2018). To understand its behavior in general it is necessary to perform recurrent studies, in several regions and sectors. However, there are not many studies regarding marketing innovation (Medrano-Sáez & Olarte-Pascual, 2016) and Portugal is not an exception. Therefore, to contribute to this issue, the main objective of this study was to understand how marketing innovation and its subtypes are related with product, process, and organizational innovations.

The literature review carried out allowed to find that there is a division between authors in the how marketing innovation and the other types of innovations are related. While some authors defend that they might be complementary, others defend that they might act as substitutes. Nevertheless, the majority of the collected studies were more favorable to a complementary relationship between marketing innovation and both technological (product and process) and non-technological innovations (organizational), being Schubert (2010); Mothe & Thi (2010, 2012); Bartoloni & Baussola (2015); Medrano-Sáez & Olarte-Pascual (2016); Joueid & Coenders (2018); Geldes et al., 2017; Soltani et al. (2015); Rebane (2018); Kijek (2013), González-Blanco et al. (2018), Schubert (2010), Gunday et al. (2011) and Aksoy (2017) some of the main studies on it.

To study the relationship between marketing innovation and product, process and organizational innovations, in Portuguese companies, it was used data from the Portuguese Community Innovation Survey for the periods between 2014 and 2016 – CIS 2016 and it was performed a logit model since all the dependent variables were dichotomous (i.e., only assume two values). The results obtained through logistic regression models performed, suggest that overall, Portuguese companies, from 2014 to 2016, presented a positive relationship between the introduction of marketing innovations and product, service, process, and organizational innovations.

This study should not be considered conclusive, but a starting point to future and recurrent works, for different countries, sectors, and time intervals in order to understand the concept of marketing innovation in its entirety. This work can also help managers and administrators in making decisions regarding the introduction of innovations, given the benefits in obtaining competitive advantages through its implementation.

5.1. Relationship between marketing innovation and the other types of innovation

When focused only on the relationship between marketing innovation and product innovation, the results obtained are in line with the researches of Mothe & Thi (2010, 2012), Joueid & Coenders (2018), Bartoloni & Baussola (2015), Kijek (2013), Rebane (2018), Schubert (2010) and Gunday

et al. (2011). It must be reminded that, the decision of including service innovation was based in the division proposed by CIS, where product innovation is also composed by service innovation and the collected studies do not consider that division, therefore there is no basis for comparison the obtained results.

When and about process innovations, the obtained results are in line with the findings of Soltani et al. (2015), for Iran, Schubert (2010), for Germany, and Mothe and Thi (2010), for Luxemburg. Portuguese companies that introduced marketing innovations were more willing to introduce process innovations.

Regarding the relationship between marketing innovations and organizational innovations, this work could obtain the same conclusions as the studies developed by Medrano-Sáez & Olarte-Pascual (2016), Soltani (2015) and Gunday et al. (2011), where is hinted that there is a positive relationship between both.

For different types of marketing innovations, it was shown that product design innovation, promotional innovation, placement innovation and pricing innovation are positively related with both technological and organizational innovations. However, these results cannot be compared since the literature centered in the effects of different types of marketing innovation is somehow limited. The only existing studies that separated marketing innovation in different subtypes and expected their positive relationship with both technological and non-technological innovations, could not prove it at all. Medrano-Sáez & Olarte-Pascual (2016), showed a fully positive relationship between the types of marketing innovation and organizational innovations, but a very limited for technological innovations, where only product design innovations affected positively technological innovations. Kijek (2013) on the other hand showed the existence of a positive relationship between the subtypes of marketing innovation and product innovation but not for process innovation. Finally, Mothe & Thi (2010) only used two of the four different types of marketing innovation (product design and placement) as variables.

However, once again, it should be reminded that the conclusions from this study should never be generalized. Since, according to Rebane (2018), there is not absolute truths when studying the interactions between innovations, since their relationship may vairy across countries, sectors, and overtime, what can potentially explain the discrepancies with other authors, that defend a substitute relationship between marketing innovation and the other types of innovations such as Rammer et al. (2008), Grimpe et al. (2017) and Bhaskaran (2006).

5.2 Limitations

In carrying out this study, some limitations were found. The first one, that was already pointed out in results' presentation, is associated with the not inclusion of some control variables for this analysis. Some variables related to firm's characteristics and technological activities were excluded from this analysis, since, according to CIS, those variables were dependent in the

implementation of or product or technological innovations. Due to this condition, it was not possible to use all innovation drivers, defined in the literature review, as control variables, which, in a certain way, could somewhat limit the predictive capacity of the models.

There was also a limitation regarding to the direction of the analysis, since this study only explores the effect of marketing innovation in the other types of innovation, but not the effect of the other types of innovation in marketing innovation.

The use of a database already defined as CIS also has some drawbacks. The utilization of just a yes or no question may not be the best way to measure the implementation of marketing innovation, since, as defined in the literature review, it is a vast concept and as such a binary question may be ambiguous for a company to answer. The used data correspond only to the period between 2014 and 2016, so the time frame effect on the relationship between marketing innovation and other types of innovation could not have been studied. Also, these relationships are made only for all sectors, in general, without distinguishing between the services and industry sectors. According to Rebane (2018), the results vary over time and across sectors.

Finally, although the estimated models have a high rate of correct predictions, the values of pseudo-R^2 were between 10% and 17%, which according to McFadden, indicates that they are close, but not in the optimal adjustment range. This may be due to the fact that most variables are categorical (Laitila, 1993).

5.3 Recommendations for future work

For the future continuity of this study, suggestions are left, which respond eventually to the limitations faced in its performance.

In future researches, it would be interesting to see if the relationship between marketing innovation and the other types of innovation is positive in both directions, that is, if marketing innovation increases the propensity of the other types of innovation and vice versa. This way, it would be possible to have an in-depth knowledge of how marketing innovations behave and as such, it would be possible for companies to take greater advantage of the benefits of their implementation.

Finally, following an approach like Rebane (2018) and Pinto et al. (2019), in order to understand how the time frame effect influences the relationship between marketing innovation and other types of innovation, more CIS waves can be used.

Also, to try to understand how these interactions vary across different sectors, it can be done an aproach similar to Mothe & Thi (2010), where separated analysis is made for both services and industry sectors. This knowledge could give an idea of how results can vary over time and sectors.

These recommendations have as objective bring new proof on how the introduction of marketing innovations can affect the decision of a firm to innovate.

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Appendix

Table A - Relevant collected studies summarized

Author	Objective	Variables	Model	Sample	Conclusions
Moreira et al. (2012)	Identify the drivers of marketing innovation	**Dependent Variables:** Marketing Innovation **Independent Variables:**Technological capacity; R&D Activities (Internal R & D activities; External acquisition of R & D; Acquisition of machinery, equipment and software; Acquisition of other external knowledge; Completion of technical preparations and procedures); Marketing activities	Logistic Regression Model	CIS 4 (Portugal)	R&D internal activities, acquisition of machinery, equipment and software, acquisition of other external knowledge and performance of other procedures, and marketing activities are Marketing Innovation drivers.

Barata & Fontinha (2015)	Identify the determinants of process and product innovation in the European Construction Sector	**Dependent Variables:** Product innovation; Process innovation; Product and process innovation **Independent Variables:** Firm Size; Regional Client; National Client; Client; Supplier; Business growth; Leader as goal; Follower as goal; Macroeconomic context; Science & Technology context	Probit Model	e-Business Survey of the European Commission	The results show that the sector of construction innovates. Suppliers and growth of business are the determinants that most contribute to product and process innovation. Firm size is more relevant for process innovation than for product innovation. Companies that focus in international markets tend to innovate more than ones that focus on local and regional markets.

Pinto et al. (2019)	Understand how country's economic slowdown impacts product and process innovation	**Dependent:** Breadth of innovation activities implemented; Introduction of product innovation; Introduction of process innovation **Independent:** -Structural (Sector; Group; External Markets; Total turnover; Evolution of turnover; Company has 25% or more of employees with a HE degree) -Innovative Efforts (External sources of innovation; Cooperation with external entities in innovative activities; Total investment in innovative activities; Public funding for innovation) -Strategic (Strategy and goals focused on developing new products and new markets; Strategy and goals focused on reducing costs, increasing market share, increasing turnover, and market flexibility)	Cross-Sectional Approach and Probit Model	CIS 2008	Knowledge exploration is important for product innovation. Exploitation is a strong determinant for process innovation. Size, market knowledge sources and public funding for innovation are positively associated with product and process innovation in the peak of the crisis. Innovation might be important to mitigate the effects of economic crisis and boost recovery.
Medrano-Sáez & Olarte-Pascual (2016)	Analyze the determinants of marketing innovation for Spanish SMEs Study the relationship between marketing innovation and product, process and organizational innovations	**Independent:** Product Innovation; Process Innovation; Organizational Innovation; Group; Employment Women; Market (Local, national, EU, other); Training; Public Financing; Company Class **Dependent:** Marketing Innovation	Logistic Regression (4 models that considers each of the 4 variables as response variable)	PITEC database	The introduction of new marketing methods have a positive impact in product, process and organizational innovation. Also, all these methods have positive impact in the propensity to introduce marketing innovations.

Schmidt & Christian Rammer (2007)	Study the relationship between non-technologiacal (organizational and marketing) and technological (product and process) innovations. (1) The effects of non-tech innovation in firm's performance and in the success of product and process innovation. (2)	**Dependent:** Non-Technological Innovation **Independent:** Technological Innovations **Control:** Competitive environment an enterprise faces; Firm's characteristics; Enterprise's employees; Technological Activities	Bivariate Probit Model (1) and Tobit Model (2)	CIS 4 (Germany)	The determinants of technological innovations are similar to non-technological innovations. The introduction of non-technological innovations increase the propensity of technological innovations. The combination of non-tech innovations (product and marketing) with technological innovations (product and process) allow profit increase.
Prokop & Stejskal (2019)	Identify the determinants that influence technological innovations activities of SMEs in three German industries (Electrical, Chemical and Pharmaceutical and the Metal Industry).	**Dependent Variable:** Product Innovation; Process Innovation **Independent Variables:** Activities and expenditures for technological innovations; Acquisition of machinery, equipment, software & buildings; Acquisition of existing external knowledge; Training for innovative activities; Market introduction of innovations; Sources of information and co-operation for product and process innovation; Methods for maintaining or increasing the competitiveness of product and process innovations	Logistic Regression	CIS 2010-2012 (Germany)	The determinants across the three industries are the same, however they variate according to the size of enterprise: -Small enterprises should focus on In-house R&D and acquisition of capital assets -Medium size enterprises should concentrate on training for innovative activities Also, the determinants analyzed have different impacts depending on the type of technological innovation, having a greater effect on product innovations.

Rebane (2018)	Study the complementary relationship between product innovation, marketing innovation and cooperation with clients. Complementary relationship in terms of its effect on the firm's total factor productivity.	**Variables:** Innovation (Marketing, product, process and organizational); Total Factor Productivity; Cooperation with clients; Size; Capital intensity; Location; Group	Heckman Selection Model and Supermodularity Approach	CIS and Estonian Business Register data from the years 2002–2012	Product innovation and marketing innovation are complementary in the service industry, but in manufacturing industry there is lack of evidence for the effect of complementarity. Cooperation with clients showed inconclusive complementarity test results involving both innovation types (product and marketing) in both industries (service and manufacturing).
Grimpe et al. (2017)	Understand the relationship between investments in marketing and tech innovations and new product's performance	**Dependent Variable:** New product's share of sales (Product's Perfromance) **Control Variables:** Share non-innov. market; Firm age; Nº of employees; Share exports of sales; Location; Group; Process innovation; Herfindahl index; Ind. Marketing int; Med. high-tech manuf; High-tech manuf.; Distributive services; Knowledge intens. in services; Technological services **Focal Variables:** Share innov. mark. exp. of sales; Share R&D exp. of sales; Interaction innov. mark	Tobit Model	Mannheim Innovation Panel (MIP) - German contribution to the Community Innovation Survey (CIS) of the European Union	Investments in marketing innovation have at least the same potential to create superior innovation performance as R&D investments do. Technological Innovation and Marketing Innovation have a negative interaction, which suggests that some firms do not benefit from pursuing a dual strategy.

Bartoloni & Baussola (2015)	Analyse the relationship between product and marketing innovation in manufacturing (food industry)	**Dependent Variables:** Marketing Innovation; Product Innovation **Indenpendent Variables:** Marketing Innovation; Product Innovation; Market Power; Firm's debt structure; Firm's financial condition; Firm's leverage **Control variables:** Firm size; Sectors; Geographical areas.	Bivariate Probit Model	CIS (2006-2008) and AIDA database (financial data)	Marketing Innovation has greater impacts product innovation than the contrary.
Mothe & Thi (2010)	Studied the effects of non-technological innovations on technological innovation	**Dependent variables:** Technological Innovations; Percentage of the total turnover from innovations **Independent Variables:** Organizational innovations; Marketing Innovation; R&D intensity; Sources of information; Business Practices; Innovation Barriers **Control:** Size; Sector	Tobit Model	CIS4 (Luxemburg)	Marketing innovation has a positive impact in the implementation on both product and process innovations. Both product design and placement innovations increase the propensity to innovate
Kijek (2013)	Understand how the: 1) Introduction of technlogical innovations 2) The Investment in technological innovations Affects the probability to introduce the different types of marketing innovations	**Dependent Variables:** Marketing Innovation (the 4 different types) **Independent Variables:** Technlogical Innovations (1st Part); Investments in technological innovations (2nd Part)	Logistic Regression	Polish CIS 2008-2012	1) Product Innovations act as complements of Marketing Innovations (and its subtypes) while Process Innovations act substitutes of Marketing Innovations. 2) Marketing innovations benefit only from investments in the acquisition of external knowledge and marketing expenses for new and improved products.

Medrano-Sáez & Olarte-Pascual (2016)	Identify marketing innovation determinants before and after the economic crisis and compare the propensity to innovate in marketing in both periods	**Dependent Variable:** Marketing Innovation **Independent Variable:** Company's Characteristics; Product Innovation; Process Innovation; Organizational Innovations	Binomial Logit Model	PITEC database	Companies in Spain were less likely to implement marketing innovations before the economic crisis than after in 2010 than in 2008. Largers enterprises were more likely to innovate in marketing. The introduction of Marketing Innovations was increased for companies that also implemented organizational innovations. In contrast to 2008, in 2010, the enterprises that were most likely to innovate in marketing were those that exported to countries outside the European Union.
Medrano-Sáez & Olarte-Pascual (2012)	Understand what factors influence the firm's decision to innovate in marketing	**Dependent Variable:** Marketing innovation **Independent Variables:** Firm's size; Business Activity; Exports; Technological Capacity; Belongs to a group	Logit	PITEC database	Size, Business Activity, Export Tasks and Internal R&D appear to be the features that make companies more inclined to innovate in marketing.
Soltani et al. (2015)	In Iran's Small Food Industries context: 1) Study the relationship between Marketing Innovation and Product and Organizational Innovations 2) Identify the Determinants of Marketing Innovation	**Dependent Variable:** Marketing innovation **Independent Variables:** Product Innovation; Organizational Innovation; Factors Influencing Marketing Innovation	Stepwise Regression Model	Census Sampling Method	There is a cause-and-effect relationship between both product and organizational innovations and marketing innovation.

Joueid & Coenders (2018)	Understand the impact that marketing inoovation have on Product innovation performance	**Dependent:** Product innovation performance (New products to market; New products to firm) **Independent:** Marketing Innovation; Cooperation (suppliers, customers, competitors); Source of information (consultants, universities); Technological activities **Control variables:** Firm size; Sectors; Geographical areas	Orthogonal Coordinates For Compositional Regression	CIS Spain 2012	Marketing innovation is a driver of both sales of new-to-the-firm and new-to-the-market products.
Geldes et al. (2017)	Understand how technological and non-technological innovations are related to innovative performance of firms and to their propensity to innovate	**Dependent:** Company innovative performance (Share of new products to market); Technological innovations; Non-technological innovations **Independent:** Technological innovations; Non-technological innovations **Control:** Group; R&D; Cooperation; Patent; Export; Sales	Logit	"Seventh Survey of Innovation in Companies" of the Ministry of Economy of Chile	Product innovation is related to innovative performance across manufacturing, services and agriculture sectors for Chile companies. Organizational innovation is only related to innovative performance in the manufacturing sector.
Mothe & Thi (2012)	Study the impacts that non-technological innovation strategies have on technological innovation	**Dependent:** Likelihood of innovation or product innovation; New Products turnover **Independent:** Non-technological innovation; R&D; Barriers to innovate; Formal protection (patents and trademarks); Cost-push; Demand-pull **Control:** Size; Sector; Group; Foreign ownership	Logit model and Probit model	CIS 2006 (Luxembourg)	Marketing and organizational innovations significantly increase the likelihood of innovation, but not the commercial success of innovation.

Yrkkö & Martikainen (2008)	Study the effects that both technological innovations and non-technological innovations have on firm's growth	**Dependent:** Growth of net sales **Independent:** Non-technological innovations; Technological innovations; R&D intensity; Size; Age	Evans' model	OSKARI questionnaire and data from and Statistics Finland	The introduction of technological innovations alongisde with non-technological innovations favours company's growth. Technological Innovations and nonTechnological innovations are complementary.
Aksoy H (2017)	How marketing innovation and product innovation influence market performance of SMEs. How innovation culture impact on both marketing and product innovation in SMEs. To what degree do marketing and product innovation interact with each other to affect the market performance of SMEs.	Variables: Innovation culture; Marketing Innovation; Product Innovation; Market Performance	Structural Model	Own survey	Innovation culture is a driver increases the propensity of both marketing innovation and product innovation. Marketing innovation is positive related with relationship with both product innovation and market performance. Product innovation has a significant and positive relationship with market performance
Ferreira & Marques (2013)	Analyze the impact of non-technological innovations (both organizational and marketing innovations) on technological innovations for the industry and services sectors.	**Dependent:** Probability to innovate; New products turnover **Independent:** Marketing Innovation; Organizational Innovation; Size; Group; R&D intensity	Probit model	CIS 2008 (Portugal)	Marketing innovations are important for the services companies. The effects of the non-technological innovation, on the technological innovation vary according to the sector at which the company performs. Services companies are more likely to innovate.

Table B: Spearman's correlation matrix for independent variables

	mi	*mktdgp*	*mktpdp*	*mktpdl*	*mktpri*	*sector*	*marloc*	*marnat*	*mareur*	*maroth*	*gp*	*s_small*	*s_medium*	*s_large*	*rev*	*empud*
mi	1															
mktdgp	0,6719	1														
mktpdp	0,7557	0,4928	1													
mktpdl	0,4866	0,3659	0,4453	1												
mktpri	0,5350	0,3522	0,3575	0,4413	1											
sector	0,1048	0,0315	0,1253	0,1141	0,0865	1										
marloc	0,0516	0,0359	0,0508	0,0432	0,0345	0,0228	1									
marnat	0,1330	0,1190	0,1241	0,0717	0,0588	0,0586	0,0367	1								
mareur	0,0947	0,1018	0,0896	0,0261	0,0157	-0,1558	-0,0830	0,3509	1							
maroth	0,1469	0,1421	0,1533	0,0689	0,0428	-0,0538	-0,0116	0,2848	0,5391	1						
gp	0,0536	0,0454	0,0592	0,0253	0,0027	0,1183	-0,0865	0,0590	0,0221	0,0989	1					
s_small	-0,0511	-0,0537	-0,0708	-0,0419	0,0123	0,0399	0,0806	-0,0586	-0,1522	-0,1928	-0,3715	1				
s_medium	0,0266	0,0252	0,0331	0,0201	-0,0089	-0,0003	-0,0423	0,0345	0,0909	0,0996	0,1627	**-0,6853**	1			
s_large	0,0210	0,0159	0,0410	0,0310	-0,0175	-0,0133	-0,0451	0,0286	0,0473	0,0652	0,2590	-0,3409	-0,1057	1		
rev	0,1231	0,1063	0,1210	0,0829	0,0240	0,1205	-0,0715	0,1782	0,2379	0,2856	0,4865	**-0,6302**	0,3851	0,3377	1	
empud	0,2060	0,1632	0,2212	0,1319	0,0765	0,3623	-0,0293	0,1610	0,0623	0,2273	0,3506	-0,2030	0,0834	0,0881	0,3506	1

Table C: Estimated coefficients for the effects of marketing innovation in the other types of innovation

	Product Innovation		Service Innovation		Process Innovation		Organizational Innovation	
Model	1	2	3	4	5	6	7	8
Marketing innovation		1.567***		1.324***		1.564***		1.736***
		(0.060)		(0.060)		(0.057)		(0.058)
Sector	-0.784***	-0.965***	0.462***	0.438***	-0.385***	-0.516***	-0.031	-0.126*
	(0.063)	(0.068)	(0.063)	(0.065)	(0.056)	(0.061)	(0.059)	(0.064)
Local market	0.036	-0.102	0.225***	0.128	0.113	-0.003	0.052	-0.105
	(0.080)	(0.085)	(0.086)	(0.090)	(0.075)	(0.079)	(0.078)	(0.085)
National market	0.379***	0.254***	0.200**	0.082	0.164**	0.042	0.240***	0.088
	(0.083)	(0.087)	(0.083)	(0.087)	(0.070)	(0.075)	(0.078)	(0.084)
EU market	0.314***	0.304***	0.138*	0.112	0.288***	0.282***	0.199***	0.179**
	(0.072)	(0.076)	(0.073)	(0.076)	(0.064)	(0.068)	(0.069)	(0.075)
Other countries	0.572***	0.522***	0.058	-0.043	0.211***	0.117*	0.258***	0.158**
	(0.065)	(0.069)	(0.069)	(0.072)	(0.061)	(0.065)	(0.064)	(0.070)
Group	-0.060	0.006	0.035	0.096	-0.055	0.005	0.053	0.145*
	(0.073)	(0.077)	(0.073)	(0.077)	(0.068)	(0.072)	(0.069)	(0.075)
Medium size	-0.164**	-0.167**	0.057	0.072	-0.075	-0.064	0.027	0.048
	(0.077)	(0.082)	(0.081)	(0.085)	(0.073)	(0.078)	(0.075)	(0.081)
Large size	-0.098	-0.071	0.416***	0.489***	0.247*	0.314**	0.244*	0.343**
	(0.137)	(0.145)	(0.141)	(0.148)	(0.138)	(0.146)	(0.133)	(0.144)
Revenue	0.115***	0.102***	-0.052**	-0.085***	0.146***	0.134***	0.074***	0.050**
	(0.023)	(0.024)	(0.023)	(0.024)	(0.021)	(0.023)	(0.022)	(0.023)
Employees education	0.123***	0.067***	0.206***	0.170***	0.101***	0.047***	0.210***	0.167***
	(0.018)	(0.019)	(0.018)	(0.019)	(0.016)	(0.017)	(0.017)	(0.018)
Constant	-3.162***	-3.215***	-1.467***	-1.259***	-2.749***	-2.755***	-2.736***	-2.714***
	(0.324)	(0.343)	(0.330)	(0.345)	(0.303)	(0.321)	(0.310)	(0.337)
Observations	6,766	6,766	6,766	6,766	6,766	6,766	6,766	6,766
Correctly classified	62.67%	70.57%	60.20%	67.47%	59.06%	68.61%	60.79%	71.49%
LR Chi-squared	635.7	1373	385.7	897.6	370.7	1192	463.1	1435
p-value:	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pseudo-R:	0.0737	0.159	0.0484	0.113	0.0395	0.127	0.0525	0.163

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table D: Estimated coefficients for the effects of the types marketing innovation in technological innovations

	Technological innovation				
Model	9	10	11	12	13
Product design innovation	1.823***				1.119***
	(0.086)				(0.094)
Promotional innovation		1.650***			0.894***
		(0.075)			(0.084)
Placement innovation			1.886***		0.756***
			(0.116)		(0.130)
Pricing innovation				1.722***	0.924***
				(0.098)	(0.108)
Sector	-0.302***	-0.416***	-0.400***	-0.391***	-0.441***
	(0.060)	(0.061)	(0.060)	(0.060)	(0.063)
Local market	0.041	0.005	0.048	0.069	-0.026
	(0.080)	(0.080)	(0.079)	(0.079)	(0.082)
National market	0.170**	0.178**	0.216***	0.212***	0.128*
	(0.072)	(0.072)	(0.072)	(0.072)	(0.074)
EU market	0.224***	0.227***	0.263***	0.263***	0.241***
	(0.068)	(0.068)	(0.067)	(0.067)	(0.070)
Other countries	0.291***	0.268***	0.334***	0.343***	0.256***
	(0.066)	(0.066)	(0.065)	(0.065)	(0.068)
Group	-0.007	-0.001	0.006	-0.019	0.029
	(0.074)	(0.074)	(0.072)	(0.073)	(0.076)
Medium size	-0.085	-0.120	-0.104	-0.071	-0.092
	(0.080)	(0.080)	(0.079)	(0.079)	(0.082)
Large size	0.230	0.109	0.154	0.245	0.208
	(0.154)	(0.155)	(0.153)	(0.153)	(0.158)
Revenue	0.117***	0.126***	0.116***	0.125***	0.115***
	(0.023)	(0.023)	(0.023)	(0.023)	(0.024)
Employees education	0.137***	0.126***	0.160***	0.172***	0.121***
	(0.018)	(0.018)	(0.017)	(0.017)	(0.018)
Constant	-2.235***	-2.296***	-2.174***	-2.403***	-2.261***
	(0.326)	(0.327)	(0.322)	(0.324)	(0.336)
Observations	6,766	6,766	6,766	6,766	6,766
Correctly classified	65.43	65.98%	64.01%	64.59%	69.92%
LR Chi-squared	1089	1084	877.6	908.0	1484
p-value:	0.0000	0.0000	0.0000	0.0000	0.0000
Pseudo-R:	0.120	0.119	0.0966	0.1000	0.163

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table E: Estimated coefficients for the effects of the types marketing innovation in organizational innovations

	Organizational innovation				
Model	14	15	16	17	18
Product design innovation	1.271***				0.406***
	(0.063)				(0.075)
Promotional innovation		1.619***			1.044***
		(0.061)			(0.072)
Placement innovation			1.731***		0.714***
			(0.082)		(0.096)
Pricing innovation				1.623***	0.895***
				(0.075)	(0.086)
Sector	-0.004	-0.144**	-0.137**	-0.127**	-0.194***
	(0.061)	(0.063)	(0.062)	(0.062)	(0.066)
Local market	-0.017	-0.079	-0.026	-0.002	-0.117
	(0.080)	(0.083)	(0.081)	(0.081)	(0.084)
National market	0.149*	0.130	0.190**	0.188**	0.090
	(0.080)	(0.082)	(0.080)	(0.081)	(0.084)
EU market	0.177**	0.182**	0.223***	0.221***	0.208***
	(0.071)	(0.073)	(0.072)	(0.072)	(0.075)
Other countries	0.194***	0.147**	0.230***	0.242***	0.142**
	(0.066)	(0.068)	(0.067)	(0.067)	(0.070)
Group	0.097	0.128*	0.128*	0.093	0.167**
	(0.071)	(0.073)	(0.072)	(0.072)	(0.075)
Medium size	0.042	0.007	0.028	0.068	0.039
	(0.077)	(0.080)	(0.078)	(0.078)	(0.082)
Large size	0.311**	0.205	0.237*	0.343**	0.290**
	(0.137)	(0.141)	(0.138)	(0.137)	(0.144)
Revenue	0.058***	0.065***	0.054**	0.069***	0.054**
	(0.022)	(0.023)	(0.023)	(0.023)	(0.024)
Employees education	0.180***	0.162***	0.199***	0.216***	0.168***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.019)
Constant	-2.588***	-2.668***	-2.520***	-2.840***	-2.630***
	(0.321)	(0.330)	(0.324)	(0.325)	(0.340)
Observations	6,766	6,766	6,766	6,766	6,766
Correctly classified	64.44%	67.37%	64.88%	65.44%	71.03%
LR Chi-squared	885.0	1198	959.0	976.2	1515
p-value:	0.0000	0.0000	0.0000	0.0000	0.0000
Pseudo-R:	0.100	0.136	0.109	0.111	0.172

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1