Eco-innovation determinants in Portuguese companies

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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 article 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.

1 Introduction

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 article 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.

2 Literature Revision

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].

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).

2.1.1 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 (OECD, 2005).

[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.

2.1.2 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 (OECD, 2005).

2.1.3 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 (OECD, 2005).

2.1.4 Organizational Innovation

Organizational innovation is the introduction of a new organizational method for increased productivity which is divided in three main categories: (a) 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; (b) 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; and (c) 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 (OECD, 2005).

2.1.5 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.

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 (Freeman, 1992).

2.2 Eco-innovation

The first appearance of the term was written by Fussler & James (1996), 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*" (Kemp & Pearson, 2007, p. 07). 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).

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.

2.2.1 End-of-pipe and Cleaner Technologies

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; A. Triguero et al., 2015). These are considered to be an immensely 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; A. 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

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 2.1.5. 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. The table below gathers some barriers more concisely, adapted from (Polzin et al., 2016).

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

2.3 Empirical evidence and hypotheses

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.

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), and Tsai & Liao (2017) 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), and Doran & Ryan (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 (INE, 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 CO2 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 CO2 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 CO2 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.

3 Data and Methodology

The data conducted for the empirical analysis of the present article 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 article, the material was made available by DGEEC, the Portuguese entity responsible for the custody and protection of CIS data and the anonymity of companies.

In Portugal the collection of data took place through means of an electronic online platform and considered the sections universe presented in 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).

After a descriptive study of the variables and performing a multicollinearity test to avoid high degrees of relationships, the data was processed using STATA and the logit models were run to obtain the marginal effects, suitable to validate or reject the hypotheses.

4 Results

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 four group sets of 6+6+6+3 models were run, with the first being related do the first dependent variable *eco-innovation*, the second to *eco_inov-in* regarding benefits happening within the company, the third *eco_inov_out* regarding potential benefits happening while consumption by the end user, and the fourth again using *eco-innovation* to test hypotheses H3a, H3b, and H3c since there were correlation issues amongst the variables associated with it.

On the first group set, 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 separately. The only hypothesis which got rejected was H6 (*External factors* are positively related to eco-innovation). From the second group set, the change in dependent variable did not alter the previous outcomes for validation and rejection of hypotheses. The third group set, changed dramatically, from the margins values obtained the validated hypotheses are now H1 (*Geographical market reach* is positively related to eco-innovation), H3[3] (*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). Finally, the fourth group set noticeably showed that the *market available partners cooperation* is always significant, validating H3a. The *institutional partners cooperation* also revealed significance and validated H3b while H3c was rejected with no

[3] H3 is a conjoined hypothesis of H3a, H3b and H3c meant to simplify the notation since at this stage they had not been properly evaluated.

significance but showed a negative relation with eco-innovation.

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

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. 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 distant 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[4] 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 a healthy loop where companies searching for better financial 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 article 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 police 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.

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

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