Eco-innovation determinants in Portuguese companies

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"...anything that we can't do forever is by definition unsustainable."

David Attenborough 2020, *A Life on our Planet*.

Abstract

It is still not prevalent in the scientific community enough consensus around the relation between eco-innovation and business activities. After developing the concept of innovation and trying to identify the main eco-innovation determinants in a Portuguese business context, this dissertation analyzes a set of variables found during the literature review that through econometric models, establishes the significance relationships with 10 types of eco-innovation. Thus, this study uses a sample composed of 7,083 Portuguese companies that responded to the Community Innovation Survey CIS2014, which is outlined by guidelines from the Oslo Manual and supported by EUROSTAT. After developing the study's hypotheses, the logit model was chosen to analyze the determinants of eco-innovation. Results indicate *Local and regional markets*, *Financial performance*, *Market available partners*, *Institutional partners*, *Company size* and *Manufacturing sector* have a positive relationship with eco-innovation. On the other hand, *Other countries markets* showed a negative relationship. As a follow-up, a similar analysis was performed for two group types of eco-innovation since CIS separates it by benefits happening within the company and benefits happening while consumption by the end user. For the first case the same results were evidenced. As for the second case a lot of dissimilarities appeared with only Market available partners and Institutional partners getting significant relations with the second group type of eco-innovation, revealing outside benefits to be harder to achieve.

Key words: Eco-innovation, CIS 2014, Determinants, Innovation, Portugal, Environmental innovation.

Resumo

Ainda não é prevalente na comunidade científica um consenso suficiente à volta das relações entre eco-inovação e atividades empresariais. Depois de desenvolver o conceito de inovação e ao tentar identificar os principais determinantes da eco-inovação num contexto empresarial português, esta dissertação analisa um conjunto de variáveis encontradas durante a revisão de literatura que através de modelos econométricos, estabelece as relações de significância com 10 tipos de eco-inovação. Desta forma, este estudo usa uma amostra composta por 7,083 empresas portuguesas que responderam ao Inquérito Comunitário à Inovação CIS2014, que é delineado com indicações provenientes do Manual de Oslo e apoiado pelo EUROSTAT. Depois das hipóteses de estudo, o modelo logit foi o escolhido por forma a analisar os determinantes da eco-inovação. Os resultados indicam que *Mercados locais e regionais*, *Performance financeira*, *Parceiros disponíveis no mercado*, *Parceiros institucionais*, *Dimensão da empresa* e *Sector da industria* têm uma relação positiva com eco-inovação. Por outro lado, os *Mercados de outras regiões* revelaram uma relação negativa. No mesmo seguimento, uma análise semelhante foi realizada para dois grupos de tipos de eco-inovação, uma vez que o CIS a separa por benefícios que acontecem dentro da empresa e benefícios que acontecem durante o consumo do consumidor final. Para o primeiro caso, os mesmos resultados foram evidenciados. No segundo caso, surgiram muitas diferenças, com apenas *Parceiros disponíveis no mercado* e *Parceiros institucionais* a obter relações significativas com o segundo grupo de tipos de eco-inovação, revelando que os benefícios externos são mais difíceis de alcançar.

Palavras-chave: Eco-inovação, CIS 2014, Determinantes, Inovação, Portugal, Inovação ambiental

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O mais sincero Obrigado.

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CAE – Classificação Portuguesa das Atividades Económicas

CAE Ver.3 – Classificação Portuguesa das Atividades Económicas, Revisão 3

CIS – Community Innovation Survey

CIS2014 – Community Innovation Survey referring to the period of 2012 to 2014

DGEEC – Direção-Geral de Estatísticas da Educação e Ciência

EI – Eco-innovation

EMS – Environmental Management Systems

ETS – Emissions Trading System

EU – European Union

EUROSTAT – European Union statistical office

MLE – maximum likelihood estimation

OECD – Organization for Economic Co-operation and Development

R&D – Research and Development

SME – Small and Medium Enterprises

UN – United Nations

1 Introduction

In the following section the general topic of discussion will be stated along with some background on innovation and the scope of the research. It will be presented the motivations and the main objectives coupled with the dissertation's structure.

UN Intergovernmental Panel on Climate Change (IPCC) last report divulged in October 2018, points out for the fast increase in global greenhouse gas emissions. Global temperatures are in risk of reaching the dreaded 1.5ºC above pre-industrial times as short as 2030, elevating sea levels, worsening desertification, decreasing food supplies, and aggravating climatic events (Masson-Delmotte et al., 2018). Furthermore, the scarcity of natural resources, the disorderly growth of world population and the intensity of environmental impacts emerge on the conflict of sustainability in the economic and natural systems. Modern society is concerned with the implications that climate changes have been resurfacing, making the environment a strategic and urgent topic to take into consideration by companies, governments, and organizations (Aragón-Correa & Sharma, 2003; García-Pozo et al., 2016). This global concern drove humanity to engage on developing mechanisms that promote the adoption of better technologies while walking towards sustainability (Hall & Helmers, 2010). New methods and approaches have a fundamental importance on reformulating corporate practices to reduce the negative impacts of business decisions. Conscious innovation is the way to go. Nowadays it is known as eco-innovation, and it has become an important tool to counter the industry sector adversities (Masson-Delmotte et al., 2018).

The topic of innovation is still very much associated to the evolution of economy as Schumpeter (1934) framed initially. Something new applicable to commercial or industrial use was the focus, and in today's standards it clearly lacks a modern refreshment. One way of updating business practices is by following the three pillars of sustainability, in this sense not only should economic viability be the center but also environmental protection and social equity (Ryszko, 2016). Another way is to further increase the number of studies to reach a baseline supported by evidence that provides mitigating solutions on environmental problems.

Eco-innovation composes any innovation that as a result provides measurable advancements towards sustainability. Although the term has existed since 1996 it has not been subject to as many researches as the other types of innovation (Fussler & James, 1996; He et al., 2018). Many research finds contradictory results when it comes to the determinants of eco-innovation. Some authors stablish relations showing significant connections with eco-innovation, such as geographical reach, or subsidies but others challenge those impressions by reaching to opposing results (del Río et al., 2017; Horbach, 2008; Horbach et al., 2013; Jové-Llopis & Segarra-Blasco, 2018). This indicates the need to expand on the subject because depending on the use case, circumstances, and time period the outcomes might get unclear (Borghesi et al., 2012; Cainelli et al., 2012; De Marchi, 2012; Doran & Ryan, 2012; Ghisetti et al., 2015; Horbach & Rammer, 2018).

1.1 Problem Statement

The primary purpose of this dissertation is to identify and analyze the main determinants of eco-innovation in the context of Portuguese companies. In what way do company characteristics like its structure, business plan, performance, market choices, and others influence their capacity to innovate while obtaining environment benefits? Furthermore, it is also a goal of investigation to leave a record, for future work comparisons, of the Portuguese economy for the ability to read the progress it has had combating outdated polluting practices over the years. For without knowing history it becomes harder to conduct well fitted solutions.

Current and still prevalent environmental anthropogenic problems namely the climate change, melting of the ice caps, ozone layer depletion, deforestation, and so forth have an urgency for change. The implementation of innovations with ecological awareness is the process bringing the much-needed theory into practice.

1.2 Motivation for this Study

It is consensual that the Earth is heating up. Scientific expert's data point out for the frequency of severe episodes and the intensification of destructive weather conditions (Gil & Bernardo, 2020). The motivation for writing this study relates to the rapid propagation of pollution and its effects which are transversal to every living being on our planet. Although it is not a novel subject, and in recent years we started seeing a movement towards reducing the carbon footprint, there is still a clear scarcity of action on applying an assiduous commitment to the environment. Which constitutes an evident research opportunity to vindicate.

Companies face climate change challenges and the necessary transition to a low-carbon economy as something unavoidable and in need of immediate action. Since there is a very defined tempo trajectory to carbon neutrality. It brings an additional relevance and research interest to help decision makers achieve that goal, which in Portugal's case will hopefully materialize by the year of 2050 (Gil & Bernardo, 2020).

1.3 Dissertation Structure

This dissertation is organized according to five chapters: the *Introduction* to the document, the *Literature Revision* where a collection of papers give context to the research topic, the *Data and Methodology* which presents the data and the analysis methods, the *Results* with the findings of the model used, and finally the *Concluding Remarks* summing up the purpose of the dissertation. In greater detail each section, after the current one, is comprised by:

Literature Revision

Begins with a description of the concept of innovation and its evolution from the founding father Joseph Schumpeter's definition to the most modern approach. Following the same thought process the eco-innovation definition is given as well as a characteristic solution often used in its application and some implementation barriers. Afterwards an empirical research is presented which in turn offer the basis for the formulation of hypothesis.

Data and Methodology

Sets the data from the Community Innovation Survey 2014 by showcasing the sample to better understand the information relative to different aspects like the observation and collection period, dimension, amongst others. Afterwards the dependent, independent and control variables are characterized and put into context following the literature revision research. Finally, the statistical model is presented in the expanded form of equations.

Results

Outlines the results obtained from the logit model together with a primary analysis of the findings and a summary of the validation and rejection of hypotheses.

Concluding Remarks

Draws the final conclusions of the results within context of the variables proposed, some limitations of the study, and suggestions to complement further work.

2 Literature Revision

In essence, this chapter gathers the knowledge evolution on the concept of innovation. It will show the predominant authors' perspectives and their notions on the subject which, as it will be further disclosed, is a difficult term to define, complex to analyze, and has diversified approaches. The constant introduction of new variables over time, such as ecology, is the main reason for a continuous development of the notion for innovation. This concept was introduced by Schumpeter in his theses, one of the first economists to consider technological innovation as a development catalyst (Pavel et al., 2015). To this end, the present work addresses the principles of sustainable development and innovation as premises for the sustainable development of companies in future markets.

2.1 Innovation

Joseph Alois Schumpeter is considered one of the first minds to study and characterize innovation, thus a unique perspective comes with its recognition along with a speck of the evolution on economic development.

In Schumpeter's point of view, innovation is the key strategic stimulus to economic development. The author defines it as something new applicable to commercial or industrial usage. Therefore, new products; new methods/processes of production; new commercial, business, or financial structures; and new markets are all examples of innovation (Schumpeter, 1934). Although a nearly century-old definition, Schumpeter's thesis merit attention today since it contains remarkable and farsighted visions on economic theory that recent authors such as (Aghion & Festré, 2017; Balbino et al., 2020; Florida et al., 2017; Malerba & McKelvey, 2020; Pedersen, 2020), and others have been using as a starting point for their work in innovation. Even the European Commission acknowledges his value by naming and organizing the yearly *Schumpeter Innovation in Enterprise* lecture, one of the highlights of the SME Assembly[1].

The term has suffered changes over time, having numerous definitions used in different contexts. More recently, the member states of the European Union brought together a consensus to define innovation research in a broader and more suitable way. In this manner, the Oslo Manual was created, gathering a common methodological approach of what is the perception for innovation in the 21st century. Based on it, CIS accomplished a series of surveys modeled to output information of activities on an enterprise level by sector and region. Moreover, in the 2016 CIS edition, innovation is characterized by "the implementation of a new or significantly improved product (good or service), process, new marketing method, or new organizational method in business practices, workplace organization or external relations"[2].

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[1] https://blogs.ec.europa.eu/promotingenterprise/tag/schumpeter/, consulted on 19/10/2020.
[2] https://ec.europa.eu/eurostat/cache/metadata/en/inn_cis10_esms.htm, consulted on 19/10/2020.

Important to mentioned the idea Schumpeter (1934) defended about innovation and invention. Both are very close to each other; however he states they are not interdependent and not the same. Innovation remits to the introduction of something disruptive and applicable to commerce, while invention is portrayed as irrelevant if unable to be put to practice. This notion induces to what nowadays can be perceived as the advantage that firms have by continuously innovate. This strategy leads to long term improved capabilities in a competitive environment (Popadiuk & Choo, 2006).

As mentioned above the Oslo manual written by OECD jointly with Eurostat, gave a generalized description addressing a disparity the previous edition had. This time the manual separates innovation in four main areas: product, process, marketing and organizational. On the other editions the definition revolved around the first two mentions, with organization appearing only in the annexes and marketing not being addressed at all. The manual also brought clarity on a misconception created when the combination of product and process innovation were simply referred as technological innovation, which was interpreted solely as “using high-technology plant and equipment”. As a result, many services companies thought they did not meet the requirements to be called innovators, although they were within the status. Nowadays it is understood that technological innovations are comprised of product and process innovations and as for the other half, marketing and organizational innovation are put together as non-technological innovation. Subsequently the new improved generalized description says innovation is 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). Whether the novelty comes from another company or is completely new, it is considered innovation if it is developed from the first time by its practitioner (Kemp & Pearson, 2007).

The innovation status depends on the engagement of a firm in an observation period that is advised to go from one to three years. In the course of the assessment an innovation activity can (1) produce and conclude an innovation, (2) be the continuing work of an innovation to be implemented, or (3) be the complete abandonment of an innovation project (OECD/Eurostat, 2018). Four outcomes emerge from the previous points as shown in table 1 below.

Table 1 - Innovative and Innovative-active firms

		The firm has innovation activities in the observation period	
		Yes	No
The firm has at least one innovation in the observation period.	Yes	The firm has one or more innovations and is therefore an innovative firm. Innovation activities can be ongoing, put-on hold, completed, or abandoned.	It might occur if all work to introduce an innovation was conducted before the observation period.
	No	The firm is innovation -active, but has not introduced an innovation, although it might do so in the future.	The firm is not engaged in innovation activities and has not introduced any innovations in the observation period.

(adapted from (OECD/Eurostat, 2018)

These outcomes in turn characterize the firm status in three possible definitions:

- Innovative firm – one reporting at least one innovation inside the time frame, engaging or not with external sources.
- Non-innovative firm – one that does not report any innovation inside the time frame.
- Innovation-active firm – one processing at least one innovation inside the time frame, with the intent of carrying out a new or improved product/service for later usage. Firms can have this status along with one of the previous two at the same time.

By own judgment it would be beneficial to add a restriction to the innovation-active firms regarding consecutive classification on this status, since a firm never getting to innovative status might indicate it is not performing well, thus being non-innovative.

It is important to view innovation as a system, meaning there should be a combined effort to enhance product and processes along with the marketing and organizational structure. Linkages and diffusion cannot succeed without one another (OECD, 2005). A company to succeed should follow some type of framework capable of guiding the creation and diffusion of innovation. The process to better identify crucial factors and predict faults is accomplished by metrics of quality and stage control (Rothwell, 1994). The figure 1 below portrays a model from the perspective of a company.

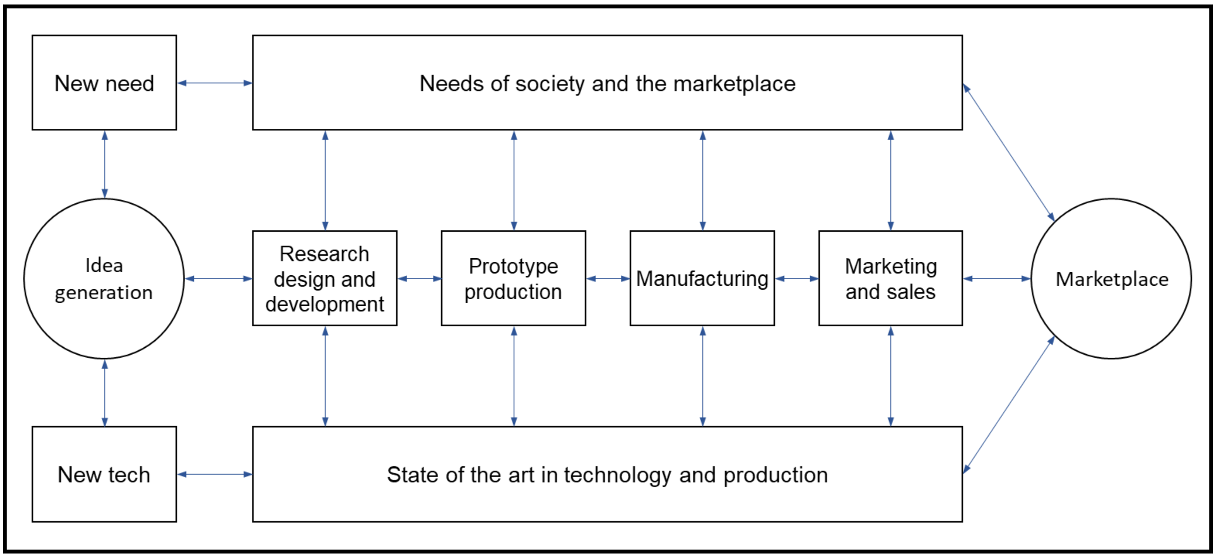

Figure 1 - Innovation process model
(adapted from Rothwell, 1994)

2.1.1 Schumpeter Thesis

Joseph Schumpeter came to disrupt the neoclassic economic theories of his time. He defended that the market should not be viewed as having a static behavior (*Walrasian Equilibrium*[3]) but a continuous evolutionary one with an interdependent system. Following the lifecycle of firms and industries, Schumpeter acknowledges their permanent change driven by what he designated as the never-ending creative destruction. The process by which the old is replaced with the new, in waves of improved innovations, happening randomly dispersed trough time. This is the main culprit for economic change from Schumpeter's point of view. However, he argues that minor changes do not necessarily produce innovations, instead he asserts innovations as new combinations carrying interference to the current economic equilibrium. To make his point he sets the example of adding as many mail-coaches as desired to a system, it will never be a railroad. Changes to the system do not appear on their own, they are thrived by entrepreneurs with new ideas and ambitions. These innovators gain the advantage of monopolizing a section of the market, although it is briefly. Second movers are attracted to the success of the profits and start imitating, which Schumpeter explains as competitive capitalism. This leads to the decay of the primary innovation, but also to the opportunity of creating new ones i.e., technology advancement. As for government intervention, there is no clear structured map to follow. Schumpeter claims that any policy to be implemented must not hinder the natural development of innovation. The choice of said policies also needs careful attention, since copying what resulted in other markets might not prosper on the targeted one due to particular circumstances and needs (Hospers, 2005; Schumpeter, 1934).

[3] Walrasian Equilibrium – the representation of an aggregated market, rather than a collection of individual markets. https://www.investopedia.com/terms/g/general-equilibrium-theory.asp, consulted on 28/10/2020

2.1.2 Product Innovation

Product innovation is described as a noteworthy improvement to a good or service, or the introduction of an entirely new one, both cases with regards to their functional characteristics. On this matter may be included incremental or disruptive technical improvements, or even different materials applied for more user-friendly experience. To be considered an innovation the product does not need to be necessarily brand new, the novel input can be a combination of two existing technologies or knowledge to generate a new good/service. To notice that the term *product* encompasses the pair, goods, and services. In other words, new products are the ones displaying different attributes or traits from the companies' pre-existing originals. A slight change is also considered an innovation when the technical specifications point towards a new use of the product. In opposition, and although the design is fundamental to the conception of a product, minor modifications that do not alter the function at its essence are not perceived as a product innovation. Additionally, upgrades or other cyclical regular changes are also not product innovations (OECD, 2005).

2.1.3 Process Innovation

Process innovation is the employment of enhanced techniques, equipment and/or software that meaningfully modify the production or logistics methods. In this sense, a reduction on production/delivery expenses to enhance quality, or the introduction of automation equipment for product development, are considered process innovation if it brings a significant improvement to the services' supply. Secondary support activities are also considered when again they have a significant improvement to the system, for instance by implementing new software, higher computing power, or better organizational communication exchange technology (OECD, 2005).

2.1.4 Marketing Innovation

Different from the product innovation, here, design changes are a marketing innovation. Not only design but packaging, price-fixing, publicizing or other type of product exposure is considered innovative if it brings enhanced modifications to the product marketing method. To this end, the companies' sales are the final eyesight to aspire. To achieve it, companies can invest in customer needs, try to broad their target audience or better position their product on the market. Marketing innovation differentiates itself from other previously applied strategies, by the need for being new to the company, otherwise it is not innovative. To note that this new insurgence may derive from external sources and not just from within the company. Once again contrary to product innovation, the goal here is to tackle the image without changing the function of the product itself. Hence, remodeling the aesthetics of a piece of furniture or adding a new food flavor to a firm's repertoire are illustrations to further understand the concept. Another form of marketing innovation goes through the implementation of a new sales channel, whether it be the use of movie for publicity, a television advertisement, social network endorsement, or any other subtype of public display that is new to the company. Additionally, cyclical regular changes are not marketing innovations, unless they have not been used previously (OECD, 2005).

2.1.5 Organizational Innovation

Organizational innovation is the introduction of a new organizational method for increased productivity which is divided in three main categories:

- **Business practices** – is the execution of never used before procedures to the regular day-to-day organizing system. Therefore includes, information and expertise sharing, or other skill sharing practices. In addition, there are also management systems to facilitate organizations' operations such as lean methodology or reengineering.
- **Workplace organization** – is the attribution of roles with different decision-making authority's as well as responsibilities, building a hierarchy structure. An example could be the decentralization of autonomy for employees, creating flexibility on problem solving. That can be achieved with business practices like personnel training and development.
- **External relations** – is a web of interconnections a company has. Namely partners, public institutions, or other collaborators that contribute to positive success on either side. It can emerge for example as outsourcing or subcontracting leading to costs reduction and workplace satisfaction.

Every category mentioned can be an organizational innovation, if implemented as new to the company in order to bring higher performance levels, consequently, previously used managerial strategies are not to be considered as innovative (OECD, 2005).

2.1.6 Incremental and Radical Innovations

The majority of innovations occur incrementally (Hellström, 2007; Hemmelskamp, 2005). To attain sustainable development in useful time radical innovations must grow greatly, current technology needs an overturn (Huesemann, 2003).

Incremental innovations are the ones derived from creation and enhancements from those more directly engaged on the production process. Meaning it comes from a day-to-day learning route that is more prone to happen to users or doers and not necessarily intentionally done by R&D departments. It directly affects performance, productivity, and efficiency of the production capacity. The periodicity is not something constant. It can have different paces and flows across time, however, it is proven to happen, give or take, in a continuous state. The diversity occurs from several reasons that can be related to geography and different industries, as well as a mixture of demand pressures, socio-cultural causes, technological chances, or different firm paths. They are more linked to production size expansion, products/services overall standards, and process innovations (Freeman, 1992).

Radical innovations on the other side, is mostly planned by R&D operations and sporadically come and go across time. Its periodicity is not bonded to any schedule. The nature associated leads to the dawn of new industries or development of existing ones, by creation of new products that consequently lead to new markets. Every type of innovation (product, process, marketing, or organizational) can be linked to radical innovations since disruptive creations happen on all four of them. Secluded industries do not convey grouped economic or social effects, nevertheless have great impact on their root industry (Freeman, 1992).

Regarding organizational integration, it seems more suited for incremental innovations to employ an approach of authority by chain of command whereas higher employee autonomy, a looser and more flexible approach, might lead to better radical innovations. Important to mention that although small increments of innovation are harder to quantify and measure, they should not be neglected because a sequence of minor changes are also deemed innovation. In contrast on visual impact, the radical innovation may also suffer from an initial uncertainty because only at later stages can it be truly claimed as radical. Moreover, the motive for companies to lean on incremental choices may fall on them being inserted in a stable, mature sector on which goals are defined more carefully around costs of new inputs and their turnover (Hemmelskamp, 2005; OECD, 2005). When it comes to sustainable goals, one of the solutions perceived as incremental incurs in extra expenses and is seen as a burden to companies. The solution is named end-of-pipe technology, and it leads to firms' competitiveness detriment and other adverse results (Hojnik & Ruzzier, 2016).

2.2 Eco-innovation

It is generally accepted in the scientific community that to reach sustainability, major environmental educational changes must be put into practice. Global adverse impacts have led to the awakening of environment related concerns, particularly ones generated by the industrial sector. Back in 2004, the European Commission adopted a plan named Environmental Technologies Action Plan (ETAP), that has the mission to promote eco-innovation activities and environmental technologies. Additionally, it also has the aim to overcome entry barriers like the employment of new technologies over traditional ones, or the lack of funds that block the progression of environmental technologies (Calleja & Delgado, 2008; ETAP, 2004). Nowadays, more companies have a greater tendency to invest in environment concerned solutions, despite the many challenges this change faces (Dowell & Muthulingam, 2017; Lončar et al., 2019). Ramirez et al. (2014) studied the factors that restrain companies from pursuing environmentally sustainable operations. Their findings show that two of the primary culprits for this rejection relate to associated costs and organizational culture. On the opposite side, Agyabeng-Mensah et al. (2020) show how the influence of environmental practices can bring a competitive advantage and superior quality business performance. Moreover there are studies showing that eco-innovation does not hinder economic performance on a short term, or even in a financial turmoil (Cai & Li, 2018; Cainelli et al., 2011; García-Pozo et al., 2016).

How is eco-innovation defined? Its first appearance was written by Fussler & James (1996, p. 384), where it is described as *"the process of developing new products, processes or services which provide customer and business value but significantly decrease environmental impacts"*. The European Commission published an update to broaden a consensual approach by defining it has *"any innovation resulting in significant progress towards the goal of sustainable development, by reducing the impacts of our production modes on the environment, enhancing nature's resilience to environmental pressures,* *or achieving a more efficient and responsible use of natural resources”* (European Comission, 2012, p. 01).

Kemp & Pearson (2007) conceptually clarify eco-innovation based on environmental performance rather than environmental aim, justifying this choice by saying that it is more important to measure the environmentally favorable effects associated with its use. The purpose behind this reasoning was to not belittle those innovations that are not directly aimed at reducing harm to our planet, since they too can be less harmful compared to equivalent products/services. Also, their work sheds light to previous confusion when using terminology like “environmentally friendly technologies”, “eco-friendly technologies”, or “green energy technologies”. A subject to be dwelled further on. Additionally, the crucial point the authors wanted to transmit is that this concept should not be limited to new or better technologies, but instead, any product or service with an ecological upgrade should be seen as eco-innovation. With that said, their proposed definition goes as follows *“Eco-innovation is the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organization (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives”*. For research measurements, the authors also distinguish the need to differentiate minor and major novelties for more meticulous work and results (Kemp & Pearson, 2007, p.07).

Eco-innovation concept has gained multiple definitions throughout the years, mainly because it started quite general (Falk & Ryan, 2007). To grasp the full peculiarities, without losing practical meaning derived from the several sorts of innovation, it is important additional categorization for eco-innovation (Arundel & Kemp, 2009). Below on table 2 are other found definitions. To mention that one of the common points of agreement is the fine attention that should be given towards innovations whose traits involve for example, energy efficiency, waste reduction, resources management, or greenhouse gases cutback. Other eco-innovations directly aimed at reducing environmental harms should not be the one focus.

Table 2 - Authors’ eco-innovation definitions over time

Environmental innovations are new and modified processes, equipment, products, techniques, and management systems that avoid or reduce harmful environmental impacts.	(Kemp & Arundel, 1998; Rennings & Zwick, 2003)
Eco-innovations are all measures of relevant actors (firms, politicians, unions, associations, churches, private households) which develop new ideas, behavior, products, and processes, apply or introduce them, and which contribute to a reduction of environmental burdens or to ecologically specified sustainability targets.	(Klemmer et al., 1999)

Eco-innovations are innovation processes toward sustainable development Environmental innovations are …measures of relevant actors (firms, …, private households), which: (i) develop new ideas, behavior, products, and processes, apply or introduce them, and (ii) contribute to a reduction of environmental burdens or to ecologically specified sustainability targets.	(Rennings, 2000)
Environmental innovation is innovation that serves to prevent or reduce anthropogenic burdens on the environment, clean up damage already caused or diagnose and monitor environmental problems.	(VINNOVA, 2001)
Eco-innovation is innovation which is able to attract green rents on the market.	(Andersen, 2002)
Environmental technologies include all those whose use is less environmentally harmful than relevant alternatives.	(European Comission, 2004)
Technological environmental innovations (TEIs) may help to reduce the quantities of resources and sinks used, be they measured as specific environmental intensity per unit of output, or as average consumption per capita, or even in absolute volumes. Overriding priority, however, is given to improving the qualities and to changing the structures of the industrial metabolism. Rather than doing less of something, TEIs are designed to do it cleaner and better by implementing new structures rather than trying to increase eco-productivity of a suboptimal structure which has long been in place. TEIs are about using new and different technologies rather than using old technologies differently. TEIs can be characterized as being upstream rather than downstream, i.e., upstream in the manufacturing chain or product chain respectively, as well as upstream in the life cycle of a technology.	(Huber, 2004)
Innovation is 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)
Sustainability-driven innovation is the creation of new market space, products and services or processes driven by social, environmental or sustainability issues.	(Little, 2005)
Hardware or software innovation that is related to green products or processes, including the innovation in technologies that are involved in	(Chen et al., 2006)

energy-saving, pollution-prevention, waste recycling, green product designs, or corporate environmental management.	
Eco-innovation is any form of innovation aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment or achieving a more efficient and responsible use of natural resources, including energy.	(European Comission, 2007)
In a broad sense, environmental innovations can be defined as innovations that consist of new or modified processes, practices, systems, and products which benefit the environment and so contribute to environmental sustainability.	(Oltra & Saint Jean, 2009)
Eco-innovation is generally the same as other types of innovation but with two important distinctions: 1) Eco-innovation represents innovation that results in a reduction of environmental impact, whether such an effect is intended or not; 2) The scope of eco-innovation may go beyond the conventional organizational boundaries of the innovating organization and involve broader social arrangements that trigger changes in existing socio-cultural norms and institutional structures.	(OECD, 2009)

Adapted from (Carrillo-Hermosilla et al., 2010).

Eco-innovation has evolved from a blurry vague concept to a more precise definition, although still bearing many interpretations that tolerate different terminologies (e.g., green, sustainable). With that said, all authors present in the table above conceptualize eco-innovation as an action to generate novelty aimed at minimizing detrimental anthropogenic activities on our planet's ecosystems. In addition, eco-innovation relies its foundations on regular innovation. Taking product, processes, market, and organizational learnings further to what most authors insinuate on their definitions, which is the conjoint and mutual benefit to environment and industrial prosperity.

The scope of eco-innovation goes beyond conventional organizational boarders, and entails extensive social arrangements that trigger changes in socio-cultural norms and institutional existing structures (OECD, 2009). Rennings (2000) draws attention to the named double externality problem. Being an externality a cost or benefit that incurs on a third party without its a priori consent. One adverse example is the air pollution derived from vehicles. That is to say that when people buy fuel, they pay for its use (an internal cost), but do not pay for the adjacent pollution (an externality). Eco-innovation has the characteristic of having both positive impacts on the introduction of novel technologies and on their diffusion phase. The problem arises when the market does not penalize non-ecological products or services, creating a disadvantage between the two, given that environmental policies alone make eco-innovators internalize negative externalities. To combat environmental policies as a sole main driver of eco-innovations, it is crucial to have a synergy between innovation policies and environment policies implicating a carefully applied regulatory framework that does not impair eco-innovation (Ozusaglam, 2012; Rennings, 2000). Porter & Linde (1995) and Sanni (2018) defend that suitable environmental regulations can encourage the engagement on eco-friendly innovations while offering advantageous outcomes for both companies' higher productivity and for a greener planet.

Now, more on the issue of using similar terminology. Are they synonyms? There are essentially four terms found in the literature research, those are sustainable, environmental, green, and the eco or ecological innovation.

Sustainable development was first introduced on the World Conservation Strategy report, by IUCN 1980), where it is described as the integration of conservation and development to ensure that modification to the planet do indeed secure the survival and well-being of all people. Subsequently, the Brundtland report, *Our Common Future* in 1987 really put this concept on the map. Within the report, the following description can be found: ensure the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland et al., 1987).

Environmental innovation however, is defined by Oltra & Saint Jean, 2009 as innovations that consist of new or modified processes, practices, systems and products which benefit the environment and so contribute to environmental sustainability. More particularly but not just associated with environmental innovation, is the term frugal[4] which resonates throughout the research as its implementation implies lesser environmental tolls (Le Bas, 2020).

Green innovation, according to Chen et al. (2006) and Lanjouw & Mody (1996), is hardware and software innovations that are divided into green products and processes, more specifically technological innovations which are engaged in energy saving, pollution suppression, waste recycling, green product designs, or corporate environmental management. Driessen & Hillebrand (2002) complements by simply saying that any innovation providing environmental benefits, even though it may not be developed with that goal, is indeed a green innovation.

In conclusion as Schiederig et al. (2012) say in his work, confirming what was found by own research, the four terms are commutable with each other. This explains the difficulty on encountering individual original definitions since several authors use the same ones for the four different terms. As examples it is advised to read the following articles for comparison (De Marchi, 2012; D. Li et al., 2018; Lin et al., 2014). Furthermore, the striking difference between notions highlighted by Schiederig et al. (2012), is the missing social factors unused in the definitions of sustainable, green, and eco-innovation. Contrary to the others, sustainable innovation takes into consideration both ecological and social factors. Also, the author mentions that across time the terms green and eco-innovation have been more frequently used, with eco uprising has the better developed and precise concept.

What remains to be answered is what follows, the challenge to understand which innovations in fact truly reduce the environmental impact from the exercise of technological operations (Del Río et al., 2016).

[4] Frugal – to do more with less, the economical consumption of resources (Merriam-Webster dictionary).

2.2.1 End-of-pipe and Cleaner Technologies

End-of-pipe technology is an interesting concept characteristic of eco-innovations. It gained its name for the location where these solutions are figuratively implemented. Figure 2 renders an example where nets are applied to the ends of pipes to catch waste before reaching the oceans. Another example was studied by Olajire (2010) where CO_2 is captured through membranes and filters which allow for multiple practical industrial applications as well as non-industrial.

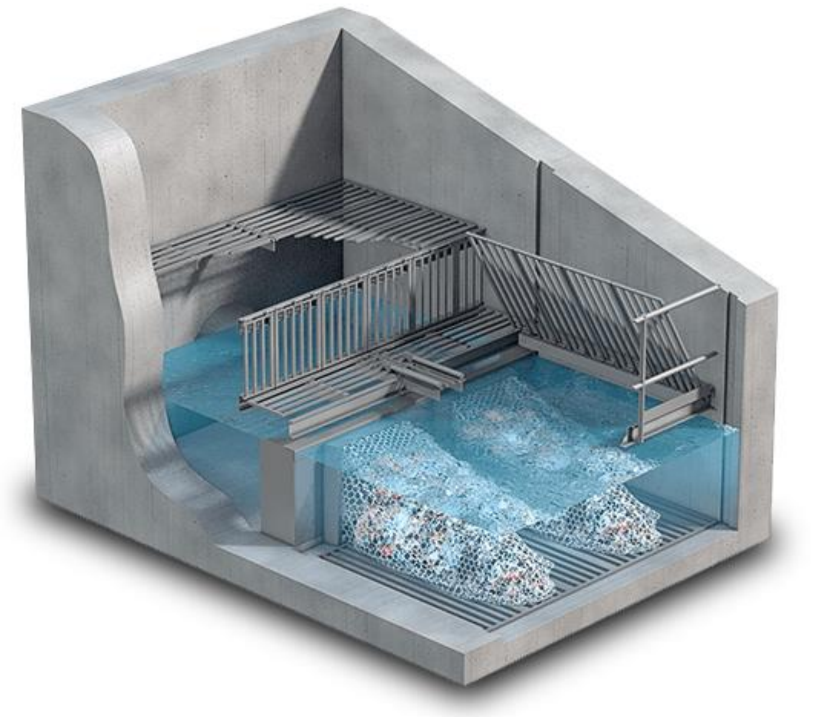

Figure 2 - End-of-pipe technology example: net for catching liter, trash, and debris[5]

Some authors distinguish eco-innovation between end-of-pipe and cleaner technologies (Horbach & Rennings, 2013; Mantovani et al., 2017; Triguero et al., 2015). Despite the fact that innovation occurs predominantly over end-of-pipe solutions and they indeed result in improvements to the environment, these are incremental and do not suffice for the needs of sustainable development (Hemmelskamp, 2005).

End-of-pipe technologies are applied to an already existing system, to this end this solution aims to reduce the pollutants emitted and/or recover part of the resources previously used without altering production processes. They are seen as a partial fix to an already made wrongdoing, as so they do not prevent negative environmental impacts, but rather frivolously delay them (Frondel et al., 2007; Mantovani et al., 2017). On the other hand, cleaner technologies combine with the production process. That is to say they compel a fundamental change in production methods to attack resource usage and pollution emitted (Frondel et al., 2007; Triguero et al., 2015). These are considered to be an immensely

[5] Image retrieved from https://stormtrap.com/products/trashtrap/

better option since they directly affect the planet's wellbeing and reduce the allocation of firms' resources (financial and workforce) to the maintenance at the end-of-pipe (Horbach & Rennings, 2013; Triguero et al., 2015). Moreover, the weak government incentives may be one of the reasons for less cleaner solutions adoption (Reid & Miedzinski, 2008).

2.2.2 Eco-innovation Barriers

Eco-innovation has the power to affect economic sectors while also helping us reach a better environment through a more sustainable way of living (OECD/Eurostat, 2018). Jesus & Mendonça (2018) argue that it is capable of locally pressurize movements that lead to a succession of changes, shaping a new technological economic system. This can be scary to adopt as it is very unpredictable in its nature (Tovstiga & Birchall, 2008). Nevertheless, Schot & Kanger (2018) assert that eco-innovation is the way to go on transforming the carbon concentrated industry onto a path to a greener future.

Sharing some barriers common to other types of innovation (Carrillo-Hermosilla et al., 2009), eco-innovation also falls on investment costs barriers, knowledge plus skill acquisition barriers, and market barriers (Segarra-Blasco et al., 2008). However regarding costs, Reid & Miedzinski (2008) recognized the high price and lack of funding support but pointed out that most firms are not familiar with the long term initial investment cut back, especially with eco-efficiency options. For the author it is both a driver, and a barrier. Additionally, he states that how a firm's image is perceived by the public is a major factor for eco-innovators entry, and non-innovators should also consider it as possible extra earnings from gaining new customers. On the knowledge barriers Segarra-Blasco et al. (2008) identify shortage of qualified workforce and barriers to partner procurement as a handicap. As for the market barriers, the uncertainty of the market from lack of feedback by consumers and the pre-established dominant tenants are the motives for this obstacle. In line with the last point, Könnölä et al. (2006) notes that established technological systems have a strong inclination do deter radical eco-innovation, which is preferable as seen in 2.1.6. In fact, many authors see the currently in practice firms' system as a potential barrier to the diffusion or implementation of a new one (Carrillo-Hermosilla & Unruh, 2006; Foxon et al., 2005; Frenken et al., 2004; Jacobsson & Johnson, 2000; Kline, 2001). The reason behind may come from the current system being so socially and economically permeated (Unruh, 2000), and to surpass it Carrillo-Hermosilla et al. (2010) suggest the need for strong government policies. Additionally, the authors also point to the lack of motivation as a consequence of the complexity involved, foreseen costs and long return on investment, and a concern for known expertise not to be sufficient, which Foxon et al. (2005) and Reid & Miedzinski (2008) support. Table 3 gathers some barriers more concisely.

Table 3 – Barriers to eco-innovation

Barriers
- Capital intensity
- Economic/Technological/Institutional (system) lock-in
- Infrastructure and skills set
- Market/demand feedback
- No investment/R&D partners
- No motivation

adapted from (Polzin et al., 2016)

2.3 Empirical Evidence

Upon getting acquainted with the foundations for the subject, this dissertation will now reflect on evidence encountered in eco-innovation article studies, which can be found in table A1 of the appendix with a condensed summarization.

Innovation and internationalization come alongside each other as drivers for business growth. Expansion of products to foreign consumers can bring higher returns on investment, coupled with developing new products/services to satisfy national and over borders demand (Hagen et al., 2014; Kriz & Welch, 2018). Firms' performance has been found to rise with internationalization which in turn reveals a bigger predisposition to act on eco-innovation (Cainelli et al., 2012; Hojnik et al., 2018). Ryszko (2016) with a similar stance, calls into question the possibility of exports to induce proactive environmental options and eco-innovation. On a more stablished ground, Cainelli et al. (2010) suggest a greater aptitude for eco-innovation on companies operating outside their mainland. With a growing stream of international brands there might be a sway to consumers in adopting more ecological products by virtue of a more responsible culture (Guarín & Knorringa, 2014). Additionally, exports initiate a cycle of improvements for firms. The interaction with foreign green technologies astute competitors unlocks a healthy motivation to pursue more sustainable investments (Cainelli et al., 2012).

On the other side, Jové-Llopis & Segarra-Blasco (2018) enumerate some authors' studies (del Río et al., 2017; Horbach, 2008) indicating that exportation is not necessarily the reason to eco-innovate but rather simply innovate. In a similar direction, Biscione et al. (2020) findings reveal eco-innovation to be more related with national markets, with eco-organizational innovation appearing as a counter measure for the adaptation to a different regulatory system. The reason for these contradictions might derive from the difficulty to internalize far away from home benefits.

Amidst both sides De Marchi (2012) recognizes that internationalization does affect green innovation admission, however the author got results displaying positive and negative correlations. Revealing the subject to be not well defined and in need of further analysis. Which is more eco-innovation inducing, smaller market reach or larger market reach?

Given this information the first hypothesis manifests itself:

Hypothesis 1 (H1): Geographical market reach is positively related to eco-innovation.

A distinctive number of authors from the scientific community support the harmonious interconnection between eco-innovation and firms' performance. Although different case studies specificities can produce different conclusions, general results tend to connect eventually on the prominence of corporate environmental strategies (Aragón-Correa & Sharma, 2003; Hart & Dowell, 2011; Tsai & Liao, 2017). Ghisetti & Rennings (2014) gather statistical numbers from a few studies showing 55% to have positive relation, 30% without direct relation, and only 15% with negative relation. Moreover, findings suggest firms to go after eco-innovation for various factors, with a predominant one being the achievement of better performance (Adelegan & Carlsson, 2010; Bansal & Gao, 2006; González-Benito & González-Benito, 2005; Sanni, 2018). Firms with better performance tend to be recurrent on embracing eco-innovation, with some having superior results than non-eco-innovators (Biscione et al., 2020; Chassagnon & Haned, 2015; Doran & Ryan, 2012). Borghesi et al. (2012) explain that the sequence of training along with labor productivity leads to higher eco-innovation levels which in change strengthens financial performance. To evaluate performance Doran & Ryan (2012) use turnover per worker as a measurement unit and Cainelli et al. (2020) and Horbach et al. (2012) relate eco-innovation more to the technology side with fields such as material savings, recycling and energy use. A similar approach confirmed technological eco-innovation to have propensity to affect performance (Ryszko, 2016). Upon these authors affirmations, the following hypothesis is presented:

Hypothesis 2 (H2): Financial performance is positively related to eco-innovation.

External information can be obtained by partnership with other firms in order to facilitate eco-innovation (Biscione et al., 2020). Cooperation has the ability to stockpile knowledge if handled harmoniously between the whole value chain network (Borghesi et al., 2012; Chassagnon & Haned, 2015; Doran & Ryan, 2012). As so, it is divided by market sources, institutional sources, and internal or belonging to the same group sources (EUROSTAT, 2014). Some of which deliver higher impact on eco-innovation activities, like suppliers, consultants, research institutes, and universities, depending on the case study (Borghesi et al., 2012; Cainelli et al., 2012; De Marchi, 2012; Doran & Ryan, 2012; Ghisetti et al., 2015; Horbach & Rammer, 2018). Particularly, Horbach et al. (2013) found that university partnerships where very beneficial in France, but not so much in Germany due to harder to manage incentives with private companies.

On the side of ecological advantages, studies show CO_2 abatement and energy savings as the most frequent positive results appearances (Cainelli et al., 2012; Ghisetti et al., 2015; Triguero et al., 2018). The importance of these alliances is very present on environmental innovations due to their unpredictable nature, unfamiliarity with its intricacies and the requirement to expand core skills within the firm (Jové-Llopis & Segarra-Blasco, 2020). A large portion of firms does not have the required assets to engage in further own development. To bridge this gap, cooperation is a low-cost easy solution providing win-win situations to all parties involved (Triguero et al., 2018).

Conforming with the evidence above and the need to differentiate between cooperation partner type the following hypotheses are introduced:

Hypothesis 3a (H3a): Market available partners cooperation is positively related to eco-innovation.

Hypothesis 3b (H3b): Institutional partners cooperation is positively related to eco-innovation.

Hypothesis 3c (H3c): Same group partners cooperation is positively related to eco-innovation.

Firm size is strongly associated with the adoption of eco-innovation, with some authors even saying it is a crucial structural trigger (Biscione et al., 2020; Chassagnon & Haned, 2015; De Marchi, 2012; Jové-Llopis & Segarra-Blasco, 2020; Triguero et al., 2018; Tsai & Liao, 2017). This might happen due to the fact that bigger companies tend to possess bigger financial support and market power than small and medium-sized enterprises (Biscione et al., 2020; Horbach & Rammer, 2018; Jové-Llopis & Segarra-Blasco, 2020; Triguero et al., 2018). Additionally, Chassagnon & Haned (2015) say the stability resulting from this larger capital and economies of scale opportunities open more propensity to develop a higher magnitude of all types of innovations. Yu et al. (2019) denote the benefits on CO_2 abatement as well as energy savings as indicators of positive environmental improvement, although recyclability takes a fall on the opposite direction. The measurement unit for firm size tends to be the number of employees within the company (e.g. Cainelli et al., 2012; Chassagnon & Haned, 2015; Tsai & Liao, 2017).

Giving a hint to formulate the next hypothesis, Jové-Llopis & Segarra-Blasco (2020) concluded that firm size had a big impact on the eco-innovation of the manufacturing and service sectors.

Since studies highlight the struggles that SMEs go through to eco-innovate, the following hypothesis is formulated:

Hypothesis 4 (H4): Firm size is positively related to eco-innovation.

This next hypothesis comes from the common appearance on eco-innovation studies in the literature, which is related to the sector companies operate. Manufacturing firms seem to be the most relevant sector, gaining the title of “the leader” in innovation (Jové-Llopis & Segarra-Blasco, 2020). Although it may seem like an innocent label, it comes from the fact that it is considered the most damaging to the environment (Biscione et al., 2020; Jové-Llopis & Segarra-Blasco, 2018). The reason for the charming title happens to be obtained by the substantially higher regulatory measures that somehow push these companies to eco-innovate (Chassagnon & Haned, 2015). The reason being might be explained by financial reasons such as avoiding fines and lawsuits from over pollution or extra expenses on end-of-pipe solutions (Tsai & Liao, 2017). Adding to the above mentioned, many authors associate manufacturing firms to eco-innovation for the potential derived from its reputation (e.g. Biscione et al., 2020; Cainelli et al., 2020; Chassagnon & Haned, 2015; Triguero et al., 2018). Related to this topic, da Silva (2014) studied the Portuguese manufacturing industry on eco-innovation and suggested as future work a sequential analysis for comparison purposes. Following these arguments, the following hypothesis is proposed:

Hypothesis 5 (H5): The manufacturing sector is positively related to eco-innovation.

Lastly, to put into context the next hypothesis, it is important to notice the risk firms put themselves in when trying to acquire new technologies. By doing so, the future may be prosperous, but it must never be seen as certain. Early investments imply capital expenditures that will only bring returns over a more distance period. Adding the uncertainty of innovation, it is understandable that firms require some sort of aid which can emerge as financial resources (Ghisetti & Rennings, 2014; Tsai & Liao, 2017). Government subsidies, fiscal incentives or similar types of grants can have a positive relationship with innovation, particularly when it comes to environmental innovation pursuit (Chassagnon & Haned, 2015; De Marchi, 2012; Doran & Ryan, 2012; Horbach & Rammer, 2018; Tsai & Liao, 2017). The reason behind this affirmation might surge from companies not wanting to pay higher taxes for not meeting certain environmental standards (Biscione et al., 2020; De Marchi, 2012; Triguero et al., 2018). On the other hand, some authors found no significant correlation between subsidies and eco-innovation, pointing out to an outdated regulatory framework which is no longer effective (Horbach et al., 2013; Jové-Llopis & Segarra-Blasco, 2018). As for concrete consequences of subsidy provisions, Horbach (2016) and Horbach et al. (2012) found evidence of CO_2 abatement with Doran & Ryan, 2012 additionally stating the multitude of green benefits it can provide like the avoidance of utilizing harmful substances. Considering this information, the following hypothesis concludes the conjecture for the model analysis:

Hypothesis 6 (H6): External factors (subsidies, fiscal incentives/benefits, and similars) are positively related to eco-innovation.

2.3.1 Hypotheses Summarized

With the knowledge presented in the previous subsection and to facilitate reading and consultation, table 4 below gathers all hypotheses summarized with the respective authors' citations.

Table 4 – Investigation hypotheses

Hypotheses	Authors on which the hypotheses were based
H1. Geographical market reach is positively related to eco-innovation.	(Biscione et al., 2020; Cainelli et al., 2010, 2012; De Marchi, 2012; del Río et al., 2017; Guarín & Knorringa, 2014; Hagen et al., 2014; Hojnik et al., 2018; Horbach, 2008; Jové-Llopis & Segarra-Blasco, 2018; Kriz & Welch, 2018; Ryszko, 2016)
H2. Financial performance is positively related to eco-innovation.	(Adelegan & Carlsson, 2010; Aragón-Correa & Sharma, 2003; Bansal & Gao, 2006; Biscione et al., 2020; Borghesi et al., 2012; Cainelli et al., 2020; Chassagnon & Haned, 2015; Doran & Ryan, 2012; Ghisetti & Rennings, 2014; González-Benito & González-Benito, 2005; Hart & Dowell, 2011; Horbach et al., 2012; Ryszko, 2016; Sanni, 2018; Tsai & Liao, 2017)
H3a. Market available partners cooperation is positively related to eco-innovation.	(Biscione et al., 2020; Borghesi et al., 2012; Cainelli et al., 2012; Chassagnon & Haned, 2015; De Marchi, 2012; Doran & Ryan, 2012; EUROSTAT, 2014; Ghisetti et al., 2015; Horbach et al., 2013; Horbach & Rammer, 2018; Jové-Llopis & Segarra-Blasco, 2020; Triguero et al., 2018)
H3b. Institutional partners cooperation is positively related to eco-innovation.	
H3c. Same group partners cooperation is positively related to eco-innovation.	
H4. Firm size is positively related to eco-innovation.	(Biscione et al., 2020; Cainelli et al., 2012; Chassagnon & Haned, 2015; De Marchi, 2012; Horbach & Rammer, 2018; Jové-Llopis & Segarra-Blasco, 2020; Triguero et al., 2018; Tsai & Liao, 2017; Yu et al., 2019)
H5. The manufacturing sector is positively related to eco-innovation.	(Biscione et al., 2020; Cainelli et al., 2020; Chassagnon & Haned, 2015; da Silva, 2014; Jové-Llopis & Segarra-Blasco, 2018; Jové-Llopis & Segarra-Blasco, 2020; Triguero et al., 2018; Tsai & Liao, 2017)
H6. External factors are positively related to eco-innovation.	(Biscione et al., 2020; Chassagnon & Haned, 2015; De Marchi, 2012; Doran & Ryan, 2012; Ghisetti & Rennings, 2014; Horbach, 2016; Horbach et al., 2012, 2013; Horbach & Rammer, 2018; Jové-Llopis & Segarra-Blasco, 2018; Triguero et al., 2018; Tsai & Liao, 2017)

3 Data and Methodology

The third chapter gives some statistical observations to the data sample Community Innovation Survey 2014. Also, a description along with an explanation for the different types of variables to be used by the model. Finally, the methodology for the logit model is defined.

3.1 Data Sample

The data conducted for the empirical analysis of the present dissertation derives from the Community Innovation Survey 2014 (CIS 2014). In order to study the eco-innovation determinants for Portuguese companies the period from 2012-2014 was chosen because it is the most recent with information regarding to the main topic of sustainability and ecology (Madaleno et al., 2020). This European survey was first implemented in 1992 and it has been perfected and refined every two years by Eurostat, being now the norm used by a large portion of scholars regarding innovation related activities. It is mandatory for the EU members to participate and follows the directions stablished in OECD's Oslo Manual 3rd edition (OECD, 2005). Particularly for this dissertation, the material was made available by DGEEC, the Portuguese entity responsible for the custody and protection of CIS data and the anonymity of companies.

For the sake of using rigorous and credited survey information, Eurostat provides guidelines for a proper statistical data treatment, which include parameters like the need for the inquired companies to be randomly sampled within a set of the same economic activity, the dimension class and region (EUROSTAT, 2014). Furthermore, all countries receive a standard core questionnaire for comparability purposes which is designed to gather information on the different types of innovativeness across sectors by type of enterprise, and on various other determinants that help or hinder innovation.

In Portugal the collection of data took place through means of an electronic online platform and considered the following sections universe for the companies, Section B (Division 05 to 09); C (Divisions 10 to 33); D (Division 35); E (Divisions 36 to 39); F (Divisions 42 to 43); G (Division 46 and Group 471); H (Divisions 49 to 53); J (Divisions 58 to 63); K (Divisions 64 to 66); M (Divisions 69 and 71 to 75) and Q (Division 86) from CAE – Rev. 3, the Portuguese Economical Activities Classification norm. Following Eurostat directions, the Portuguese National Statistical Institute built a sample composed by 9,455 companies. From those initial numbers only 7,083 answers were considered valid after considering 8,736 companies from the corrected sample. Obtaining a response rate of 81% which falls into the above 70% regarding very good quality measures (DGEEC, 2014; Groves, 2006).

Following the different sectors divisions presented in CAE – Rev. 3 the extractive industry and the manufacturing industries sectors were identified amongst the 05 to 09 and the 10 to 33 classifications respectively, with both composing the whole industry sector for the analysis. For analysis purposes scholars tend to focus on the secondary and tertiary sectors, that is the manufacturing and services. As so, the services sector is referred to the numbers between 35 and 86 for being the ones available on the data sample CIS2014 (DGEEC, 2014). In figure 3 it is represented the distribution of companies along the two sectors with the majority belonging to manufacturing (3,921 companies) and the remaining to services (3,162 companies). From these numbers it is also possible to comprehend that companies in the manufacturing sector are more eco-innovative representing 44.20% (1,733 companies) of the total, while in services only roughly a quarter 26.09% (825 companies). This was to be expected since in the literature research presented, general innovation usually is more prevalent in manufacturing.

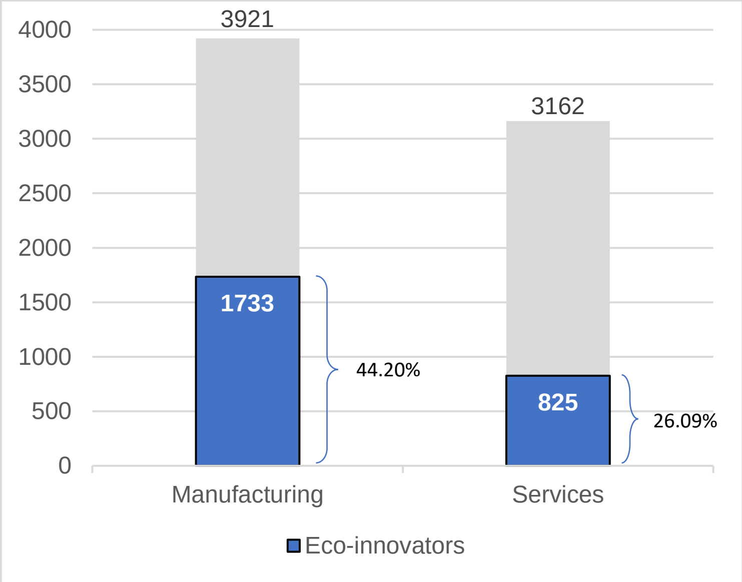

Figure 3 - Industry and Services companies distribution
(INE, 2014)

Considering only the type of innovators researched in the literature review, product, process, marketing, organizational and ecological a little over half of companies engaged in at least one type of these innovations which can be seen in figure 4. The 58.14 percentage translates to 4,118 innovators with the remaining companies either not investing in innovation or not being able to conclude the activity within the time frame considered. Of these innovators, 38.60% (2,734 companies) developed eco-innovation, 33.88% (2,400 companies) product innovation, 39.32% (2,785 companies) process innovation, 31.89% (2,259 companies) marketing innovation and 29.46% (2,087 companies) organizational innovation.

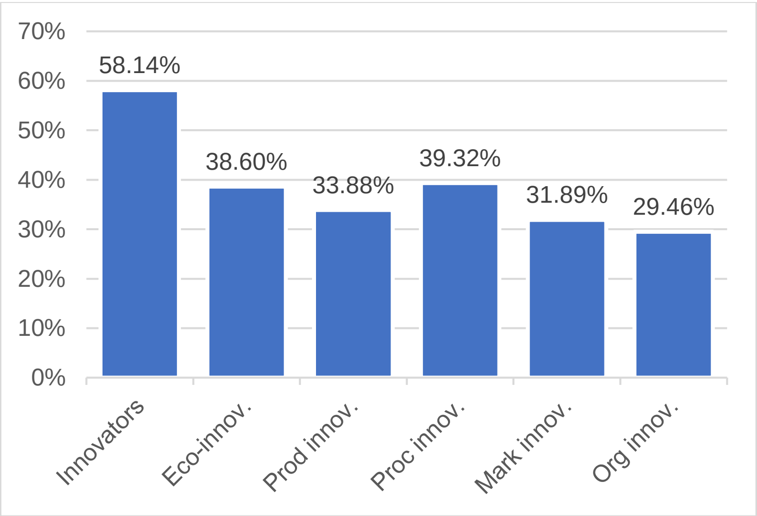

Figure 4 - Types of innovation distribution
(INE, 2014)

Emphasizing the 2,734 companies that eco-innovated, there are ten different types measured by CIS 2014. These types take action on a multitude of environmental positive contributions including the reduction of resources, energy, emissions or the replacement for better less-polluting materials and the increase of recycling options. Moreover, the benefits implied are to be obtained inside the companies or potentially during the consumption of a good/service by the end user. With all this considered figure 5 clearly shows a winner, *ECOREC* with 76.55% (2,093 companies) which pertains to the recycled waste, water, or materials. On the other side is *ECOREP* with 15.22% (416 companies) indicating that at the time it was harder to replace a share of fossil fuel energy used with renewable energy sources. The other variables co-exist between the range of 32.19% to 50.44%, having a similar behavior. For further description information on the acronyms in xx axis consult the dependent variables table 5.

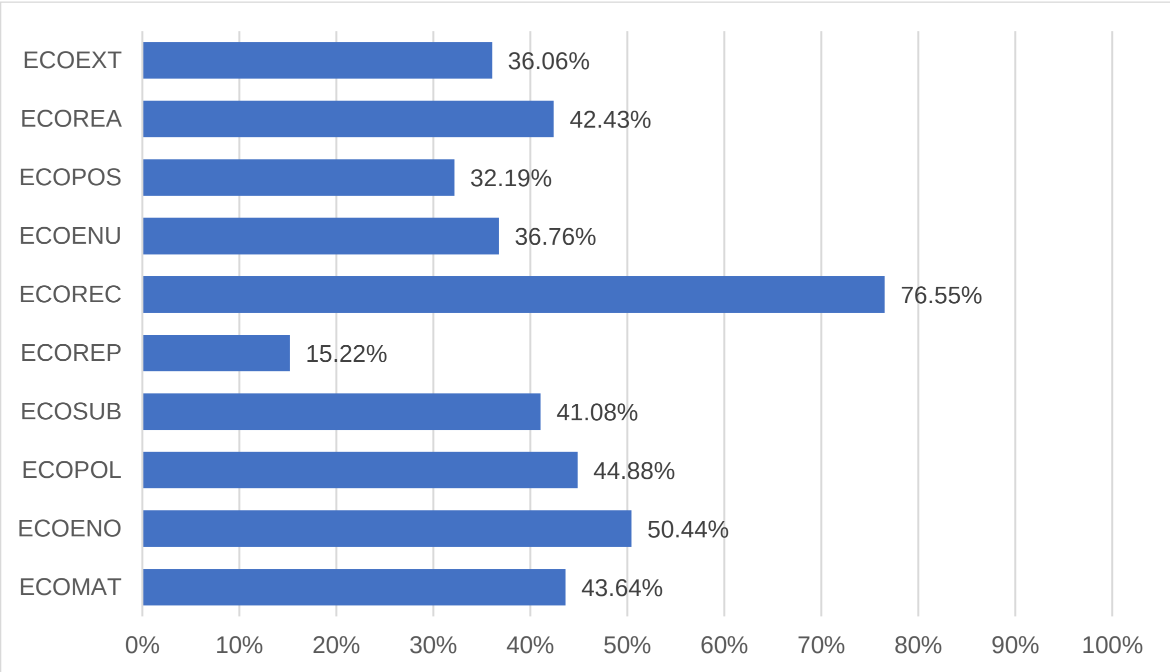

Figure 5 - Eco-innovator types distribution
(INE, 2014)

From the hypothesis formulation section there was an expectation for larger firms to be more innovative. To get a sense of the distribution, figure 6 divides firms into small & medium (SME's) and large ones. Being the first characterized for having 10 to 49 employees or 50 to 249 employees respectively, accounting for 85.68% (6,069 companies). The second refers to firms having 250 employees or more, which encompass large firms getting 14.32% (1,014 companies).

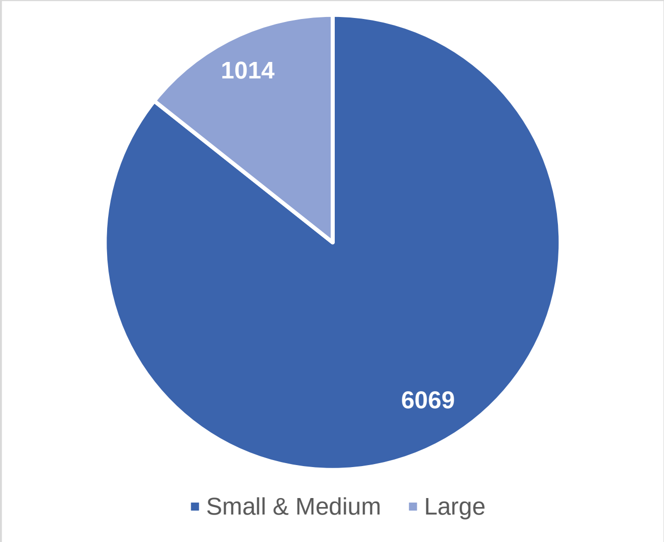

Figure 6 - Company size distribution
(INE, 2014)

Analyzing the graph represented on figure 7 there is a tendency for larger companies to engage in eco-innovation, which goes in line with what was expected and the majority of scholars (Biscione et al., 2020; Chassagnon & Haned, 2015; De Marchi, 2012; Jové-Llopis & Segarra-Blasco, 2020; Triguero et al., 2018; Tsai & Liao, 2017). With that said, all types of eco-innovation have this trend behavior which might be explained by the advantage of taking the opportunity of using economies of scale (Chassagnon & Haned, 2015). The total amount of large companies is 1014 compared to 6069 small and medium companies, every other absolute value can be obtained within the respective parenthesis.

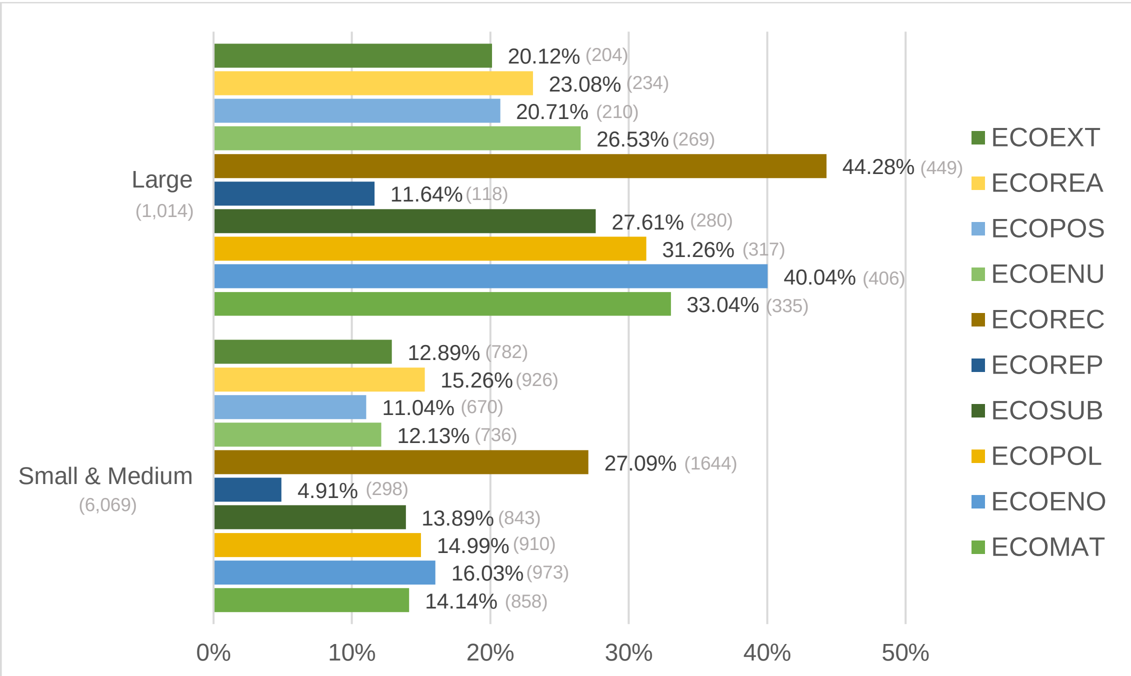

Figure 7 - Eco-innovation types distribution along company size
(INE, 2014)

It might be interesting to identify how many eco-innovation types that each company simultaneously operates on, figure 8 describes just that. It is noticeable and expected that the behavior of the curve presented on below to have a downwards trend meaning that more companies tend to introduce less eco-innovations at the same time. As so, only 116 companies got to implement all 10 types of eco-innovation during the period of 2012 to 2014.

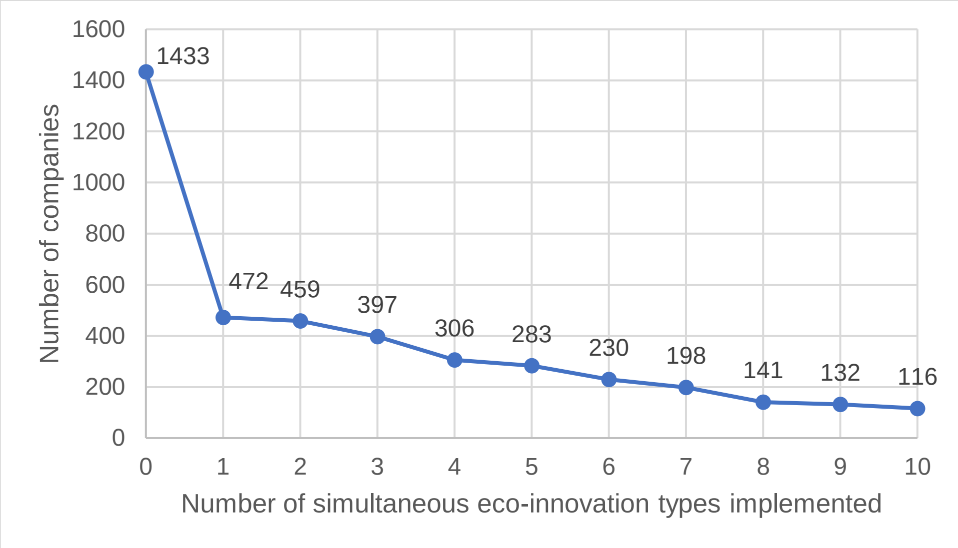

Figure 8 - Number of simultaneous eco-innovation types implemented
(INE, 2014)

This section allows to understand the ecological benefits happening within the company (figure 9) and the potential benefits during consumption from the end user (figure 10). The most preponderant gain obtained inside the companies is the “recycled waste, water, or materials for own use or sale” with 47.70%. On the other side, the potential gain by the end consumer with best results is from the “facilitated recycling of product after use” with 28.00%. For acronyms details visit table 5.

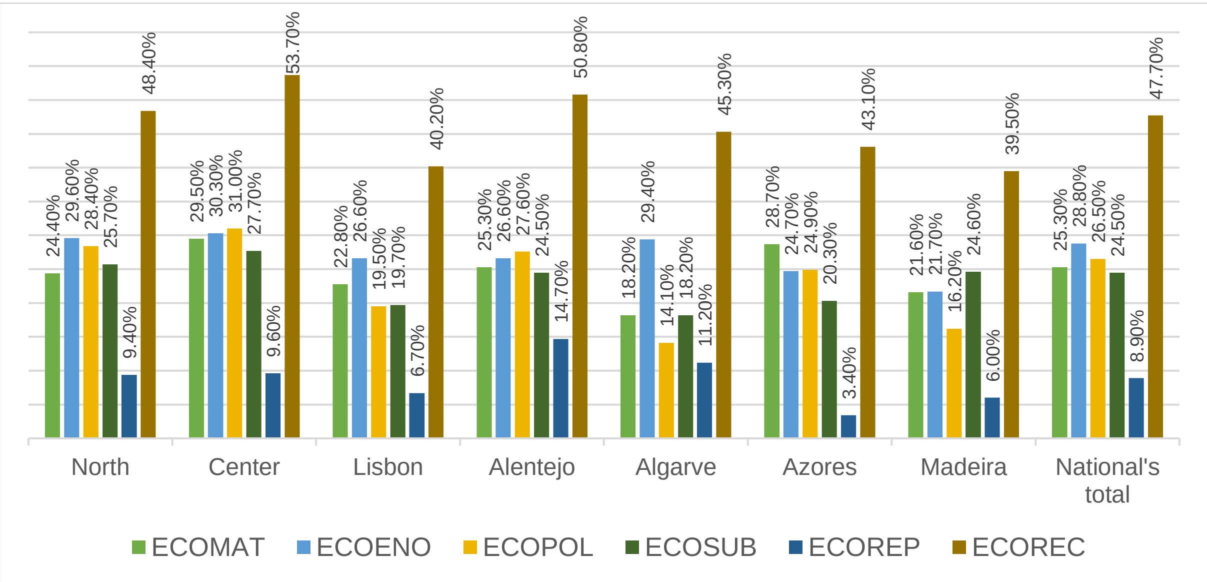

Figure 9 – Inside company ecological benefits distribution across regions
(adapted from DGEEC, 2014)

Most regions follow the trend mentioned in the previous passage except Algarve region which had a more important role in "reducing energy use or CO_2 footprint". Overall, the regions with the highest percentage of eco-innovation implementation are the North, Center and Alentejo. This regional data was obtained directly from the statistical summaries executed by DGEEC and later handled in excel (DGEEC, 2014). For acronyms details visit table 5.

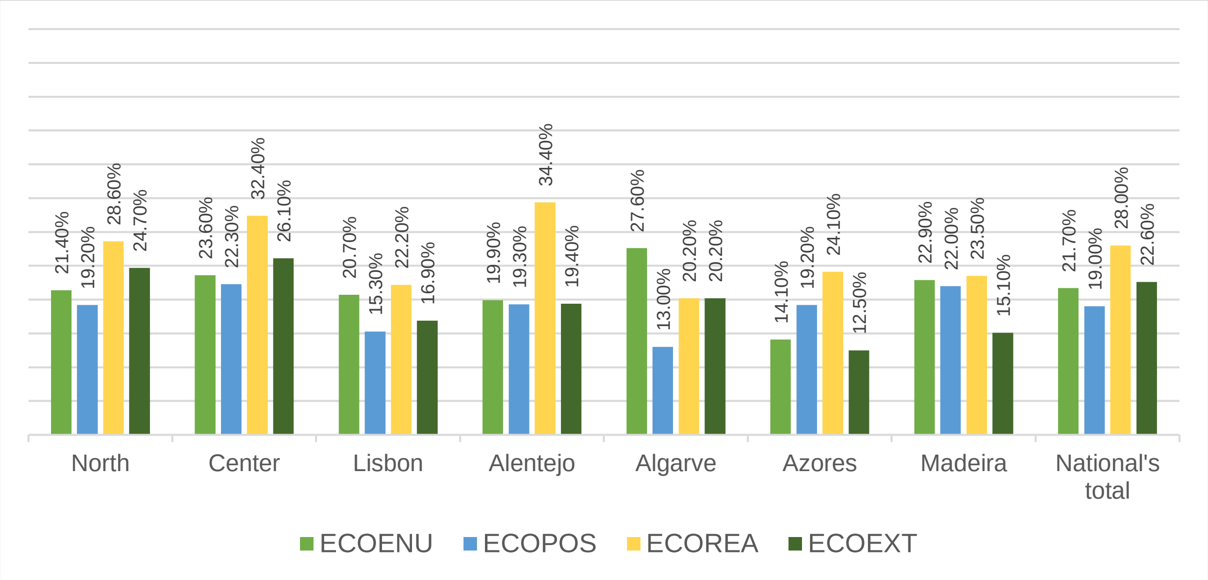

Figure 10 – Potential end user ecological benefits distribution across regions
(adapted from DGEEC, 2014)

3.2 Variables for the analysis

Here all variables used for the analysis are elaborated according to the chosen data. At the same time, a description within the context of the hypothesis is set for the model.

3.2.1 Dependent Variables

Considering what was discovered in the Empirical Evidence section, the main dependent variable eco-innovation (*eco_inov*) is decomposed in ten different components. The first six components regard environmental benefit gains obtained within the company, these will be referred to as *eco_inov_in*. The remaining four components being the potential environmental benefit gains obtained during final consumers' goods or services consumption, will be perceived as *eco_inov_out*. Every dependent variable is what is defined as a dummy or binary, denoting it can only take two values. When the value is "1" it means the called innovation was implemented, otherwise it receives a "0" meaning it did not. Below, table 5 resumes the dependent variables describing the meaning and outcomes.

Table 5 - List of dependent variables

Acronym/Marker			Description	Outcomes
eco_inov	Eco-innovation within the company	ECOMAT	Reduced material or water use per unit of output.	“1” for yes, “0” for no.
		ECOENO	Reduced energy use or CO_2 footprint.	
		ECOPOL	Reduced air, water, noise, or soil pollution.	
		ECOSUB	Replaced a share of materials with less polluting or hazardous substitutes.	
		ECOREP	Replaced a share of fossil energy with renewable energy sources.	
		ECOREC	Recycled waste, water, or materials for own use or sale.	
	Eco-innovation on the side of end consumer	ECOENU	Reduced energy use or CO_2 footprint.	
		ECOPOS	Reduced air, water, noise, or soil pollution.	
		ECOREA	Facilitated recycling of product after use.	
		ECOEXT	Extended product life through longer-lasting, more durable products.	

Using the information encountered on the CIS 2014, this dissertation considers innovation with environmental benefits as the definition which better relates to eco-innovation. Particularly, when a new or significantly improved product, process, organizational method, or marketing method introduced in favor of other compared alternatives, leads to environmental benefits. Moreover, these benefits can come from a primary intention or descend as consequence of another target within the company, provided that it occurs during production, or during its consumption by the end user. The reason for taking this approach when defining eco-innovation comes from the evidence found on many papers mentioning CO_2 abatement, resource management, and so on, as factors of eco-innovation with positive affecting results (Borghesi et al., 2012; Cainelli et al., 2012; Ghisetti et al., 2015; Horbach, 2016). Furthermore, it will be interesting to analyze eco-innovations occurring “near” the companies versus the ones a little bit out of grasp since they are meant to happen on the side of the end-user.

3.2.2 Independent and control variables

For the inputs of the model and in order to add real context to the study at hands, the explanatory variables otherwise known as independent are defined. These were the outcomes of the literature review research, with all of them having some expected extent of influence on the eco-innovation dependent variable implementation.

Table 6 - List of independent variables

Acronym/Marker	Description	Outcomes
MARLOC	Local and regional markets	“1” for yes, “0” for no
MARNAT	National market	“1” for yes, “0” for no
MAREUR	EU market	“1” for yes, “0” for no
MAROTH	Other countries markets	“1” for yes, “0” for no
FPERFm	Financial performance relative to the years 2012 and 2014 measured in turnover per employee.	“1” for equal or above average, “0” for below average
TURN12	Turnover from 2012 in euros	[0 to 99.999.999.999]
TURN14	Turnover from 2014 in euros	[0 to 99.999.999.999]
EMP12	Number of employees in 2012	[0 to 999.999]
EMP14	Number of employees in 2014	[0 to 999.999]
MApart	Market available partners	“1” for yes, “0” for no
CO21_CO25	Partner type coop: suppliers of equipment, materials, components, or software	“1” for yes, “0” for no
CO311_CO315	Partner type coop: Clients or customers from the private sector	“1” for yes, “0” for no
CO321_CO325	Partner type coop: Clients or customers from the public sector	“1” for yes, “0” for no
CO41_CO45	Partner type coop: Competitors or other enterprises in the same sector	“1” for yes, “0” for no
CO51_CO55	Partner type coop: Consultants or commercial labs	“1” for yes, “0” for no
Ipart	Institutional partners	“1” for yes, “0” for no
CO61_CO65	Partner type coop: Universities or other higher education institutes	“1” for yes, “0” for no
CO71_CO75	Partner type coop: Government, public or private research institutes	“1” for yes, “0” for no
SGpart or CO11_CO15	Partner type coop: Other enterprises within the enterprise group	“1” for yes, “0” for no
SIZE	Small & medium enterprises (10 to 49 employees or 50 to 249 employees) and large enterprises (250 or more employees)	“0” for small and medium, “1” for large
MANUF	Manufacturing activity sector	“1” for manufacturing sector “0” for other activity sectors
FUNLOC	Local or regional authorities’ subsidies	“1” for yes, “0” for no
FUNGMT	Central government (including central government agencies or ministries) subsidies	“1” for yes, “0” for no
FUNEU	European Union subsidies	“1” for yes, “0” for no

The above table is color coded, meaning the hypothesis are alternating between blue and white. The first set of four variables bears upon the first hypothesis concerning to geographical market reach. Not only the exploration of farther territory brings more demand it also contributes to a more diverse mindset of people who have concerns with the environment (Cainelli et al., 2010, 2012; Guarín & Knorringa, 2014; Hojnik et al., 2018). These variables allow to understand if companies working on different geographies have higher or less tendency to eco-innovate.

The next set, colored white, refers to the financial performance for every company. From the data sample CIS 2014, was extracted four variables *TURN12*, *TURN14*, *EMP12* and *EMP14*. These helped build the remaining one, *FPERFm* which concerns to the mean financial performance calculated following Doran & Ryan (2012) suggestion of using turnover per employee as a measurement unit. As so, after the mean values were calculated *FPERFm* was transformed into a binary variable by assigning the value “1” to companies scoring above the average calculated, and “0” to who falls below that score.

The next three colored sets pertain to the hypothesis H3a, H3b and H3c that refer to the types of partners. These variables due to correlation issues were aggregated into three main variables: market available partners (*MApart*), institutional partners (*Ipart*) and same group partners (*SGpart*). The solution went through consigning the value “1”, for instance to *MApart*, if every *CO##* had already the value “1” and “0” if at least one had the value “0”. The same procedure was done to *Ipart*, as for *SGpart* as there was only one *CO##* code the variable is exactly the same as the code variable.

The variable *SIZE* had also some data manipulation which had the objective of understanding if bigger companies have higher tendency to eco-innovation like some authors mention (Biscione et al., 2020; Horbach & Rammer, 2018; Jové-Llopis & Segarra-Blasco, 2020; Triguero et al., 2018). With this purpose the variable *SIZE* gets the value “0” for both small and medium companies, otherwise known as PME’s, and the value “1” for large companies.

The binary variable *MANUF* is split into manufacturing and services, the two main industry work types. The division was made with the help of CAE Rev.3 that lists all sectors of Portuguese companies (INE, 2007). The reason behind this decision is based on the literature research saying that manufacturing firms are more likely to develop new products than their counterpart, services firms (Biscione et al., 2020; Cainelli et al., 2020; Chassagnon & Haned, 2015; Triguero et al., 2018). This variable was transformed into a binary and gets the value “1” for manufacturing firms and “0” for service firms.

Lastly, the end set refers to external factors which in this dissertation, and with the available CIS2014 data, describes it as subsidies. Due to the risks associated with engaging in an innovation and the length of time it requires for a company to see profits from its investment, some authors point to the crucial benefit these incentive have for a firm decision to innovate (Chassagnon & Haned, 2015; De Marchi, 2012; Doran & Ryan, 2012; Horbach & Rammer, 2018; Tsai & Liao, 2017). Other factors might also interfere like extra taxes for not obliging with government regulation. Not every company has the means to innovate, the subsidies can be of great help in order to comply with all legal requirements (Biscione et al., 2020; De Marchi, 2012; Triguero et al., 2018).

Following the independent variables come the control variables which may not have a particular intent to the study however have an enhanced internal validity to the outcomes from the model. Subsequently three control variables were identified assisted by the table A1 in the appendixes which gathered similar studies using similar data samples. The first one (*GP*) is concerned with a company being part of a group or not assuming the value "1" if yes or "0" otherwise. Belonging to a group might influence knowledge and ecological practices different from the parent firm (Cainelli et al., 2020; Horbach & Rammer, 2018; Jové-Llopis & Segarra-Blasco, 2018; Jové-Llopis & Segarra-Blasco, 2020). Furthermore, according to Le Bas & Poussing (2015) being a member of a group changes R&D conduct. The second (RRDIN) and third (RRDEX) are related to the capacity of a company to introduce R&D activities both internally and externally (De Marchi, 2012; Doran & Ryan, 2012; Horbach & Rammer, 2018; Jové-Llopis & Segarra-Blasco, 2018; Jové-Llopis & Segarra-Blasco, 2020; Triguero et al., 2018). They are also dummy variables getting the value "1" to affirmative answers and "0" alternatively.

3.2.3 Descriptive statistics for the variables

To obtain more sensitivity on the given data, table 7 summarizes the sample by expressing a measure of central tendency more specifically the mean, and measures of variability like standard deviation, minimum and maximum values. For the variables acronyms details visit table 6.

Table 7 - Variables descriptive statistics

	Variables	Mean	Std. Dev	Min. Value	Max. Value	Individual Observations
Dependent Variables	eco_inov	0.6561	0.4751	0	1	4167
	eco_inov_in	0.6225	0.4848	0	1	
	eco_inov_out	0.4370	0.4961	0	1	
Independent Variables	MARLOC	0.8609	0.3460	0	1	7083
	MARNAT	0.8169	0.3868	0	1	
	MAREUR	0.6377	0.4807	0	1	
	MAROTH	0.4795	0.4996	0	1	
	FPERFm	0.1230	0.3284	0	1	
	part	0.2518	0.4341	0	1	3539
	MApart	0.7632	0.4254	0	1	891
	Ipart	0.3771	0.4849	0	1	
	SGpart	0.5836	0.4932	0	1	
	SIZE	0.1432	0.3503	0	1	7083
	MANUF	0.5536	0.4972	0	1	
	FUNLOC	0.0393	0.1943	0	1	3539
	FUNGMT	0.2450	0.4301	0	1	
	FUNEU	0.1291	0.3354	0	1	
Control Variables	RRDIN	0.4402	0.4965	0	1	
	RRDEX	0.2617	0.4396	0	1	
	GP	0.2832	0.4506	0	1	7083
Number of observations			3539			

The number of observations differs from the original 7,083 and individually as it can be seen in the far-right column. This is due for example to some questions in CIS2014 to have precedency, meaning that companies that did not engage in a certain activity were instructed to skip any number of questions related to that activity. Other reasons might come from a company not wanting to disclose sensible information. The bottom number of observations (3,539) counts for the actual number when the model was run, where every variable was used except for *MApart*, *Ipart* and *SGpart* which will be used collectively in turns with *part*. This alternation results from the need to maintain a high level of observations so that the results do not get undermined while also allowing to discriminate between the three types of partnership. Therefore, different models will be run to accommodate this situation.

3.2.4 Variables Multicollinearity

Multicollinearity is a phenomenon noteworthy of studying before advancing to the models' execution. It is explained in logistic regression by a correlation that can happen to explanatory variables that as a consequence inflates the estimates and thus the relation between explanatory and response variables (Midi et al., 2010). Due to that fact high correlation among independent variables are ought to be averted. With that in mind, an extra step was made by calculating Spearman's correlation to determine if the independent variables had a high degree of relationship. According to Akoglu (2018) and Masson-Delmotte et al. (2018) the acceptable values for the correlation are approximately placed between -0.5 and +0.5. Utilizing the software STATA capabilities, the Spearman method gave table A2 presented in the annexes which shows that most of the values check the requirements.

With no absolute rules for correlation interpretation, since coefficients differ greatly within the scientific community areas, no scholar should overinterpret the strength of these associations (Akoglu, 2018).

3.3 Model

Normally when the dependent variables to be analyzed have a binary nature, scholars first try to use a logistic regression method analysis (Berry et al., 2010). Looking at table A1 most studies ultimately use either logit or probit models which fit in the category. Additionally, if the data sample size is large (above 500) with many observances, it is preferred the logit model because of easier convergence (Cakmakyapan & Goktas, 2013). The sample comprises 7,083, so it meets the criteria. Consequently, the present dissertation applies the logit model owing to its great precision and flexibility to work different types of variables, that is binary and continuous (Tay et al., 2011). The development of this multivariate analysis offers a simple readable linear modulation for categorical dependent variables[6], making use of a set of predictors to obtain an assessment from explanatory variables (Demaris, 1992). In other words, it is a logistic regression method (logit), that provides an estimation for a certain event to occur from the analysis of independent variables. Which in turn mathematically speaking, is a model of the conditional probability $P(Y = 1|explanatory\ variables)$ of the output binary variable Y as a function of any number

[6] Categorical variables - Also known has qualitative variables, meaning they take on values that are labels or names.

of unknown explanatory variables x. Also, $Y = 1$ is an arbitrary choice (between 0 and 1) to make Y an indicator variable while simultaneously assuming the axiom $P(Y=1) = E[Y] \Leftrightarrow P(Y=1|X=x) = E[Y|X=x]$ (Tserng et al., 2014).This whole operation will have parameters that are to be estimated by another method called maximum likelihood (Bel et al., 2015).

Since the analysis will encompass the relation between more than one explanatory variable, it is important to first distinguish the multivariate linear regression expression which takes the form of (Tserng et al., 2014):

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_i x_i + \varepsilon = \beta_0 + \sum_{i=1}^{n} \beta_i x_i + \varepsilon \tag{1}$$

Where:

Y – represents the binary output variable.

x_i – known constants, the explanatory variables.

β_i – parameters or regression coefficients.

ε – associated error.

Taking the above into consideration, it is now needed a logit transformation with the intention of obtaining the linear logistic regression model. This will also ensure that the probabilities obtained are within the interval of zero and one, so that the results have significant meaning. The linear function model is obtained through the logit value of the unknown binomial probability, as so it is represented as (H. Li et al., 2011):

$$logit(probability\ Y) = \ln\left(\frac{probability\ Y}{1 - probability\ Y}\right) = \beta_0 + \sum_{i=1}^{n} \beta_i x_i \tag{2}$$

Solving the equation for p we obtain (to simplify the upcoming notation let p be the $probability\ Y$) (H. Li et al., 2011):

$$\ln\left(\frac{p}{1-p}\right) = \beta_0 + \sum_{i=1}^{n} \beta_i x_i \tag{3.1}$$

$$p = \frac{e^{\beta_0 + \sum_{i=1}^{n} \beta_i x_i}}{1 + e^{\beta_0 + \sum_{i=1}^{n} \beta_i x_i}} = \frac{1}{1 + e^{-\beta_0 + \sum_{i=1}^{n} \beta_i x_i}} \tag{3.1}$$

$$p = \frac{1}{1 + e^{-Y}} \tag{3.3}$$

As for the β parameters, they can take any value belonging to $\mathbb{R}$ and are typically obtained using the maximum likelihood estimation (MLE) method. Which uses the probability distribution of a sample to estimate said parameters by maximizing a log-likelihood L function (Bel et al., 2015; Tserng et al., 2014):

$$L(\beta) = \prod_{i=1}^{n} p^{Y_i}(1-p)^{1-Y_i} \quad (4)$$

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

Particularly for this work, Y_i gets the value of "1" when the company_i implemented at least one type of eco-innovation described in this dissertation dependent variables, or gets "0" if it did not implement any.

By applying the natural logarithm to eq. (4), characteristic of the log-likelihood transformation, products turn into sums. After some algebraic manipulations and the inclusion of eqs. (2) and (3), we get (Bel et al., 2015; Tserng et al., 2014):

$$\ln L(\beta) = \sum_{i=1}^{n} [Y_i \ln(p_i) + (1-Y_i)\ln(1-p_i)] \quad (5.1)$$

$$= \sum_{i=1}^{n} \ln(1-p_i) + \sum_{i=1}^{n} Y_i \ln\left(\frac{p_i}{1-p_i}\right) \quad (5.2)$$

$$= \sum_{i=1}^{n} -\ln(1+e^{\beta_0+\beta_i x_i}) + \sum_{i=1}^{n} Y_i \ln(\beta_0 + \beta_i x_i) \quad (5.3)$$

Finally, the parameters can be solved numerically by using the derivative operation on an equation system:

$$\begin{cases} \dfrac{\delta \ln L(\beta)}{\delta \beta_0} = 0 \\ \quad \cdots \\ \dfrac{\delta \ln L(\beta)}{\delta \beta_i} = 0 \end{cases} \quad (6)$$

For the actual logistic regression analysis being used later, a few equations need to be defined. It was defined that three groups of models were going to be analyzed and an extra one had to be added for correlation issues amongst two of the variables. The reason to name each equation a group is because of the hierarchical method used, that branches each equation into six except for the last group (equation 10) that branches into three.

The first three groups included the following independent variables: *Local and regional markets* (*MARLOC*), *National markets* (*MARNAT*), *EU markets* (*MAREUR*), *Other countries markets* (*MAROTH*), *Financial performance* (*FPERFm*), *Partners cooperation* (*part*), *Firm size* (*SIZE*), *Manufacturing sector* (*MANUF*), *Local and regional subsidies* (*FUNLOC*), *Central government subsidies* (*FUNGMT*), *EU subsidies* (*FUNEU*). The remain variables are for control: *Internal R&D* (*RRDIN*), *External R&D* (*RRDEX*), and *Part of a group* (*GP*). For the dependent variables *eco_inov* represents eco-innovation, *eco_inov_in* the eco-innovations happening inside the companies, and lastly *eco_inov_out* represents the eco-innovations happening during consumption by the end user.

$$Logit(eco\_inov) = \beta_0 + \beta_1 MARLOC_i + \beta_2 MARNAT_i + \beta_3 MAREUR_i + \beta_4 MAROTH_i + \beta_5 FPERFm_i + \beta_6 part_i + \beta_7 SIZE_i + \beta_8 SECTOR_i + \beta_9 FUNLOC_i + \beta_{10} FUNGMT_i + \beta_{11} FUNEU_i + \beta_{12} RRDIN_i + \beta_{13} RRDEX_i + \beta_{14} GP_i + \varepsilon \quad (7)$$

$$Logit(eco\_inov\_in) = \beta_0 + \beta_1 MARLOC_i + \beta_2 MARNAT_i + \beta_3 MAREUR_i + \beta_4 MAROTH_i + \beta_5 FPERFm_i + \beta_6 part_i + \beta_7 SIZE_i + \beta_8 SECTOR_i + \beta_9 FUNLOC_i + \beta_{10} FUNGMT_i + \beta_{11} FUNEU_i + \beta_{12} RRDIN_i + \beta_{13} RRDEX_i + \beta_{14} GP_i + \varepsilon \quad (8)$$

$$Logit(eco\_inov\_out) = \beta_0 + \beta_1 MARLOC_i + \beta_2 MARNAT_i + \beta_3 MAREUR_i + \beta_4 MAROTH_i + \beta_5 FPERFm_i + \beta_6 part_i + \beta_7 SIZE_i + \beta_8 SECTOR_i + \beta_9 FUNLOC_i + \beta_{10} FUNGMT_i + \beta_{11} FUNEU_i + \beta_{12} RRDIN_i + \beta_{13} RRDEX_i + \beta_{14} GP_i + \varepsilon \quad (9)$$

The extra group also makes use of the same independent variables except for *Part of a group* (*GP*) and the variable *part* that was decomposed in three to adjust for the correlation problems. With this is mind the new addition are: *Market available partners coop* (*MApart*), *Institutional partners coop* (Ipart), *Same group partners coop* (*SGpart*).

$$Logit(eco\_inov) = \beta_0 + \beta_1 MARLOC_i + \beta_2 MARNAT_i + \beta_3 MAREUR_i + \beta_4 MAROTH_i + \beta_5 FPERFm_i + \beta_6 MApart_i + \beta_6 Ipart_i + \beta_6 SGpart_i + \beta_7 SIZE_i + \beta_8 SECTOR_i + \beta_9 FUNLOC_i + \beta_{10} FUNGMT_i + \beta_{11} FUNEU_i + \beta_{12} RRDIN_i + \beta_{13} RRDEX_i + \varepsilon \quad (10)$$

The dependent variable used here was again the *eco_inov* since it encompasses the ten types of eco-innovation described on table 5 and is the one defined in the hypotheses for testing.

In any of the equation groups the following is true:

- β_i are the dependent and control variables regression coefficients
- ε is the associated error

4 Results

The model used for the analysis of the study is named logit which applies the maximum likelihood method to transform the binary variables estimated probabilities into an S-shaped curve with a continuous behavior. This estimate is calculated through a process of iteration until it finds the best approximated values for the constants (x_i) and respective coefficients (β_i) in order to maximize the observed probability of the output variable (Y) represented in equation 2. (Hausman & McFadden, 1984; Kim & Arbel, 1998).

From the three most common model building procedures, direct, sequential and step-wise it was chosen the second also known as hierarchical because it incrementally adds variables to understand the improvement progression of adding a new independent variable (Stoltzfus, 2011). In total there are 18 plus 3 models with the latter set being a special case since it encountered correlation issues amongst independent variables, as so the variable *GP* was excluded from these particular runs and *part* was split into the three variables it represents (*MApart*, *Ipart* and *SGpart*). Furthermore, *part* individually had far fewer observations which would compromise the results for other variables, these are the main reasons to analyze this hypothesis separately.

Regarding the models the first six have as the dependent variable *eco_inov*, the next set of six uses *eco_inov_in*, and lastly the final set of six utilizes the *eco_inov_out* variable. The three extra models use the complete *eco_inov* response variable as the intent is to analyze particularly the explanatory variables connected to hypotheses H3a, H3b and H3c. Nonetheless across all four sets the methodology used will be the same, first the independent variables related to the first hypothesis is run along with the control variables, followed by the second set pertained to the second hypothesis, after which every remaining explanatory variable will be added incrementally until the last variables are added to also be tested. Accompanying each model there will be some statistical outputs important to understand in more detail since they give a notion whether the models are being well built and also how to interpret the results.

Each table will present two values per independent variable being the first related to the marginal effects, and the second to the associated standard error enclosed between brackets. STATA as a default using the logit command outputs estimated coefficients which do not carry an accurate result to interpret, since this type of model portrays a transformation of the dependent variables that may not be linear. Only when working with purely linear models the coefficients and the marginal effects are always equal. As so, only the positive or negative sign indicate the tendency route but not the magnitude of the variables' relation. To counter this issue and to properly quantify the values, another command was used to immediately give said marginal effects that measure the impact a unit change in one variable has on the response variable while all other variables are held constant, regardless of linearity (Norton et al., 2019; Williams, 2012). Furthermore, every time there is statistical significance one, two, or three asterisks will be shown besides the margins results depending on their degree level with three being best.

At the end of the result tables there will be five other statistic measures to understand, those being the likelihood ratio chi^2 test, p-values, pseudo R^2, percentage of correct prediction and the number of observations. Starting with the LR chi^2, this test allows a researcher to know whether a model fits better compared to another where the predictor variables have been changed. By itself it does not hold any significant meaning, again from the same reason that the model is not linear. Instead, as the models are composed each one produces a LR chi^2 value that can be compared mutually to identify the better fit. A good model is one that obtains higher likelihood ratio values. Next come the p-values that tell the significance on the mathematical relationship between independent and dependent variables. It is to be used as a rough numerical guide on the effect opposing the null hypothesis. It cannot reject nor confirm relationships, instead it provides a sense of greater significance when falling below 1%, 5%, or 10% with the values closer to zero being more significant (Dahiru, 2011; Halsey et al., 2015). The pseudo-R^2 is another measure for goodness of fit, contrary to the case in ordinary least square models in logistic regression it can only explain the improvement in model likelihood over the null model. Also, direct comparisons can only occur between models using the same sample with the one having higher values getting the better fit assessment (Hemmert et al., 2016). To note that most empirical research does not typically offer strong predictors that directly give results close to the boundaries of the pseudo-R^2 (0-1), with that in mind it is not uncommon to obtain smaller than expected values (Mittlböck & Heinzl, 2001). Lastly, the percentage of correct prediction relates more to the efficiency or performance of the model. STATA uses what it calls sensitivity and specificity to calculate this percentage, which translates to the number of true positive and true negatives correctly classified by the model. Once again, the closer the number is to the upper limit the more accurate it is on predicting. In this case and although the scale goes from 0 to 1 it is best to have values above 0.5 or a simple toss of a coin would predict the same or better results. With this basis information acquired we can now proceed to the results presentation.

This first table 8 regarding the marginal effects presents the results for the *eco_inov* dependent variable and the incremental addition of each set of independent variables linked to the respective hypothesis.

Table 8 - Marginal effects for eco-innovation

Models	**1**	**2**	**3**	**4**	**5**	**6**
VARIABLES	.	.	.	.	.	.
MARLOC	0.052**	0.055**	0.057***	0.059***	0.064***	0.065***
Local and regional markets	(0.022)	(0.022)	(0.022)	(0.022)	(0.021)	(0.021)
MARNAT	0.004	0.003	0.004	0.008	0.025	0.026
National markets	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
MAREUR	0.080***	0.080***	0.081***	0.075***	0.026	0.023
EU markets	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
MAROTH	-0.008	-0.011	-0.013	-0.017	-0.029	-0.031*
Other countries markets	(0.019)	(0.019)	(0.019)	(0.019)	(0.018)	(0.018)
FPERFm	-	0.074***	0.065***	0.035	0.064**	0.065***
Financial performance		(0.024)	(0.024)	(0.026)	(0.025)	(0.025)
part	-	-	0.091***	0.086***	0.086***	0.078***
Partners cooperation			(0.021)	(0.021)	(0.021)	(0.021)
SIZE	-	-	-	0.078***	0.046**	0.044*
Firm size				(0.024)	(0.023)	(0.023)
MANUF	-	-	-	-	0.189***	0.187***
Manufacturing activity sector					(0.015)	(0.015)
FUNLOC	-	-	-	-	-	0.006
Local and regional subsidies						(0.041)
FUNGMT	-	-	-	-	-	0.016
Central government subsidies						(0.021)
FUNEU	-	-	-	-	-	0.037
EU subsidies						(0.026)
RRDIN	0.045***	0.040**	0.022	0.018	0.012	0.007
Internal R&D	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
RRDEX	0.056***	0.049**	0.028	0.027	0.036*	0.034*
External R&D	(0.019)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
GP	0.032*	0.011	0.002	-0.005	0.024	0.025
Part of a group	(0.017)	(0.018)	(0.019)	(0.019)	(0.018)	(0.018)
LR chi-squared	57.57	67.02	85.55	96.37	232.60	235.90
p-values	0.000	0.000	0.000	0.000	0.000	0.000
pseudo R-squared	0.0128	0.0150	0.0191	0.0215	0.0519	0.0526
% of correct prediction	67.14%	67.11%	67.19%	67.19%	67.34%	67.84%
Observations	3,539	3,539	3,539	3,539	3,539	3,539
Standard errors in parentheses						
***** p<0.01, ** p<0.05, * p<0.1**						

Following the progression characteristic of the hierarchical method it is noticeable that with each model the statistical indicators ensue an upwards trend signaling increasingly better model fits. The LR chi^2 and the pseudo R^2 are the most evident quadrupling their initial outputs which gives a higher degree of confidence in the results. The overall p-value of the models repeats itself along the columns obtaining the best score in terms of significance while also indicating strong mutual exclusivity of variables. The percentage of correct prediction although varying slightly, also experienced an increase.

Regarding the marginal effects, on a distant look we can see that every variable has a positive effect on eco-innovation with the exception of *MAROTH* pertained to companies operating in intercontinental markets, more specifically outside Europe.

Companies working in local and regional markets (*MARLOC*) show a positive relationship with *eco_inov* throughout the six models with an increase in significance after the third reaching values of $p<1\%$ and a marginal effect of 0.065. On the other side MAREUR had a similar but opposite behavior, starting with high significance but ending with a marginal effect of 0.023 and outside the boundary of $p<10\%$. Almost passing under the radar *MAROTH* finishes the sixth model with $p<0.1$ but as the margins value is negative it indicates that these companies have a -0.031 probability to introduce *eco_inov*. The financial performance related variable (*FPERFm*) went from being in the best significance intervals to not showing significance at the introduction of *SIZE* but bounced back to the three asterisks score ending with a marginal effect of 0.065. The variables' *part*, *SIZE* and *MANUF* received all some degree of significance to corroborate the increased probability of companies to implement eco-innovation. Finally, the variables related to subsidies (*FUNLOC*, *FUNGMT* and *FUNEU*) did not show an indication of being significant within the stablished parameters of 1%, 5%, and 10%.

Overall, the results validate Hypothesis 1 where the geographical market reach was tested in the sense that companies operating in more local markets tend to eco-innovate more, the intercontinental ones have decreased probability, and the remaining not getting conclusive results. The other validated hypotheses where H2 (Financial performance is positively related to eco-innovation), H4 (Firm size is positively related to eco-innovation), and H5 (The manufacturing sector is positively related to eco-innovation). Hypotheses H3a, H3b, and H3c as a whole are validated by the variable *part* but will get an individual analysis later. The only hypothesis which got rejected was H6 (External factors are positively related to eco-innovation).

This second marginal effects table 9 presents the results for the *eco_inov_in* dependent variable.

Table 9 - Marginal effects for eco-innovation within the company

Models	1_in	2_in	3_in	4_in	5_in	6_in
VARIABLES	.	.	.	.	.	.
MARLOC	0.047**	0.050**	0.052**	0.053**	0.060***	0.061***
Local and regional markets	(0.023)	(0.023)	(0.023)	(0.023)	(0.022)	(0.022)
MARNAT	-0.018	-0.018	-0.017	-0.013	0.007	0.006
National markets	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
MAREUR	0.083***	0.083***	0.083***	0.076***	0.022	0.020
EU markets	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
MAROTH	-0.003	-0.006	-0.007	-0.013	-0.026	-0.029
Other countries markets	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
FPERFm	-	0.067***	0.060**	0.020	0.051**	0.050**
Financial performance		(0.024)	(0.024)	(0.026)	(0.026)	(0.026)
part	-	-	0.070***	0.064***	0.064***	0.057***
Partners cooperation			(0.021)	(0.021)	(0.021)	(0.021)
SIZE	-	-	-	0.102***	0.068***	0.066***
Firm size				(0.024)	(0.024)	(0.024)
MANUF	-	-	-	-	0.204***	0.202***
Manufacturing activity sector					(0.015)	(0.015)
FUNLOC	-	-	-	-	-	-0.034
Local and regional subsidies						(0.041)
FUNGMT	-	-	-	-	-	0.024
Central government subsidies						(0.021)
FUNEU	-	-	-	-	-	0.025
EU subsidies						(0.026)
RRDIN	0.033*	0.028	0.014	0.009	0.002	-0.003
Internal R&D	(0.017)	(0.017)	(0.018)	(0.018)	(0.018)	(0.018)
RRDEX	0.068***	0.061***	0.045**	0.044**	0.053***	0.051**
External R&D	(0.020)	(0.020)	(0.021)	(0.021)	(0.020)	(0.020)
GP	0.025	0.006	-0.001	-0.010	0.021	0.021
Part of a group	(0.018)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
LR chi-squared	52.42	59.89	70.63	88.63	241.27	244.13
p-values	0.000	0.000	0.000	0.000	0.000	0.000
pseudo R-squared	0.0113	0.0129	0.0152	0.0191	0.0520	0.0526
% of correct prediction	63.52%	63.58%	63.72%	63.80%	65.50%	65.87%
Observations	3,539	3,539	3,539	3,539	3,539	3,539
Standard errors in parentheses						
***** p<0.01, ** p<0.05, * p<0.1**						

This table uses the same method of incremental addition of each set of independent variables linked to their respective hypothesis. It is important to remind that *eco_inov_in* concerns just with eco-innovations happening within the company, as so it will set a comparison basis to understand the origin of these innovations.

The progression of the hierarchical method again shows the upwards trend that signals the increasingly better model fit. The LR chi^2 and the pseudo R^2 this time rose in a 4.6x magnitude regarding the first model run and the last, however these indicators got different values relative to the first analysis in table 8. There was an 8-point improvement in the LR chi^2 score, the pseudo R^2 and overall p-value maintained the exact same score and there was 2% points decrease on the percentage of correct prediction.

The margins positive and negative relations were retained excluding one more addition to *MAROTH*, that is the local or regional authorities' subsidies (*FUNLOC*) portraying the unfavorable results.

In line with the first analysis there are variables preserving the same statistical significance and others changing their status. The variable *MAROTH* that only got one asterisk ($p<0.1$) now lost complete significance and is put together with the inconclusive ones. As for the financial performance variable (*FPERFm*) it is now with a lesser significance of $p<5\%$. On the contrary raising two levels of significance is *SIZE* that here scores the best p-values under 1%.

From the prior table 9 the same conclusions previously made for rejection or validation of hypotheses can be withdrawn.

The third marginal effects table 10 closes the other half of the comparison, this time using *eco_inov_out* as the dependent variable i.e., it relates to potential benefits obtained during the end user consumption.

Table 10 - Marginal effects for eco-innovations happening by the end user side

Models	1_out	2_out	3_out	4_out	5_out	6_out
VARIABLES	.	.	.	.	.	.
MARLOC	0.038	0.040*	0.043*	0.044*	0.049**	0.048**
Local and regional markets	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
MARNAT	-0.001	-0.002	-0.000	0.002	0.016	0.018
National markets	(0.027)	(0.027)	(0.027)	(0.027)	(0.026)	(0.026)
MAREUR	0.075***	0.075***	0.077***	0.073***	0.033	0.031
EU markets	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
MAROTH	-0.012	-0.013	-0.016	-0.019	-0.029	-0.027
Other countries markets	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
FPERFm	-	0.047*	0.037	0.018	0.039	0.043
Financial performance		(0.024)	(0.024)	(0.026)	(0.026)	(0.026)
part	-	-	0.104***	0.101***	0.101***	0.098***
Partners cooperation			(0.021)	(0.021)	(0.021)	(0.022)
SIZE	-	-	-	0.048**	0.026	0.025
Firm size				(0.024)	(0.024)	(0.024)
MANUF	-	-	-	-	0.150***	0.153***
Manufacturing activity sector					(0.017)	(0.017)
FUNLOC	-	-	-	-	-	0.088**
Local and regional subsidies						(0.043)
FUNGMT	-	-	-	-	-	-0.015
Central government subsidies						(0.022)
FUNEU	-	-	-	-	-	0.026
EU subsidies						(0.026)
RRDIN	0.059***	0.056***	0.034*	0.031*	0.026	0.025
Internal R&D	(0.018)	(0.018)	(0.018)	(0.019)	(0.018)	(0.019)
RRDEX	0.059***	0.054***	0.029	0.029	0.035*	0.035*
External R&D	(0.020)	(0.020)	(0.021)	(0.021)	(0.021)	(0.021)
GP	-0.006	-0.020	-0.031	-0.035*	-0.014	-0.012
Part of a group	(0.018)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
LR chi-squared	48.13	51.87	75.36	79.44	151.92	157.82
p-values	0.000	0.000	0.000	0.000	0.000	0.000
pseudo R-squared	0.0099	0.0106	0.0155	0.0163	0.0312	0.0324
% of correct prediction	55.98%	56.03%	58.35%	57.73%	58.15%	58.77%
Observations	3,539	3,539	3,539	3,539	3,539	3,539
Standard errors in parentheses						
***** p<0.01, ** p<0.05, * p<0.1**						

Pursuing the same verification the hierarchical method can provide, in other words, the capacity of increasing prevision it is observable the growth tendency with all statistical predictors. But once again, when compared to the initial table 8 there are dissimilarities. In this case none improved but instead worsen except for the overall p-value which kept the highest significance level. The LR chi^2 and the pseudo R^2 got a threefold increment across the first and last model but took an expressive downfall regarding their values when compared to the first table 8 analysis. Calculating the differences, the LR chi^2 dropped roughly 78 points, the pseudo R^2 lost around 0.02 and the percentage of correct prediction lowered close to 9% points.

In consonance with what happened in the *eco_inov_in* analysis one more variable joined the negative relation that *MAROTH* presented in table 10, this time was also within the scope of hypothesis H6 but referred to the central and governmental subsidies (*FUNGMT*).

With regards to the table 10 core values, two variables lost significance and one gained when previously had not yet obtained it, while others suffered minor alterations. *MARLOC* saw its level decrease by one, meaning here has a p-value under 5%, *MAROTH* strayed to non-significance along with *FPERFm* and *SIZE*. On the other side local and regional authorities' subsidies (*FUNLOC*) seem to be significant obtaining a score of 0.088 with $p<0.05$.

These results are much different from what was previously stated. From the margins values in the above table the validated hypotheses are now H1 (Geographical market reach is positively related to eco-innovation), H3[7] (Partners cooperation is positively related to eco-innovation), H5 (The manufacturing sector is positively related to eco-innovation), and the new addition H6 (External factors are positively related to eco-innovation). The rejected hypotheses are H2 (Financial performance is positively related to eco-innovation) and H4 (Firm size is positively related to eco-innovation).

[7] H3 is a conjoined hypothesis of H3a, H3b and H3c meant to simplify the notation since at this stage they have not been properly evaluated but will on the next page.

Finally, the last table 11 in reference to marginal effects will analyze particularly hypotheses H3a, H3b, and H3c concerned with the type of partners cooperation.

Table 11 - Marginal effects for MApart, Ipart and SGpart (H3a,b,c) hypothesis verification

Models	**3.1**	**3.1_in**	**3.1_out**
VARIABLES	.	.	.
MARLOC	0.118***	0.106***	0.095**
Local and regional markets	(0.035)	(0.038)	(0.044)
MARNAT	-0.088*	-0.150***	0.004
National markets	(0.049)	(0.054)	(0.055)
MAREUR	0.008	-0.006	0.063
EU markets	(0.039)	(0.042)	(0.049)
MAROTH	0.013	0.025	-0.072*
Other countries markets	(0.034)	(0.036)	(0.042)
FPERFm	0.089**	0.072*	0.034
Financial performance	(0.037)	(0.039)	(0.043)
MApart	0.146***	0.140***	0.156***
Market available partners coop	(0.030)	(0.032)	(0.038)
Ipart	0.096***	0.115***	0.066*
Institutional partners coop	(0.032)	(0.033)	(0.037)
SGpart	-0.014	-0.009	-0.051
Same group partners coop	(0.034)	(0.035)	(0.039)
SIZE	-0.006	0.014	0.032
Firm size	(0.035)	(0.036)	(0.041)
MANUF	0.148***	0.184***	0.121***
Manufacturing activity sector	(0.029)	(0.030)	(0.035)
FUNLOC	-0.033	-0.074	-0.055
Local and regional subsidies	(0.055)	(0.058)	(0.070)
FUNGMT	-0.015	0.003	-0.003
Central government subsidies	(0.032)	(0.034)	(0.039)
FUNEU	-0.002	-0.009	0.029
EU subsidies	(0.034)	(0.036)	(0.041)
RRDIN	-0.003	-0.025	0.007
Internal R&D	(0.035)	(0.037)	(0.042)
RRDEX	0.040	0.042	0.061*
External R&D	(0.029)	(0.030)	(0.034)
LR chi-squared	77.25	87.91	48.79
p-values	0.000	0.000	0.000
pseudo R-squared	0.0786	0.0821	0.0398
% of correct prediction	76.77%	73.29%	59.6
Observations	891	891	891
Standard errors in parentheses			
***** p<0.01, ** p<0.05, * p<0.1**			

Since there was a choice to study the three dependent variables throughout the study, table 11 presents a column for each one. Furthermore, given that the hierarchical method was already put to trial the direct procedure was used to cut unnecessary steps. Nevertheless, some consideration can be made comparing the three models (M3.1, M3.1_in, and M3.1_out)

In terms of statistical predictors, the model that obtained the highest goodness of fit values was M3.1_in with a LR chi^2 of 87.91, and a pseudo R^2 of 0.0821 only falling behind around 3% points when it came to the percentage of correct prediction. All three models scored the best significance value as to what p-values are concerned. To note the number of observations 891 that is one of the justifications for the need to run these models separately.

Cutting straight to the point of this table 11 analysis it is noticeable that the market available partners cooperation (*MApart*) is always significant with the p-values<0.01 giving a confidence interval of 99% for being correct, and a marginal effect of 0.146 when looking to the *eco_inov* complete variable. The institutional partners cooperation appears to be more significant within the company (*eco_inov_in*) and generally (*eco_inov*), than outside the companies (eco_inov_out). *Ipart* reached a p-value lower than 1% and a marginal effect of 0.096 with model 3.1. Finally, is the same group partners cooperation (*SGpart*) that presented no significant values.

With these results it is confirmed that hypotheses H3a (Market available partners cooperation is positively related to eco-innovation) and H3b (Institutional partners cooperation is positively related to eco-innovation) are validated and H3c (Same group partners cooperation is positively related to eco-innovation) gets rejected.

Finishing the marginal effects analysis, it is important to remember that the indicators are not absolute because they are pointers, which means they only stablish a possible relation, and more investigation would further help consolidate the evidence. An effect might exist but the sample size, or too much variability of data are factors that have a big impact on the outcomes and the hypothesis formulated alone might not be able to detect or prevent those issues. With that said, table 12 summarizes the validations and rejections for the hypotheses.

Table 12 - Hypotheses validation and rejection summary

Hypotheses	Results
H1. Geographical market reach is positively related to eco-innovation.	Validated.
H2. Financial performance is positively related to eco-innovation.	Validated.
H3a. Market available partners cooperation is positively related to eco-innovation.	Validated.
H3b. Institutional partners cooperation is positively related to eco-innovation.	Validated.
H3c. Same group partners cooperation is positively related to eco-innovation.	Rejected.
H4. Firm size is positively related to eco-innovation.	Validated.
H5. The manufacturing sector is positively related to eco-innovation.	Validated.
H6. External factors are positively related to eco-innovation.	Rejected.

5 Concluding Remarks

This research aimed to identify eco-innovation determinants in Portuguese companies by utilizing data obtained from the Community Innovation Survey CIS2014. With the purpose of having good base grounds, a literature research was made where numerous determinants were uncovered always having in mind the environmental field. After a careful selection and considering the variables availability in the data base chosen, eight hypotheses were formulated in order to be tested through the econometric model logit.

Results showed the determinants having a positive relation with eco-innovation were the *Local and regional markets*, *Financial performance*, *Market available partners*, *Institutional partners*, *Firm size*, and *Manufacturing sector* with *Other countries markets* and *Same group partners cooperation* having a negative relation.

Most of the findings are consistent with what was found in the literature review. However, the research showed some doubts on the relation of a couple predictors. The geographical reach divided scholars on whether internationalization is more eco-innovation inducing or rather staying in national markets is more compelling to the environmental cause. On one hand increasing market distance is seen as an opportunity to expand the customer crowd, diversity of cultures and eco-interests by some authors (Cainelli et al., 2012; Guarín & Knorringa, 2014; Hagen et al., 2014; Hojnik et al., 2018; Kriz & Welch, 2018; Ryszko, 2016), on the other hand closer operations provide easier communications and less complex internalization of profits (Biscione et al., 2020; De Marchi, 2012; del Río et al., 2017; Horbach, 2008; Jové-Llopis & Segarra-Blasco, 2018). This work contributes to the latter side were national and regional markets have the positive relation and adds Portugal's as a new region studied since there was no previous knowledge found within this context.

The only result that went against the majority of the research evidence was one that might initially surprise since it relates to subsidies, fiscal incentives and similar benefits. Ghisetti & Rennings (2014) and Tsai & Liao (2017) both pointed to the risks engaging in eco-innovation might carry and the important aid and sense of security financial support may bring. What other authors mention is that many firms only pursue eco-innovation in a way to avoid paying higher taxes and not from own initiative (Biscione et al., 2020; De Marchi, 2012; Triguero et al., 2018). With this we start to unveil the possible justification for this work to reject this hypothesis (H6). The other possible reason might come since Portugal went through a financial crisis and had strict policies from European Troika which resulted in severe cutbacks on incentives[8] all within the data period. Moreover, subsidies were also reported as outdated and ineffective (Horbach et al., 2013; Jové-Llopis & Segarra-Blasco, 2018). In brief we can say that time and circumstances are of utmost importance.

Notwithstanding the remaining verdicts follow the literature. With Adelegan & Carlsson (2010), Bansal & Gao (2006), González-Benito & González-Benito (2005), and Sanni (2018) stating the same as in this work, that might be seen has an healthy loop where companies searching for better financial

[8] https://acervo.publico.pt/economia/memorando-da-troika-anotado

performance resort to eco-innovation and financially better firms tend to be recurrent in eco-innovation (Biscione et al., 2020; Chassagnon & Haned, 2015; Doran & Ryan, 2012).

For partners cooperation and like Borghesi et al. (2012), Cainelli et al. (2012), De Marchi (2012), Doran & Ryan (2012), Ghisetti et al. (2015), and Horbach & Rammer (2018) said the impact level on eco-innovation pertains to the specific study which in Portugal's case prevailed the market available and institutional cooperation kind. It comes to show that knowledge exchange does help companies to evolve in a sustainable way.

As shown in other countries, company size emerged as a solid determinant indicating that bigger firms have indeed more possibilities to address conscious behavior and practices (Chassagnon & Haned, 2015; De Marchi, 2012; Jové-Llopis & Segarra-Blasco, 2020; Tsai & Liao, 2017). In this sense SMEs that represent the majority of firms in Portugal need incentives help to overcome barriers like the smaller capital and inability to ensue in economies of scale, described as strong suits for larger companies (Chassagnon & Haned, 2015).

Lastly, the literature also corroborates the results referred to the sector. Many scholars tend to discover that the manufacturing sector allocates the bigger portion of eco-innovators since it is the most regulated and has the biggest environmental impacts (Biscione et al., 2020; Jové-Llopis & Segarra-Blasco, 2018). With no difference the results obtained also indicate the manufacturing sector to be more eco-innovative than the services sector.

Since CIS2014 divides environmental benefits into those happening within the company and those happening on the end user side it almost compels us to analyze these two scenarios. What was shown by the results in this dissertation is that eco-innovation happening where there is more control of conditions, that is inside the firm, outputs the same conclusions received when analyzing the conjoined environmental benefits. While on the "outside" firms lose part of their influence to the customer and became dependent which is reflected on the different reject/valid outputs.

The work done allows for a general sensibility around what affects eco-innovation in Portuguese firms. It has the intent to inform and alert policy makers on the standings of the country facing environmental concerns that by no means can be disregarded. At the same time tries to exhibit some useful information that companies may use to address existing gaps and implement eco-innovation. Ultimately by upbringing this topic it is hoped that there is some contribution at least in the awareness and further discussion of the topic.

5.1 Limitations

Throughout the composition of the study there were some limitations to be taken into consideration. The first one recalls back to the choosing of the data. Although there is a continuity in editions after CIS2014, unfortunately environmental questions were removed from the surveys released afterwards. As a result, it was not possible to use more recent data from the Community Innovation Survey. Moreover, the span of the data collection was three years, however very few variables had year by year discrimination which poses a less precise analysis if it were needed a pinpoint event in time. As a result of these two limitations another emerges which alludes to the restricted branch for comparison of similar works.

On the results side, the pseudo R^2 obtained throughout the tables revealed an opportunity for refinement according to the work of McFadden (1972) where the values were not so close to the perfect fit.

Another limitation concerns with the number of answers to the questions. Since some questions had precedence companies that did not meet the requirements to one topic, were instructed to skip a given number of questions. In addition, some companies simply did not answer fully to the survey. This originated variables with observation numbers in a smaller scale which impacted the capacity to predict the hypotheses relationships with more certainty.

Being most questions answered with a simple yes or no raises disadvantages since the check boxes may not have the exact answer the respondent wants and in turn could produce incorrect analytical reports. Measuring the magnitude impact of variables becomes somewhat impaired. Adding to this, it is important to remember that the results presented should not be set in stone both for the reason described before and for different circumstances that can affect the same study objective. As so, "interpretation of results should only be preliminary" (Lewis, 2007).

One more point to take into consideration is that not all information was disclosed from the survey. Some answers were left concealed to preserve the identity of companies, like the firms' age one of the most used variables in the literature. Although understandable it limited a more robust analysis and maybe there were ways to circumvent the anonymity issue.

5.2 Future work and suggestions

Considering that eco-innovation also fits inside the other four types of innovation, future work could try to discriminate whether it comes from a product, process, marketing, or organizational innovation.

Being the environment a field subject to long periods to see actual improvements and progress subsequent of companies' eco-actions, larger period data sets for analysis are recommended.

While researching, two subtypes of eco-innovation were identified the incremental and the radical. A suggestion to CIS authors and other entities alike is to include questions regarding this subject since some solutions are known to affect financial performance with extra costs and others have the ability to create new better markets (Freeman, 1992; Hojnik & Ruzzier, 2016).

For future scholars it is suggested a continuation of the analysis on this field with more up to date information. That will enable a broader contribution for comparisons to portray the advancements regarding environment decisions inside companies.

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7 Annexes

Table A1 - Literature research findings with authors' objectives, variables, model, sample, and conclusions.

Author	Objective	Variables	Model	Sample	Conclusions
(Triguero et al., 2018)	Understand the impact of open innovation strategies on eco-innovation, specifically for product and process, considering the scale of the introduced novelty over the Spanish food and beverage industry.	**Dependent:** A set of 12 variables originates by combining: - Product; Process; Incremental; Radical. - Material; Energy; Environmental. **Independent:** - Firm resources and capabilities (R&D intensity; non-R&D-embodied; non-R&D-disembodied; R&D-formation). - Collaboration with partners, alliances networks (External R&D; Cooperation; Breadth; Depth). - Market demand for green products (Market pull). - Regulation, fiscal incentives, and subsidies (Regulatory-push). **Control:** - Size; Age; Year.	Multivariate probit model	PITEC 2008-2014	Breadth of external R&D sources have a positive impact on most eco-innovations tested. While depth only significantly impacts process, product and incremental innovations related to materials and energy. Adoption of eco-innovations is dependent on market demand and regulatory factors. Eco-innovation introduction rewards the food industry.
(Biscione et al., 2020)	Identify the environmental innovation determinants of manufacturing firms from European countries going through transition economies.	**Dependent:** - Eco-process; Eco-product; Eco-organization **Independent:** - Present Regulations; Future Regulations; Taxes and Fees; Subsidies; Reputation; Voluntary Actions; Cooperation; Cost saving; Market demand for eco-innovation; EMS[9]; National Market; European Market; International Market; Turnover; R&D; Affiliation; Polluting sectors. **Control:** - Business group affiliation - Industry sector	Multivariate probit	CIS 2012-2014	Every eco-innovation measured is affected by regulation, especially expected regulation which impacts present decisions on eco-innovation, but only if a firm has a large turnover. Also, turnover and tax rates positively affect eco-innovation which means that firms initiate environmental innovation to avoid incurring on taxes. Public policies and incentives have stronger impact on eco-innovation than demand-pull[10] factors. Moreover, market demand for eco-innovation positively correlates with eco-product but not with eco-process.

[9] Environmental Management Systems. Processes and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency.
[10] Demand-pull - when demand exceeds supply leading to higher prices on the market. Can be caused by low unemployment due to more people having more income.

Table A1 *(continued)*

(Borghesi et al., 2012)	Investigate the driving determinants for environmental innovation (EI) adoption and whether EU's emission trading scheme influences EI embracement.	**Dependent:** - ECOMAT; ECOEN; ECOCO; ECOENU; ECOPOS; ECOREA. **Independent:** - External factors (INF-GROUP; INF-SUPP; INF-CLIEN; INF-OTHFIR; INF-PRIVRES; INF-UNIV; INF-PUBRES; INF-FAIR; INF-JOURN; INF-ASSOC; COOPERATION; BUSINESS GROUP). - Internal factors (SALE_GROWTH; PRODUCTIVITY; EXPORT; R&D; TRAIN). - Policy factors (D_ETS; ETS-STRINGENCY; PUBFUND).	Probit model	CIS 2004-2006	External forces such as relationships with other institutions, public funding, and group membership boost EI adoption on radical new technologies. Training has the same positive impact. EUs emissions trading system (ETS) does not show evidence of improving EI but rather energy efficiency innovations.
(Cainelli et al., 2012)	Assess firms' environmental innovations influence over local production systems. Also, the role of inter-firm network relationships, agglomeration economies and internationalization strategies.	**Dependent:** - Eco-innovations; Innovation in material efficiency; Innovation in CO_2 abatement; Innovation in emission abatement; ISO_{14001} adoption. **Independent:** - R&D programs; University cooperation; Suppliers cooperation; ICT adoption; Training coverage; ID; Export propensity; Foreign ownership; Environmental investments; Waste reduction investments; Air emissions investments; GHG on VA.	Probit	CIS 2006-2008	The drivers providing higher impact are suppliers and universities while receiving training and adopting information and communication technologies. Agglomeration economies either act as a barrier or on the contrary, if established local production systems exist, act as an EI driver. Inter-firm and internationalization strategies help to the abatement of CO2 and ISO labelling. Regulation stimulates EI adoption.
(Cainelli et al., 2020)	Demonstrate that environmental policies and demand drivers can be resource efficient eco-innovation factors.	**Dependent:** - ECOMAT; ECOREC; ECOREA; GIN. **Independent:** - ENREG; ENDEM. **Control:** - RRDIN; BGROUP; C_HO; MARLOC; MARNAT; MAREUR; MAROTH; EURO; ETS.	Bivariate probit and Instrumental variable linear probability models	CIS 2006-2008	Environmental policies and market demand factors contribute to the adoption of eco-innovation such as recycling and waste plus material usage reduction.

Table A1 *(continued)*

(Chassagnon & Haned, 2015)	Discuss whether the "innovation leaders" are the ones applying environmental innovations. Postulate an answer by focusing on the leadership role for the application of eco-innovation.	**Dependent:** - INOTECH; ENVIP; EOP; CERT) **Independent:** - ENREG; ENDEM; ENCOST. - R&D expenses (RDINTEMP; RDEXTEMP; GP; DFOOD; DTEXT; DWPF; DPC; DRP; DMET; DMEQUIP; DELEC; DMOT) **Control:** - Sectoral (DFOOD; DTEXT; DWPF; DPC; DRP; DMET; DMEQUIP; DELEC; DMOT; DREF). - Technological intensity (DSECTH; DSECTML;).	Heckman correction and Ordered probit	French CIS 2002-2008	"Innovation leaders" are indeed the ones promoting environmental innovations, showing a strong influence on the results. Furthermore, regulations and costs savings have a big effect as determinants of eco-innovation along with strong leadership.
(De Marchi, 2012)	Understand the specificities that affect eco-innovation adoption, rather than how they are developed, particularly the externalities and drivers of their introduction like in R&D cooperation.	**Dependent:** - ENV_INN; ENV_INN2; ENV_INN3. **Independent:** - COOP; EXT_R&D; R&D_INTENSITY; CONT_R&D; EQUIPMENT; PrINNOVATION. **Control:** - SIZE; SUBSIDIARY; INNOVATION04; PUB_FUNDS; EXPORT.	Two-part logit model	Spanish CIS (PITEC) 2007	External partners cooperation stands out on environmental innovative firms. The same conclusion went for suppliers, knowledge intensive business services, and universities where again the partner intensity is higher than on non-innovative firms. Internal R&D resources found to be the same in non-eco and eco firms with the latter implementing these activities more consistently. Internationalization strategies, bigger company size, public subsidies, and firms with previous eco implementations have an easier tendency to eco-innovate.
(Doran & Ryan, 2012)	Test the factors which drive eco-innovation and assess if eco-innovating firms have better turnover performance than the antipode ones.	**Dependent:** - Innovator; Eco-innovator. **Independent:** - Existing regulation; Expected regulation; Government grants; Customer perceptions; Voluntary agreements; Forward linkages; Backward linkages; Horizontal linkages; Public linkages; Intramural R&D; Extramural R&D; Employment; Irish owned; Capital; Turnover. **Control:** - Sector; Size; Capital.	Probit model	Irish CIS 2006-2008	Findings suggest that regulation and customer impression affect decisions towards applying eco-innovation actions. These two factors added to external partners and knowledge acquisition are the four central eco-drivers. Firm performance was found to be more frequently calculated through eco-innovation degree extent. Eco-innovation positively impacts a firm's performance by a higher turnover per employee.

Table A1 *(continued)*

(Ghisetti & Rennings, 2014)	Analyze the impacts on firms' profitability, between the ones reducing negative externalities, and those allowing for efficiency and cost savings. Also, if motivation of adopting eco-innovation affects economic gains.	**Dependent:** - Firms' profitability (OM). **Independent:** - EI; EREI; ER. **Control:** - SIZE; R&D; LPAT; Market Share; HHI; EAST; PC.	Probit model	Mannheim Innovation Panel 2009 (based on CIS 2006-2008)	Negative externality reduction focused firms are hindered on competitiveness compared to those more dedicated to energy and materials usage reduction per output. However, on the long run it may pay off to have an externality strategy such as avoid using harmful materials or directly pollute air, water, noise, and soil. This is true if environmental regulations are improved, otherwise on the short run is not profitable. Motivation was concluded to be highly responsible for profitability on eco-innovations.
(Ghisetti et al., 2015)	Assess the effects that knowledge sourcing has on further environmental innovation adoption by firms. Furthermore, they estimate the significance knowledge extent has and test the firms' capacity of said absorption.	**Dependent:** - Eco-innovation. **Independent:** - BREADTH; DEPTH; R&D; SIM. **Control:** - lnTURNOVER; COUNTRY; SECTOR; COOP; EXPORT; MNC; INNOPOL; POLSTR.	Logit and bivariate probit models	CIS 2006-2008	Knowledge sourcing was revealed has having a favorable result on EI, if the broad sourcing strategy is kept below a certain limit. This limit may be imposed by cognitive capacity on digesting multiple knowledge inputs. Absorptive capacity mostly provides the ability to turn external knowledge into EI, with the difficulty of merging own management practices with the outside knowledge.
(Horbach & Rammer, 2018)	Study the function of firms in their ability and willingness to adopt green energy technologies and the impact of this process, while considering their regional environment.	**Dependent:** - Renewable. **Independent:** - Regional (Popdens; Secshare; Sharegreen; Solbiocapita; Solitens; Watercapita; Windcapita). - Tech capabilities (Externrd; Internrd; Org; Highqual). **Control:** - Agefirm; Competition; Family; International; Profit; Size; Sector dummies.	Multilevel mixed effects probit and Ordinary probit	German CIS 2014	As seen in other studies government regulations are very relevant for EI adoption, but also geographical vicinity to renewable electricity production sources, and the mindfulness of the region to achieve green solutions. Subsidies have a lesser impact on renewable energy application than other EI's. High energy costs appear to be the motive to introduce renewables. A demonstration and learning effect seem to occur on the regional level, with companies observing one another (knowledge spillovers).

Table A1 (continued)

(Horbach et al., 2012)	Determine if eco-innovation is driven by different factors (supply, firm-specific and demand factors, regulation, cost savings and customer benefits).	**Dependent:** - EcoInnovation **Independent:** - Eco-innovations within firm; Product innovations; Policy measures; Market pull; Technology Push; Information sources; Cooperation; Competition. **Control:** - Size; Age; Eastwest; Sector dummies; Innovators dummies.	Probit (Binary discrete choice model)	German CIS 2009	Expected regulations greatly impact forthcoming eco-product innovations, with current ones persuading firms to reduce air, water, and noises pollution, avert harmful substances, and boost recyclability of products. Costs reduction motivates firms to use less energy and materials. On the market side, customers influence firms' routes to more efficient products leading to more efficient processes like material and waste optimization.
(Horbach et al., 2013)	Construct an econometric analysis in order to identify common cross-country determinants and country-specific characteristics of eco-innovation between France and Germany.	**Dependent:** - Ecoinnovation; EnvGermany. **Independent:** - Policy measures; Market pull; Market characteristics; Innovative activities; Barriers; Information sources; Appropriability. **Control:** - PACE; HHI;	Probit model	CIS4 2002-2004	Government regulation together with costs savings aspirations are big EI motivators. External resources (R&D) make for a substantial part when conducting eco-innovative activities, more than internal. Since Germany and France have different policies, universities cooperation shows greater emphasis on the latter.
(Horbach, 2016)	Identify and analyze the determinants of eco-innovation activities and compare them between different countries located in Eastern Europe.	**Dependent:** - Ecoinnovation **Independent:** - Regulation measures; Subsidies; Market demand; Cost savings; Innovation inputs; Innovation objectives; Information sources; Organizational innovations. **Control:** - Size; Sector; Country dummies.	Ordinary and multivariate probit models	CIS 2006-2008	The study confirmed that government regulations and environmental grants are determinants for Eastern countries with a lesser stand on wealthier Western European countries. Eastern European countries tend to lean more against external R&D and competitors knowledge sources underlining a transposition of technology from West to East. Cost savings have great impact on motivation for eco-adoption and internal R&D is very relevant for material and energy optimization management. This leads to fewer costs in labor per unit of output.

Table A1 *(continued)*

(Jové-Llopis & Segarra-Blasco, 2018)	Study the drivers/determinants for projects of eco-innovation strategy in Spanish companies.	**Dependent:** - Technological innovation; Eco-innovation strategy; Reduce environmental impacts; Energy efficiency. **Independent:** - Environmental policy (Regulation; Subsidies). - Technology push factors (Internal R&D effort; External R&D effort; R&D cooperation; Sources of information; Breadth of sources). - Market-pull factors (New market; Market share). **Control:** - Size; Group; Industry dummies; Time dummies.	Dynamic random probit model	PITEC 2008-2014	Environmental policies and R&D efforts factor has an important determinant for eco-innovations, with subsidies not being a differentiating driver. The more a firm engages in eco-innovation the more that past experience is to perdure over time, meaning a repetitive eco-behavior is stamped. The study results seemed to point out market factors has not being relevant enough to be key drivers.
(Jové-Llopis & Segarra-Blasco, 2020)	Demonstrate which are the main drivers of eco-innovation along with an analysis of divergences and convergences between service and manufacturing firms.	**Dependent:** - Eco-innovation strategy; Green strategy; Energy efficiency strategy. **Independent:** - Policy influences (Regulation; Subsidies). - Technology push factors (Internal R&D effort; External R&D effort; R&D Cooperation). - Market-pull factors (New market; New firm). - Firm characteristics (Size; Young; Group; Exports). **Control:** - Industry dummies.	Dynamic random probit	PITEC 2008-2015	Compared to service firms, manufacturing firms are more environmentally friendly, although both sectors are moderate in their eco-strategies. Internal R&D, firm size, and eco-innovation persistence are drivers for both service and manufacturing firms. Eco-regulations and coop seem to affect more the manufacturing firms, while for the service one's market pull factors tend to be more important.
(Ryszko, 2016)	Examine the influence that proactive environmental strategy has on firm performance on a technological eco-innovation level.	**Dependent:** - Technological eco-innovation; Operational performance; Financial performance. **Independent:** - 16 Proactive environmental strategy variables; 6 Technological eco-innovation variables; 2 Operational performance variables; 4 Financial performance variables. **Control:** - Firm size; Pollution intensity; Market internationalization.	Partial least squares model	CATI (computer assisted telephone interview) 2013[11]	Results showed no direct support that proactive environmental strategies impact firms' performance. On the contrary, technological eco-innovation did play a significant part. Furthermore, the author concluded EI tech provides positive increments to the environment and to the economic pillars of sustainable development.

[11] Conducted by the largest Polish research agency, PBS Ltd., which meets the highest research standards.

Table A1 *(continued)*

(Sanni, 2018)	Analyze the determinants for eco-innovation in the manufacturing sector of Nigeria a developing country.	**Dependent:** - Eco-innovation; Innovativeness. **Independent:** - Regulatory policy determinant (Regulatory framework). - Demand-pull factors (Satisfy customer demand; Enter new market; Extend product range; Home competitor). - Technology-push factors (Informal source of knowledge; Formal sources of knowledge; Training; Software or hardware acquisition; Public research institutes). **Control:** - Firm_size; Sector.	Logit model	Nigerian innovation survey 2005-2007	The determinants for eco-innovation found were innovative organizational strategies, environmental regulatory standards, soft and hardware procurement, employee's training, public research institutes involvement, and formal sources of knowledge availability. Customer's satisfaction demand and local market competition make companies engage more in eco-innovations.
(Tsai & Liao, 2017)	Evaluate the influence of a proactive environmental strategy on eco-innovation. Understand the impacts sustainable strategies have on eco-innovation when accounting for market demand, innovation intensity and government subsidies.	**Dependent:** - Proactive environmental strategy (PES). **Moderator:** - Market demand; Innovation intensity; Government subsidy. **Independent:** - Material; Energy; CO_2; Dangerous substances; Other pollution; Recycle. **Control:** - Industry type dummy; Firme size; Export propensity; Regulation_I; Regulation_II.	Logit moderating model	TIS 2006-2008	The positive relation environmental strategy and eco-innovation have, was confirmed by the moderator's market demand and government subsidies. In particular, when grants and market demand are strong, the likelihood of assuming a proactive environmental stand increases. PES adopting firms tend to neglect material usage reduction but instead focus on the other independent variables. Firms aim to clean their image perception to the public, gaining more customers in return
(Yu et al., 2019)	Analyze three drivers of eco-innovation with regards to external factors (anticipated regulation & self-regulation) and internal factors (information sourcing openness).	**Dependent:** - Eco-Process (Material; Energy; CO_2; Hazardous Substances; S.W.N.A.; Recycling). - Eco-Product (Energy; S.W.N.A.; Recycling). **Independent:** - External Driver (Anticipated Regulation; Self-Regulation). - Internal Driver (Breadth, Importance). **Control**: - External (Regulatory Pull/Push; Market Pull; Industry-Specific Factor) - Internal (Innovative Capability; Technology Push; Firm Size; Firm Age).	Multivariate probit model and Zero inflated negative binomial regression	Korean Innovation Survey 2007-2009	Regarding both regulations, the conclusion is that they positively affect the firms' implementation of every nine eco-innovation type analyzed. For the information sourcing openness, there is an indication that only four out of the nine types of eco-innovation had a positive impact on the likelihood of firms' adoption.

Table A2 - Spearman's correlation coeficients

	eco_inov	MARLOC	MARNAT	MAREUR	MAROTH	FPERFm	part	SIZE	MANUF	FUNLOC	FUNGMT	FUNEU	RRDIN	RRDEX	GP
eco_inov	1	0,03	0,03	0,08	0,05	0,08	0,11	0,10	0,20	0,01	0,09	0,06	0,08	0,07	0,05
MARLOC	0,03	1	0,07	-0,07	-0,01	-0,05	-0,03	-0,05	-0,04	0,03	-0,02	-0,04	-0,02	0,00	-0,04
MARNAT	0,03	0,07	1	0,27	0,26	0,03	0,03	0,02	0,02	-0,02	0,10	0,02	0,11	0,02	0,00
MAREUR	0,08	-0,07	0,27	1	0,50	0,03	0,05	0,13	0,28	0,00	0,18	0,12	0,16	0,05	-0,03
MAROTH	0,05	-0,01	0,26	0,50	1	0,10	0,11	0,17	0,18	-0,03	0,20	0,12	0,20	0,09	0,06
FPERFm	0,08	-0,05	0,03	0,03	0,10	1	0,24	0,47	-0,09	-0,04	0,16	0,04	0,20	0,23	0,42
part	0,11	-0,03	0,03	0,05	0,11	0,24	1	0,22	-0,01	0,07	0,32	0,23	0,35	0,36	0,24
SIZE	0,10	-0,05	0,02	0,13	0,17	0,47	0,22	1	0,08	-0,01	0,18	0,10	0,21	0,17	0,30
MANUF	0,20	-0,04	0,02	0,28	0,18	-0,09	-0,01	0,08	1	-0,02	0,13	0,06	0,05	-0,04	-0,15
FUNLOC	0,01	0,03	-0,02	0,00	-0,03	-0,04	0,07	-0,01	-0,02	1	0,14	0,18	0,07	0,04	-0,02
FUNGMT	0,09	-0,02	0,10	0,18	0,20	0,16	0,32	0,18	0,13	0,14	1	0,27	0,34	0,24	0,12
FUNEU	0,06	-0,04	0,02	0,12	0,12	0,04	0,23	0,10	0,06	0,18	0,27	1	0,19	0,13	0,01
RRDIN	0,08	-0,02	0,11	0,16	0,20	0,20	0,35	0,21	0,05	0,07	0,34	0,19	1	0,30	0,17
RRDEX	0,07	0,00	0,02	0,05	0,09	0,23	0,36	0,17	-0,04	0,04	0,24	0,13	0,30	1	0,22
GP	0,05	-0,04	0,00	-0,03	0,06	0,42	0,24	0,30	-0,15	-0,02	0,12	0,01	0,17	0,22	1