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In International Management

The Drivers of Eco-innovation in Internationalized Firms

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Marta Filipa Mesquita Teixeira

Supervised by:
Aldina Isabel de Azevedo Correia (PhD)
Alexandra Maria da Silva Braga (PhD)

Agradecimentos

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Abstract

With the constant degradation of the environment, more and more people are looking for environmentally sustainable products and as such, eco-innovation has acquired greater importance. This subject has gained more recognition in recent years and is a topic that is beginning to be increasingly studied, hence its relevance.

This study aims to explore the influence that internationalization, cooperation and innovation have on eco-innovation, as well as to understand what factors contribute to firms adopting eco-innovations. To achieve this main objective, as well as the specific objectives, two studies were carried out.

In a first study, the influence of cooperation on innovation and eco-innovation is studied as well as the factors that lead firms to adopt eco-innovations. The CIS 2014 database was used to collect information on the four types of innovations as well as issues related to eco-innovation applied to Portuguese firms. To achieve this objective, univariate and multivariate analysis techniques were used, in particular association between variables, MANOVA and multiple linear regression models.

In the second study the influence of internationalization and eco-innovation on the firm's performance, as well as the influence of cooperation on eco-innovation are explored. A primary database was created through an online questionnaire and a final sample of 102 portuguese internationalized firms was considered. To achieve this objective, the PLS-SEM (Partial Least Squares Structural Equation Modeling) technique was performed using the SmartPLS software.

The results of the first study show that cooperation has an influence on at least three types of innovation, therefore, the more cooperation there is, the greater the existing innovation in firms. Cooperation, innovation and eco-innovation are interrelated, and the results shows that there are significant correlations between them. Lastly, the factors found that most contribute to the adoption of eco-innovations are essentially the current or expected market demand for environmental innovations, the improvement of the firm's reputation and the high costs of energy, water or materials.

The results of the second study show that in addition to influencing the firm's performance, internationalization is also influenced by eco-innovation practices. On the other hand, it was not possible to present statistical evidence that show the influence of internationalization and cooperation on eco-innovation.

Keywords: Cooperation, Innovation, Eco-innovation; Internationalization; Firm Performance; CIS 2014; SEM.

Resumo

Com a constante degradação do meio ambiente, cada vez mais as pessoas procuram por produtos ambientalmente sustentáveis e, como tal, a eco-inovação tem adquirido uma importância cada vez maior. Este assunto tem ganho mais reconhecimento nos últimos anos e é um tema que começa a ser cada vez mais estudado, daí a sua relevância.

Este estudo tem como objetivo explorar a influência que a internacionalização, a cooperação e a inovação têm na eco-inovação, bem como compreender quais os fatores que contribuem para as empresas adotarem as eco-inovações. Para atingir este objetivo principal, bem como os objetivos específicos, foram realizados dois estudos.

Num primeiro estudo, estuda-se a influência da cooperação na inovação e na eco-inovação, bem como os fatores que levam as empresas a adotarem a eco-inovação. A base de dados CIS 2014 foi utilizada para recolher informação sobre os quatro tipos de inovações, bem como questões relacionadas com a eco-inovação, aplicada às empresas portuguesas. Para atingir esse objetivo, foram utilizadas técnicas de análise univariada e multivariada, em particular a associação entre variáveis, MANOVA e modelos de regressão linear múltipla.

No segundo estudo, é explorada a influência da internacionalização e da eco-inovação na performance das empresas, bem como a influência da cooperação na eco-inovação. Foi criada uma base de dados primária através de um questionário online e foi considerada uma amostra final de 102 empresas portuguesas internacionalizadas. Para atingir este objetivo utilizou-se a técnica PLS-SEM (modelagem de equação estrutural de mínimos quadrados parciais) realizada pelo software SmartPLS.

Os resultados do primeiro estudo mostram que a cooperação tem influência em pelo menos três tipos de inovação, portanto, quanto mais cooperação existir, maior será a inovação existente nas empresas. A cooperação, a inovação e a eco-inovação estão inter-relacionadas, e os resultados mostram que existem correlações significativas entre elas. Por fim, os fatores encontrados que mais contribuem para a adoção de eco-inovações são essencialmente a procura atual ou esperada no mercado por inovações ambientais, a melhoria da reputação das empresas e os elevados custos de energia, água ou materiais.

Os resultados do segundo estudo mostram que, além de influenciar o desempenho das empresas, a internacionalização também é influenciada pelas práticas de eco-inovação. Por outro lado, não foi possível apresentar evidências estatísticas que mostrassem a influência da internacionalização e da cooperação na eco-inovação.

Palavras-chave: Cooperação; Inovação; Eco-inovação; Internacionalização; Performance da empresa; CIS 2014; SEM.

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CHAPTER I

Introduction

Problem statement

Eco-innovation has become increasingly relevant, since the current condition of the environment is increasing the concerns of business and economies about future sustainability.

Literature suggests that, eco-innovation can be influenced by several variables. Many authors have studied the impact that cooperation brings to innovation (Freel, 2006; Belderbos, Carree & Lokshin, 2004) and how these two variables contribute to eco-innovation (Calik, Badurdeen & Bal, 2020; Ayuso, Rodriguéz, García-Castro & Arinõ, 2011).

Other authors only studied the relationship between cooperation and eco-innovation and considered that cooperation becomes essential for firms to adopt eco-innovation practices (Scandelius & Cohen, 2016; León-Bravo, Caniato, Caridi & Johnsen, 2017).

On the other hand, although there are few articles relating internationalization to eco-innovation, the authors Doranova, Veen and Hinojosa (2013) and Zhu, Sarkis and Lai (2007) claim that internationalization is the engine for the development of eco-innovations, since there is an increase in world demand for environmentally sustainable products or else due to the existence of "green barriers".

However, eco-innovation brings numerous benefits that are not only based on improving environmental performance, but also on the performance of firms (Juniati, Saudi, Astuty & Mutalib, 2019). Although eco-innovation generates significant benefits economic performance of firms, there are different factors that lead to the decision to adopt it (Hojnik, Ruzzier & Manolova, 2018).

All of these questions justify the academic and scientific relevance of this work in an attempt to provide information that can help firms improve their economic development through eco-innovations.

Objectives and Research Questions

The general objective of this research is to understand the influence that internationalization, cooperation and innovation have on eco-innovation, as well as to understand which factors contribute for firms to adopt eco-innovations.

In order to achieve this general objective, the following specific objectives were outlined:

(1) To verify what is the influence of cooperation on innovation as well as the relationship of these variables with eco-innovation.

(2) To verify which are the factors that influence firms to adopt eco-innovations.
(3) To explore the influence of internationalization and eco-innovation on the firm's performance, as well as the influence of cooperation on eco-innovation.

Considering the problem addressed and the objectives of this study, the following research questions were defined:

(1) Does cooperation influences innovation, and do these variables influence eco-innovation?
(2) What factors contribute to firms adopting eco-innovations?
(3) Do internationalization and eco-innovation influence the firm's performance and cooperation influence eco-innovation?

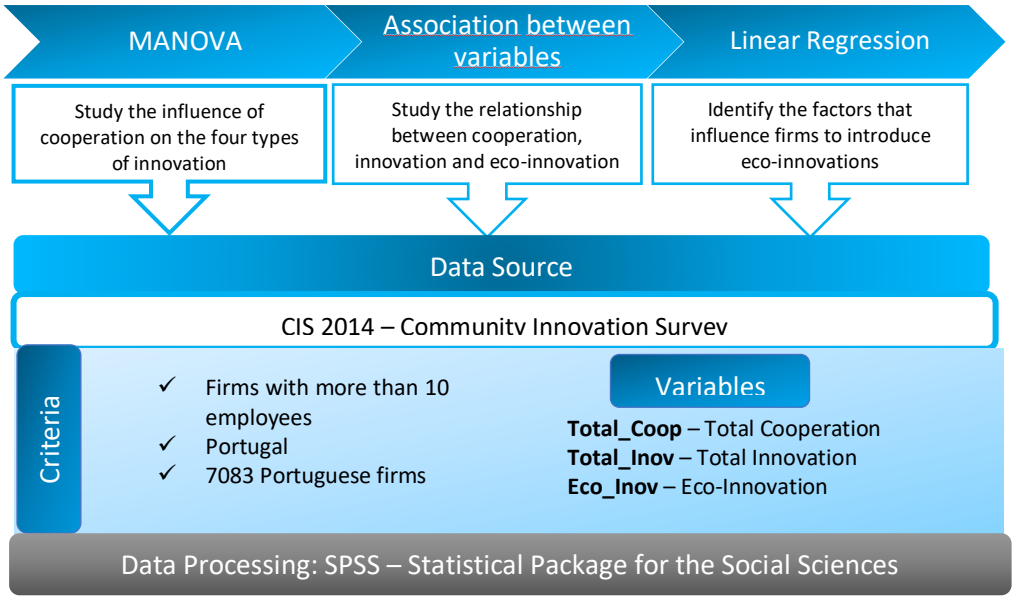
Methodology

The general objective of this research can be divided into three main specific objectives, as previously presented. Thus, in order to answer them, two studies were carried out.

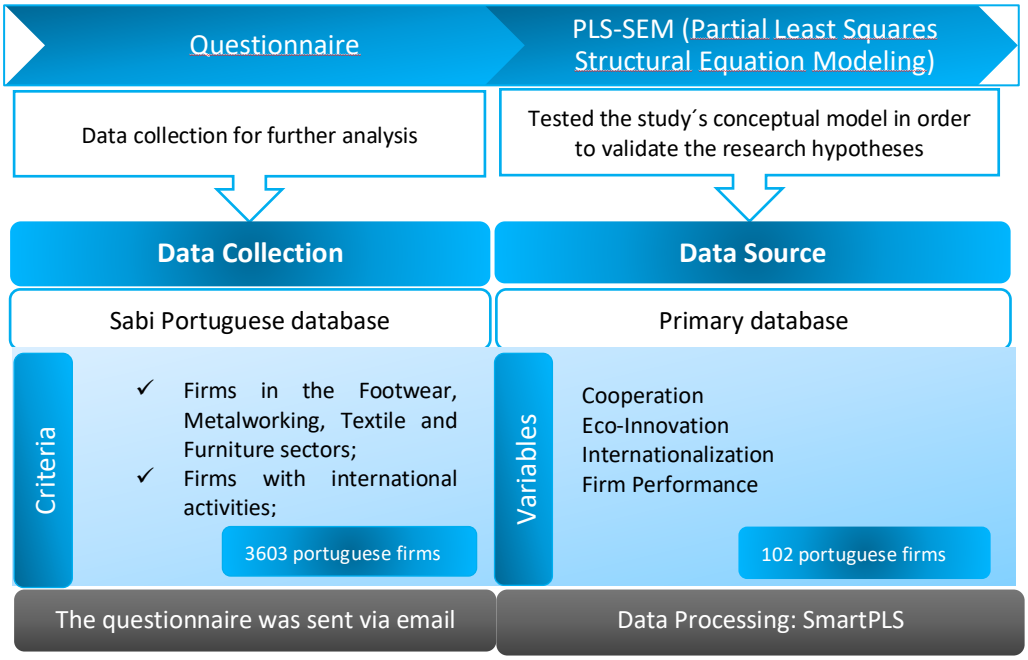
In the first empirical study "Cooperation, Innovation and Environmental Sustainability: Portuguese Firms Research " a literature review is presented in order to understand the role of cooperation in innovation, as well as the relationship of these variables with eco-innovation. It also investigated which factors influence firms to adopt eco-innovations. Afterward, several hypotheses were formulated and, the first two specific objectives were achieved, using the CIS 2014 database, and univariate and multivariate techniques, such as the association of variables, MANOVA and multiple linear regression models.

In the second empirical study entitled: "The role of eco-innovation in internationalized firm's performance", which intend to answer to the third specific objective, a literature review is performed in order to investigate the influence that internationalization and cooperation have on eco-innovation, as well as to understand the influence of eco-innovation on the firm's performance. After defining of the study hypotheses, a primary database was created through an online questionnaire representing a final sample of 102 portuguese internationalized firms. The data were analyzed using PLS-SEM (Partial Least Squares Structural Equation Modeling), performed by the SmartPLS software.

Scheme 1 and Scheme 2 summarize the methodology used in each of the studies.



Scheme 1- Study methodology: Cooperation, Innovation and Environmental Sustainability: Portuguese Firms Research



Scheme 2- Study methodology: The role of eco-innovation in internationalized firm's performance

Structure

The dissertation is organized in three sections. The first section contains the introduction, which presents the overview of the dissertation, the main objectives, the research questions, as well as the methodology used throughout the dissertation and, finally, its summary current structure. The second part includes the two studies carried out, encompassing the papers entitled "Cooperation, Innovation and Environmental Sustainability: Portuguese Firms Research " and "The role of eco-innovation in internationalized firm's performance". Finally, the third part presents the final considerations, contributions, limitations of the research and some suggestions for future investigations.

Cooperation, Innovation and Environmental Sustainability: Portuguese Firms Research

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Abstract

Purpose–Reasons/aims of paper: Innovation is essential to increase the competitive advantages of firms, thus allowing the development of new ideas (Ingram, 2011). This study aims to understand the influence of cooperation on innovation, the relationship of these variables with eco-innovation and the factors that contribute to the decision-making of firms in the adoption of eco-innovations.

Research–Methodology: The database used is the CIS 2014 (Community Innovation Survey) applied to a sample of 7083 Portuguese firms in the period 2012-2014, the sample was analyzed through univariate and multivariate techniques, in particular, MANOVA, association between variables and multiple linear regression models.

Findings-Conclusions: The results of this study show that cooperation has an influence in the at least three types of innovation, therefore, the more cooperation there is, the greater the existing innovation in firms. Cooperation, innovation and eco-innovation are interrelated, and the results shows there is significant correlations between them. Lastly, the factors that most contribute to the adoption of eco-innovations are essentially the current or expected demand in the market for environmental innovations, the improvement of the firm reputation and the high costs of energy, water or materials.

Research limitations: The database CIS 2014, has few questions that allow answers on an ordinal scale, i.e., most of the questions are for "Yes" and "No" answers, which is not conducive to the analysis, being essential the creation of other variables.

Practical implications-Applications to practice: – This study suggests thar the managers must be aware that cooperating with different stakeholders are better able to innovate and therefore have access to new opportunities in the market. At the same time that these new possibilities (cooperation and innovation) open up, they will be in a position to adopt eco-innovations. Finally, firms that are concerned with introducing eco-innovations associate them with purely strategic motivations, namely in terms of reputation, costs and demand.

Originality: This study allows us to understand the influence that cooperation has on innovation ideas, as well as to understand the importance that both cooperation and innovation provide for the adoption of eco-innovation practices. It also allows to know what the most important factors in the decision-making of firms are to adopt acts of innovation directed towards sustainability (eco-innovation).

Keywords: Innovation; Cooperation; Eco-innovation; CIS.

1. Introduction

The increase in globalization has led to greater competitiveness, for firms to be successful they need to increase their competitive advantages, i.e., develop new strategies to remain competitive in the market. Therefore, innovation is essential for the performance of firms (Ingram, 2011).

Innovation can be defined as the "new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)" (OECD/Eurostat, 2018, p.20).

In the innovation process, cooperation plays an important role. It helps to release internal restrictions on innovation, facilitating access to knowledge sources that facilitate the entire innovation process (Miotti & Sachwald, 2003).

According to Freel and Harrison (2006), product innovations are influenced by cooperation with customers and institutions, while process innovations are driven by cooperation with suppliers and universities.

Cooperation then serves as a mechanism to maximize the firm value because the greater the collaboration with partners, the greater the chance of obtaining more innovative products (Belderbos, Carree & Lokshin, 2004).

Taking into account the constant degradation of the environment, it is necessary that firms adopt major innovations in an environmentally sustainable way to be able to respond to the growing consumer demand for sustainable products and services (Hojnik, Ruzzier & Manolova, 2018).

For eco-innovations to be successful, they need cooperation, as they need more partnerships than are available within the organization (Calik, Badurdeen & Bal, 2020). In addition, firms need to learn how to manage the knowledge they acquire from cooperation with other partners to obtain new ideas for innovation, otherwise they are unable to develop eco-innovations (Ayuso, Rodríguez, García-Castro & Ariño, 2011).

The Oslo Manual (2009), defines eco-innovation as being the same as other types of innovation but represents an innovation that results in a reduction of the environmental impact (OECD, 2009).

Eco-innovation is a way of addressing future environmental problems, taking into account the reduction of energy / resources / waste / consumption, through sustainable economic activities (Hellström, 2006).

In addition to the concern for the environment, firms can adopt eco-innovation practices to improve their firm reputation, achieve cost savings, respond to market demand, enter new markets, act correctly or simply, to meet regulatory requirements (Kesidou & Demirel, 2012; Berrone, Fosfuri, Gelabert & Gomez-Mejia, 2013; Severo, Guimarães & Dorion, 2017; Hojnik et al., 2018).

Therefore, the main goal of this study is to understand the influence of cooperation on innovation, the relationship of these variables with eco-innovation and the factors that contribute to the decision-making of firms in the adoption of eco-innovations.

To answer the objective of the study, a statistical analysis is used using two multivariate techniques applied to the CIS 2014 database, which has information related to the innovation of Portuguese firms, in a period from 2012-2014. This database allowed the measurement of a significant number of variables pointed out in the literature, inherent to a group of 7083 Portuguese firms.

This study is divided into five parts, the first part an introduction to the study is presented, the second part presents a literature review on the main variables under study, as well as the hypotheses to be studied. In the third part presents the adopted methodology (MANOVA, correlation between variables and multiple linear regression models) for the treatment of the data. Then, the main results are presented, as well as their discussion. Finally, the study's conclusions are presented, as well as the main limitations and possible future investigations.

2. Innovation, Cooperation and Eco-innovation – a literature review

According to Porter (1990:74), “companies achieve competitive advantages through acts of innovation. They approach innovation in its broadest sense, including both new technologies and new ways of doing things”.

Schumpeter (1939) was one of the first authors to direct his studies on innovation and defines it as a new production function. For this author, innovation is a historic and irreversible change in the way of doing things and has great importance for long-term profitability.

Schumpeter (1950) is considered by several authors as the "father" of studies in innovation, developing the concept of "creative destruction" (Tidd, Bessant & Pavitt, 2005). According to this author, the phenomenon of “creative destruction” mentioned in his book, is characterized as a form or method of economic transformation, a constant search for the creation of something new that, simultaneously, will destroy the bases establishing new rules for the model.

Freeman and Soete (1997) states that innovation departs from the invention, for them the invention is the creation of a new product or process in relation to the existing ones and the innovation portrays the use of a non-trivial change and the improvement in a process, product or system that it is new to the organization that developed this same change.

However, Buse, Tiwari and Herstatt (2010) consider innovation as the invention and commercialization of new products, processes and / or services.

The OSLO Manual states that innovation is a continuous process from which firms constantly change products and processes and seek new knowledge (OECD, 2005). Innovation is not something that firms do only once and forget, it is a capacity that needs to be developed and practiced frequently.

In general, innovation can be defined as the “new or improved product or process (or combination thereof) that differs significantly from the unit’s previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)” (OECD/Eurostat, 2018, p.20).

According to Beaini (2015), detaining innovation as an organizational competence is considered a driving force for business success, being therefore a determining factor for the competitiveness of firms and should be a strategy for those looking to acquire a long-term sustainable advantage.

The Oslo Manual specifies four types of innovation, namely product, process, organizational and marketing innovation (OECD, 2005). Product innovation (goods and services) corresponds to "new or improved good or service that differs significantly from the firms previous goods or services and that has been introduced on the market" (OECD/Eurostat, 2018, p. 21).

Process innovation is the "implementation of a new or significantly improved production process, distribution method, or supporting activity" (CIS, 2014).

For CIS (2014), organizational innovation is a "new organisational method in your enterprise's business practices (including knowledge management), workplace organization or external relations that has not been previously used by your enterprise".

Marketing innovation is the "process of implementation of new marketing methods, involving significant improvements in product design, price packaging, distribution and promotion" (Correia, Machado, Braga, Braga & Almeida, 2017).

Cooperation is understood as an essential element in the innovation process of firms, it is not a new phenomenon, however, the term cooperation only gained prominence in the 1980s (Bayona, García-Marco & Huerta, 2001).

Cooperation between firms can be defined as the establishment of relationships based on an association of forces that make it possible to share resources, reduce risks and facilitate common projects, through stable commitments, in order to achieve a set of general or specific objectives (Sánchez & Pérez 2003).

Cooperation helps to release internal restrictions on innovation, facilitating access to external sources of knowledge that allow firms to benefit from work in the innovation process (Miotti & Sachwald, 2003).

Freel and Harrison (2006) found empirical evidence that product innovations are influenced by partnerships with customers and public sector institutions, while process innovations are driven through cooperation with suppliers and universities.

Carvalho, Madeira, Carvalho, Moura and Duarte (2018) who quaote (Belderbos, Carree, Diederen, Lokshin & Veugelers, 2004; Aschhoff & Schmidt, 2008), confirm that cooperation with competitors increases the capacity for innovation or the performance of firms.

Cooperation serves as a mechanism to maximize the firm value, which effectively combines the resources of it is partners, exploiting their complementarities (Hagedoorn, Link & Vonortas, 2000; Belderbos, Carree & Lokshin, 2004). Thus, it is possible to assume that firms that collaborate more, have access to information from their partners and, consequently, have a better position to reach more innovative products.

Taking into account the approaches presented, it is thus possible to formulate the following hypothesis:

- **H_1:** Cooperation positively influences innovation.

Due to the constant degradation of the environment, it is necessary that firms adopt major product, organizational, and technological innovations, so that they operate in an environmentally sustainable way, responding to the consumer´s growing demand for sustainable products and services and complying with regulatory requirements (Hojnik et al., 2018).

An innovative firm has a greater capacity to create sustainable competitive advantages (Camisón & López, 2010). Eco-innovation is a special type of innovation (Bossle, Barcellos, Vieira & Sauvée, 2016) and has several denominations in the literature, such as "sustainable", "green", "eco" or "environmental" innovation (Schiederig, Tietze & Herstatt, 2012; Xavier, Naveiro, Aoussat & Reyes, 2017). In this study, we will use the name "eco-innovation" to refer to this type of innovation.

Table 1 shows the different definitions of eco-innovation taking into account the literature.

Literature	Definition
Fussler and James (1996)	Process of developing of new products, processes or services which provide customer and business value but significantly decrease environmental impacts.
Rennings (2000)	Develop new ideas, behavior, products and processes, apply or present them and contribute to the reduction of environmental burdens or to ecologically specified sustainability goals.
Kemp and Foxon (2007)	Production, assimilation or exploitation of a product, production, service or management or business method i.e. novel to the organization (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and the other negative impacts of resources use (including energy use) compared to relevant alternatives.
Oltra and Jean (2009)	Innovations that consists of new or modified processes, practices, systems and products which benefit the environment and so contribute to environmental sustainability.
Carrillo-Hermosilla, Río and Könnölä (2010)	Innovation that improves environmental performance.
European Commission (2013)	The introduction of any new or significantly improved product (good or service), process, organizational change or marketing solution that reduces the use of natural resources (including materials, energy, water and land) and decreases the release of harmful substances across the whole life-cycle.
CIS (2014)	Is a new or significantly improved product (good or service), process, organizational method or marketing method that creates environmental benefits compared to alternatives.
Calik, Badurdeen and Bal (2020)	Any new or significant improvement of products, technological or organizational processes and systems commercialized or internally implemented successfully, that not only provide economic benefits but also generate positive social and environmental impacts.

Table 1- Eco-innovation definitions

For eco-innovations to be successful they need cooperation, as they need more partnerships than are available within the limits of an organization (Calik et al., 2020).

The functions of a firm when working together with other external actors are crucial for the development of successful product eco-innovation (Medeiros, Ribeiro & Cortimiglia, 2014), as cooperation between eco-innovation partners increases their number and

impact and offers opportunities to compensate for the lack of resources (Bos-Brouwers, 2010).

In addition, organizational factors, such as culture and management, influence the relationship between cooperation and eco-innovation (Calik, Badurdeen & Bal, 2020). Firms need to learn how to manage the knowledge acquired from cooperation to obtain new ideas for innovation. If they do not have enough capacity to absorb this knowledge and integrate it in the innovation processes, they are not able to develop eco-innovations (Ayuso et al., 2011).

Taking into account the mentioned approaches, it is possible to formulate the following hypotheses:

- **H_2**: There is a bidirectional relationship between:
  - **H_{2a}**: Innovation and cooperation;
  - **H_{2b}**: Innovation and eco-innovation;
  - **H_{3c}**: Cooperation and eco-innovation.

The Oslo Manual (2009), defines eco-innovation as being the same as other types of innovation but represents an innovation that results in a reduction of the environmental impact (OECD, 2009).

Eco-innovation refers to innovation directed towards sustainability (Bossle, Barcellos, Vieira & Sauvéec, 2016; Kiefer, Carrillo-Hermosilla, Río & Barroso, 2017; Hojnik et al., 2018), being a type of innovation that causes new products that use clean energy, are less polluting and have less impact on the environment (Peng & Liu, 2016; Severo, Guimarães & Dorion, 2017).

These approaches collaborate to create a new hypothesis:

- **H_3:** The factors that positively influence firms to implement eco-innovations are:
  - **H_{3a}:** Voluntary actions or initiatives for good practices;

The definitions of eco-innovation highlight the reduction of the environmental impact caused by production and consumption activities, but they may or may not consider the environment as the main motivation for its creation and implementation. Several firms have already proven that it is possible to add value while reducing environmental damage by reducing the consumption of materials and / or energy (Ghisetti & Rennings, 2014).

According to Bos-Brouwers (2010), eco-innovations that occur in small and medium-sized firms, for example, are basically incremental, as they fall on the improvement of technological processes to reduce production costs.

Eco-innovation is a way of addressing future environmental problems, taking into account the reduction of energy / resources / waste / consumption, through sustainable economic activities (Hellström, 2006; Cai & Zhou, 2014; Hojnik et al., 2018).

According to the approaches presented, it is possible to formulate the following hypothesis:

- **H_{3b}:** High costs of energy, water and material;

Sarkar (2013) states that the benefits that come from eco-innovation can be classified into direct and indirect. Direct payments are the operational advantages resulting from the most effective use of resources. Indirect ones include the improvement of the firm image, better relations with suppliers / customers / authorities and a greater capacity for innovation in general terms.

The adoption of eco-innovation practices by several firms may result from their desire to build or improve their reputation (Berrone, Fosfuri, Gelabert & Gomez-Mejia, 2013; Hojnik et al., 2018).

It is possible to develop a new hypothesis:

- **H_{3c}:** Improving the firm reputation;

Porter and Linde (1995) defend the need for more stringent and flexible environmental regulation, so that firms can find adjusted solutions to their innovation processes.

Several studies show that environmental regulations significantly influence investment in eco-innovations (Demirel & Kesidou, 2011; Luan, Tien & Chen, 2016; Hojnik et al., 2018).

New hypotheses can be formulated:

- **H_{3d}:** Existence of environmental regulations;
- **H_{3e}:** Existence of environmental taxes, charges or fees;
- **H_{3f}:** Future environmental regulations or taxes;

Kesidou and Demirel (2012) identified innovation, stakeholders, technology, the organizational capabilities of firms and the needs of the market / customers, as being the main factors that contribute to the introduction of eco-innovations.

From this last approach it is possible to elaborate two more hypotheses:

- **H_{3g}:** Current or expected market demand**;**
- **H_{3h}:** Need to meet requirements for public procurement contracts**.**

In order to facilitate the understanding of the presented literature, Figure 1 shows the conceptual model of this study.

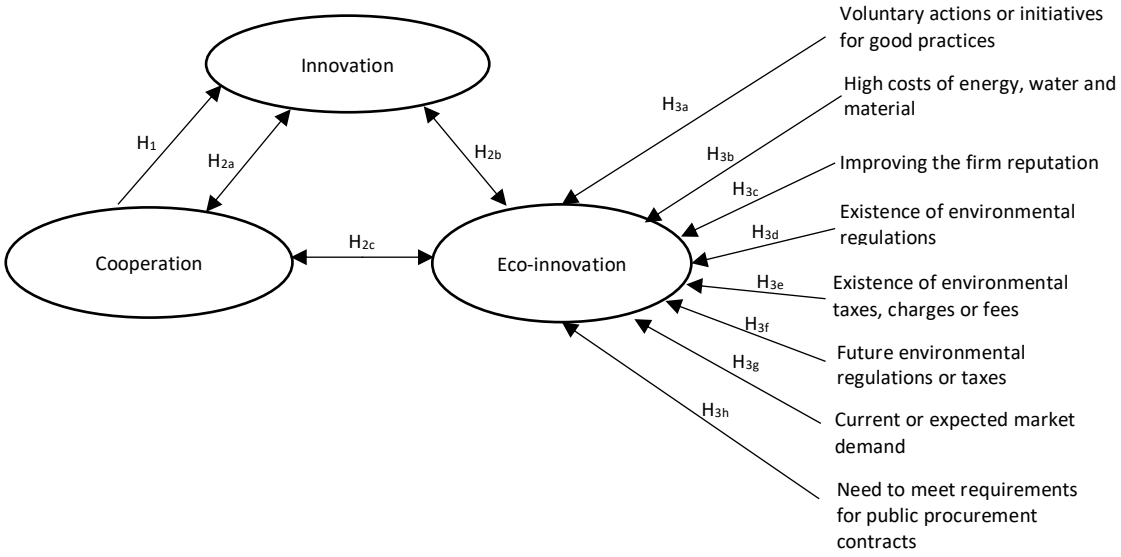


Figure 1- Conceptual model of this study

3. Research Metodology

3.1. Data and Sample

This study is based on data from CIS 2014 (Community Innovation Survey)[1, 2], which collects information on the four types of innovation, product, process, organizational and marketing activities and this edition presents new issues related to eco-innovation (DGEEC, 2016a).

The target population of CIS 2014, corresponds to a group of firms, based in Portuguese territory with more than 10 people employed. The CIS sample is a stratified sample, with it is target population divided into subgroups structured by firm size (considering the number of employees), by CAE and by regional distribution (NUTS II) (DGEEC, 2016b).

The initial sample consisted of 9455 firms (distributed over 888 strata) based on a census combination (for firms with 250 or more employees). At the end of the data collection period, between 9th October 2014 and 8th June 2016, 7083 responses were considered valid, out of 8735 firms in the corrected sample, corresponding to a rate of 81%.

Table 2 presents the synthesis of the hypotheses i.e. used for this study and the variables taken from the questionnaire (CIS 2014) that are used in their study.

[1] Link to CIS 2014 questionnaire in English - https://circabc.europa.eu/ui/group/47133480-29c1-4c23-9199-72a631f4fd96/library/32ab7d19-446e-404c-9ea5-e2524065b2a0/details

[2] Link to CIS 2014 questionnaire in Portuguese - https://www.dgeec.mec.pt/np4/207/%7B$clientServletPath%7D/?newsId=113&fileName=Sum_rios_Estat_sticos_CIS2014_30092016.pdf

Hypotheses	Authors	Method	Variables	Acronym and their designation	Questionnaire Question
H_1: Cooperation positively influences innovation	Bayona et al., (2001); Miotti and Sachwald (2003); Freel and Harrison (2006); Carvalho et al., (2018).	MANOVA	**Total Cooperation** (Sánchez & Pérez, 2003)	**Types of cooperation partner[3]:** C011, C012, C013, C014, C015 – Other enterprises within your enterprise group; C021, C022, C023, C024, C025 - Suppliers of equipment, materials, components, or software; C0311, C0312, C0313, C0314, C0315 - Clients or customers from the private sector; C0321, C0322, C0323, C0324, C0325 - Clients or customers from the public sector; C041, C042, C043, C044, C045 - Competitors or other enterprises in your sector; C051, C052, C053, C054, C055- Consultants or commercial labs; C061, C062, C063, C064, C065 - Universities or other higher education institutes; C071, C072, C073, C074, C075 - Government, public or private research institutes.	7.2
H_2: There is a relationship between innovation, cooperation and eco-innovation	Ayuso et al. (2011); Calik et al., (2020).	Association between variables	**Total innovation** (Schumpeter, 1939; Buse et al., 2010; OECD, 2005; OECD/Eurostat, 2018; CIS, 2014; Correia et al., 2017)	**Product innovation:** INPSPD – Goods innovation; INPDSV – Service innovations. **Process innovation:** INPSPD – Innovation in manufacturing; INPSLG – Innovation in logistics, delivery or distribution methods; INPSSU – Innovation in supportive activities for processes. **Organizational innovation:** ORGBUP – Innovation in business practices**.** ORGWKP – Innovation in organizing work responsibilities and decision making; ORGEXR - Innovation in organizing external relations. **Marketing innovation:** MKTDGP – Innovation in packaging**;** MKTPDP – Innovation in distribution**;** MKTPDL – Innovation in promotion; MKTPRI - Innovation in price.	2.1 3.1 8.1 9.1
H_3: The factors that positively influence firms to implement eco-innovations are: **H_{3a}:** Voluntary actions or initiatives for good practices; **H_{3b}:** High energy, water and material costs; H_{3c}: Improved firm reputation; **H_{3d}:** Existence of environmental regulations; **H_{3e}:** Existence of environmental taxes, charges or fees; **H_{3f}:** Future environmental regulations or taxes; **H_{3g}:** Current or expected market demand; **H_{3h}:** Need to accomplish the requirements for concluding public contracts.	Severo et al., (2017); Hojnik et al., (2018); Ghisetti and Rennings (2014); Hellström (2006); Sarkar (2013); Luan et al., (2016); Kesidou and Demirel (2012).	Multiple linear regression models	**Eco-innovation** (Fussler & James, 1996; Rennings, 2000; Kemp & Foxon, 2007; Oltra & Jean, 2009; European Commission, 2013; CIS, 2014; Calik et al., 2020) **Factors to eco-innovation**	ECOMAT - Reduced material or water use per unit of output; 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; 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. See the Table 7	13.1 13.3

Table 2- Synthesis of the hypotheses and their variables

[3] Termination 1 applies to Portugal, 2 to Other Europe, 3 to United States, 4 to China or India and termination 5 to Other Countries.

3.2. Measures

To test the hypotheses developed in chapter 2, our variables of study were created using the existing variables in CIS 2014, similarly to what was done by Correia et al., (2017):

- **Total Cooperation:** Total_Coop = [C011, C015] + [C021, C025] + [C0311, C0315] + [C0321, C0325] + [C041, C045] + [C051, C055] + [C061, C065] + [C071, C075]. This variable range from 1- did not implement any of the cooperation items and 28- implemented all cooperation items. The mode value is 1, i.e., of the 891 firms that responded to the cooperation questionnaire, about 248 (3.5%) answered type of cooperation 1, i.e., they have only one type of collaboration partners. Regarding asymmetry and kurtosis, it can be said that we are in the presence of a positive asymmetric and leptokurtic distribution because the values are greater than 1.96 (Table 21[4]).
- **Product Innovation:** P_S_Inov = INPDGD + INPDSV. This variable range from 0 - the firm does not implement any innovation in terms of products and / or services and 2 - the firm has implemented innovation in terms of both products and services. The value of mode is 0, this means that there are more firms that do not innovate in products and services than those that innovate (Table 25[4]).
- **Process Innovation:** Proc_Inov = INPSPD + INPSLG + INPSSU. This variable range from 0-the firm has not implemented any of the innovation items and 3- the firm has implemented all of the innovation items. The value of mode is 0, this means that there are more firms that do not innovate in process innovations than those that innovate (Table 25[4]).
- **Organizational Innovation:** Org_Inov = ORGBUP + ORGWKP + ORGEXR. This variable range from 0-the firm has not implemented any of the innovation items and 3- the firm has implemented all of the innovation items. The value of mode is 0, this means that there are more firms that do not innovate in organizational innovations than those that innovate (Table 25[4]).
- **Marketing Innovation:** Mark_Inov = MKTDGP + MKTPDP + MKTPDL + MKTPRI. This variable range from 0- the firm has not implemented any of the innovation items in terms of marketing and 4- the firm has implemented all of the innovation items in terms of marketing. The value of mode is 0, this means that there are more firms that do not innovate in marketing than those that innovate (Table 25[4]).
- **Total Innovation:** Total_Inov = P_S_Inov + Proc_Inov + Org_Inov + Mark_Inov. This variable range from 0- did not implement any of the innovation items and 12- implemented all types of innovation. The value of mode is 0, this means that there are more firms that do not innovate than those that innovate, in at least one type of innovation. Regarding asymmetry and kurtosis, we are in the presence of a symmetrical and mesokurtic data distribution, since they are between [-1.96, 1.96], i.e., it has an approximately normal distribution (Table 19[4]).
- **Eco-innovation:** Eco_Inov = ECOMAT + ECOENO + ECOPOL + ECOSUB + ECOREP + ECOREC + ECOENU + ECOPOS + ECOREA + ECOEXT. This variable range from 0- did not implement any of the eco-innovation items and 10- implemented all of the eco-innovation items. The mode value of this variable is 0, i.e., of the 7083

[4] Appendix 1

firms, about 1433 (20.2%) do not introduce any type of eco-innovation. Regarding asymmetry and kurtosis, we are in the presence of a symmetrical and mesokurtic data distribution, since they are between [-1.96, 1.96], i.e., it has an approximately normal distribution (Table 23[4]).

The methods used to test the hypotheses defined in chapter 2– Innovation, Cooperation and Eco-innovation are mentioned in Table 2.

3.3. Descriptive statistics

Descriptive statistics consists of the collection, analysis and interpretation of numerical data through the creation of appropriate instruments such as tables, graphs and numerical indicators (Reis, 1996), i.e., first, descriptive statistical research and later, an inductive statistical study.

Throughout this article, three variables stand out, namely Total Innovation, Total Cooperation and Eco-innovation. These variables were defined from the CIS 2014 database, according to the procedure defined in sub-chapter 3.2- Measures.

When analyzing Table 20[4], it appears that of the 7083 firms, 3142 (44.4%) do not carry out any type of innovation, be it in products or services, process, organizational or marketing.

The Total Innovation variable has a minimum value of zero (0-did not implement any of the innovation items) and a maximum of twelve (12- implemented all types of innovation) As previously mentioned, it presents a symmetrical and mesokurtic distribution since the values of asymmetry and kurtosis are comprised between [-1.96, 1.96]. The mean for Total Innovation is 2.29 with s.d ≈ 2.9 (Table 19[4]).

With regard to the Total Cooperation variable of the 891 firms, about 248 (27.8%) had only one type of cooperation (1), i.e., they have only one type of collaboration partners (Table 22[4]).

This variable has a minimum value of one (1 - did not implement any of the cooperation items) and a maximum value of twenty-eight (28 - implemented all cooperation items). The mean for Total Cooperation is 3.7 with s.d ≈ 3.5 as illustrated in Table 21 in the appendix. As mentioned, it presents a positive asymmetric and leptokurtic distribution because the values are greater 1.96 (Table 21[4]).

Other variable of this study is Eco-innovation, and of the 4167 firms, about 1433 (34.4%) do not introduce any type of innovation with concerns for the environment (Table 24[4]).

This variable has a minimum value of zero (0 - did not implement any of the eco-innovation items) and a maximum value (10 - implemented all the eco-innovation items). The mean for Eco-innovation is 2.75 with s.d ≈ 2.9. As mentioned, it presents a symmetrical and mesokurtic distribution since the values of asymmetry and kurtosis are comprised between [-1.96, 1.96] (Table 23[4]).

4. Results and Discussion

4.1. Influence of Cooperation on Innovation

In order to study whether the level of Total Cooperation (Total_Coop) influences product innovation (P_S_Inov), process innovation (Proc_Inov), organizational innovation (Org_Inov) and marketing innovation (Mark_Inov), MANOVA (Multivariate Analysis of Variance) is used.

With this, it is intended to know if there are significant differences in the means of these innovation variables when changes occurs in the level of cooperation. First the assumptions of normality, homogeneity and existence of correlations between variables were tested.

Regarding Normality, taking into account that the sample is large using the central limit theorem (CLT) normality can be assumed, besides that normality tests were performed and some results justifies this assumption, however the sample dimension is a limitation for normality tests.

In terms of homogenity of variances, the Box Test, which tests the equality of the covariance matrix between the groups, has a p-value of 0.671 (greater than 0.05) so that, for a 5% significance level, the null hypothesis is not rejected and the groups do not have significant differences.

The Levene Test, which studies the equality of variances, allows considering the presence of univariate homogeneity of the variables, for a 5% significant level, since the corresponding p-values are greater than 0.05.

In terms of the correlation between the dependent variables, the Bartlet's sphericity test, whose null hypothesis is the proportionality of the covariance matrix to the identity matrix, has an approximately null p-value, which is why the null hypothesis is rejected, for a 5% significance level, being able to state there is a correlation between the variables, justifying the use of MANOVA.

Multivariate Tests

Effect		Value	F	Hypothesis df	Error df	Sig.
Total_Coop	Pillai's Trace	0,187	2,030	84,000	3476,000	0,000
	Wilks' Lambda	0,821	2,089	84,000	3423,069	0,000
	Hotelling's Trace	0,209	2,151	84,000	3458,000	0,000
	Roy's Largest Root	0,155	6,406	21,000	869,000	0,000

Table 3- Multivariate Tests

Regardless the multivariate tests, independent of the statistics to be used (Table 3), we conclude that it appears that the factor (or independent variable) level of Total Cooperation (Total_Coop) has a significant effect on at least one of the four dependent

variables (P_S_Inov; Proc_Inov; Org_Inov; Mark_Inov). This mean that, at least one type of innovation depend on the level of cooperation.

After identifying the significant effects of the factor on the dependent variables under study, the analysis follows through 2 ANOVAS to see what kind of cooperation has an effect on the innovation (Table 4).

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter
Total_Coop	P_S_Inov	28,033	21	1,335	3,074	**0,000**	0,069	64,556
	Proc_Inov	73,931	21	3,521	4,330	**0,000**	0,095	90,924
	Org_Inov	104,626	21	4,982	3,750	**0,000**	0,083	78,742
	Mark_Inov	138,892	21	6,614	3,602	**0,000**	0,080	75,639

Table 4- ANOVA Tests

The analysis of the p-values illustrated in Table 4, are less than 5%, which leads us to reject the null hypothesis, of equality of means and to conclude that the factor (level of cooperation) has a significant effect on the four dependent variables (P_S_Inov; Proc_Inov; Org_Inov; Mark_Inov). This mean that there is at least one of the averages in groups defined by cooperation level that differs from the others. Thus, is possible to conclude that, there are statistically evidences that cooperation influences innovation in firms.

In order to find out which levels of Innovation are significantly different, a multiple comparison of means (post hoc tests) is performed. Analyzing the first line in Table 26[5], it appears that for a 5% significant level the average of P_S_Inov for a level of Total_Coop = 1 is different from the average of P_S_Inov for a level of Total_Coop = 28, since the corresponding p-value is less than 5%.

Taking into account the values in Table 26[5] for P_S_Inov from a level of Total_Coop = 2 and Total Coop = 15 when compared to Total_Coop = 28, there is 5% statistical evidence to consider the equality of P_S_Inov averages, since p-value is greater than 5%. Observing the confidence internal for the mean, can be observed that Lower and Upper Bounds are negative, i.e. P_S_Inov for Total_Coop = 1 and Total_Coop = 15 are less than P_S_Inov for Total_Coop = 28, which indicates that higher levels of cooperation imply higher levels of innovation in products and services.

In the case of Proc_Inov the average of the level of Total_Coop = 1 is different from the average of the level of Total_Coop = 28 since the p-value is less than 5%.

In general, it can be seen in Table 26[5] that from a level of Total_Coop = 1 to a level of Total_Coop = 4 and for a level of Total_Coop = 11, 14 and 19 when compared to a level of Total_Coop = 28 there is statistical evidence to consider the inequality of the means

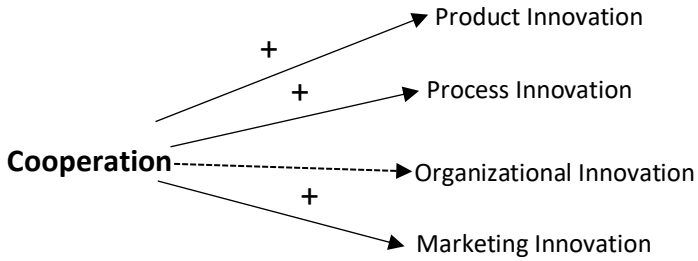
[5] Appendix 2

in Proc_Inov, since the p-values are greater than 5%. Observing the confidence internal for the mean, can be observed that Lower and Upper Bounds are negative, i.e. Proc_Inov for Total_Coop = 1 and Total_Coop = 19 are less than Proc_Inov for Total_Coop = 28, which indicates that higher levels of cooperation imply higher levels of innovation in processes.

In relation to Org_Inov, it can be seen in Table 26[5] that all p-values are greater than 5%, so that the equality of means is considered, so cooperation does not influence innovation in organizational terms.

The type of innovation that has the most differences is Mark_Inov. There is only statistical evidence to consider the equality of means for a level of Total_Coop = 9, 10, 12, 13, 20 e 23 when compared to Coop- Total = 28. All other levels have differences in means since p-values are less than 5% (Table 26[5]). Observing the confidence internal for the mean, can be observed that Lower and Upper Bounds are negative, i.e. Mark_Inov for Total_Coop = 1 and Total_Coop = 23 are less than Mark_Inov for Total_Coop = 28, which indicates that higher levels of cooperation imply higher levels of innovation in marketing.

The results are in line with the theory, so $\mathbf{H_1}$ is verified in at least three types of innovation (P_S_Inov, Proc_Inov and Mark_Inov). Scheme 3 presents the synthesis of these results.



Scheme 3- MANOVA results

4.2. Relationship between innovation, cooperation and eco-innovation

To study the relationship between innovation, cooperation and eco-innovation, an association between variables is used.

According to Marôco (2011), the verification of the correlation between the variables is essential to qualify the direction and the intensity of association between them. The most appropriate method to apply, depends on the nature of the variables to be analyzed / studied, these can be nominal, quantitative or ordinal.

In order to verify the correlation between Total Innovation (Total_Inov), Total Cooperation (Total_Coop) and Eco-innovation (Eco_Inov), the respective tests were

carried out. For this purpose, in view of quantitative variables, Pearson's r coefficient is used. For comparison Spearman test is also done (if we consider variables as ordinal).

One of the assumptions of this method is that the variables have a normal distribution, although it is not necessary to check the normality of these variables, since the sample is large (CLT), the K-S test is performed (Table 5).

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Total_Coop	0,217	891	**0,000**	0,743	891	0,000
Env_Inov	0,136	891	**0,000**	0,909	891	0,000
Total_Inov	0,118	891	**0,000**	0,960	891	0,000

Table 5- Normality Tests (association between variables)

Analyzing Table 5, it appears that the variables do not follow a normal distribution, since the p-values have approximately null values, i.e., less than 5%. However, according to CLT, because the sample is large, a normal distribution is assumed.

Once the assumptions have been tested, Pearson's r test is implemented between variables.

		Total_Coop	Eco_Inov	Total_Inov
Total_Coop	Pearson Correlation	1	**0,205**	**0,265**
	Sig. (2-tailed)		**0,000**	**0,000**
	N	891	891	891
Eco-Inov	Pearson Correlation	**0,205**	1	**0,310**
	Sig. (2-tailed)	**0,000**		**0,000**
	N	891	4167	4167
Total_Inov	Pearson Correlation	**0,265**	**0,310**	1
	Sig. (2-tailed)	**0,000**	**0,000**	
	N	891	4167	7083

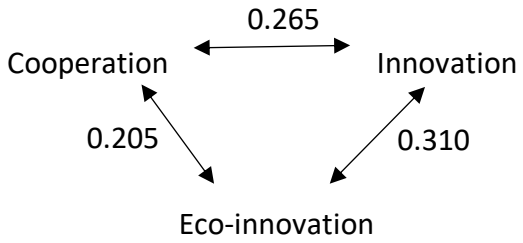
Table 6- Correlations

Analyzing Table 6, there is a weak, but significant, correlation (r <0.25) between Total Cooperation (Total_Coop) and Eco-innovation (Eco_Inov) because the r = 0.205, but significant. As the correlation is positive, it means there if total cooperation increases, eco-innovation also tends to increase.

Regarding the relationship between Total Cooperation and Total Innovation, there is a moderate correlation (0.25 ≤ r <0.5) since the r = 0.265, but significant, and being a positive correlation, it is also possible to say that if total cooperation increases, the trend for total innovation is also increasing.

Taking into account the relationship between Total Innovation and Eco-innovation, there is also a moderate and significant correlation, since the r = 0.310, a positive correlation, so if total innovation increases, eco-innovation also increases.

In all cases, the p-value is approximately null (sig ≈ 0.000), therefore less than the significance level, i.e., the null hypothesis is rejected, thus having a significant correlation between the variables leading to the $\mathbf{H_2}$ defined in the literature to be confirmed. The following scheme summarizes the results of the association between the variables (Scheme 4).



Scheme 4- Association between variables results

4.3. What drives eco-innovation?

According to Freitas, Correia, Braga and Braga (2017), multiple linear regression models is a multivariate technique that allows a set of factors to establish relationships between a dependent variable (metric) and a set of independent variables (metric or non-metric).

With this technique, it is intended to observe which are the factors that influence the decision-making of firms to introduce eco-innovations.

In addition to the variables found in the literature, it was necessary to add another one that was present in CIS 2014 that may be relevant to the study, formulating a new hypothesis:

- **H_{3i}:** One factor that influences firms to implement eco-innovations is government grants, subsidies or other financial incentives.

Table 7 shows the independent variables taken from CIS 2014 and their description.

Variables	Description
ENEREG	Existence of environmental regulations
ENETX	Existing environmental taxes, charges or fees
ENREGF	Existing environmental regulations or taxes expected in the future
ENGRA	Government grants, subsidies or other financial incentives for environmental innovations
ENDEM	Current or expected market demand for environmental innovations
ENREP	Improve the firm reputation
ENAGR	Voluntary actions or initiatives for environmental good practice within your sector
ENCOST	High cost of energy, water or materials
ENREQU	Need to meet requirements for public procurement contracts

Table 7- Description of variables

It starts by using the Enter estimation method, i.e., including all variables in the analysis.

Model Summary					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0,395	0,156	**0,154**	2,43193	**2,057**

Table 8- Enter model summary

Since R^2 is adjusted in the model to approximately 15.4%, it means that the independent variables, which are the factors underlying the implementation of eco-innovations, explain 15.4% of the total variance of the dependent variable, i.e., the eco-innovation (Table 8).

In addition, the Durbin-Watson value is close to 2 values, which means that there is no evidence to consider that the residuals are correlated. The ANOVA test is analyzed to test whether at least one independent variable has an effect on the dependent variable.

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2986,286	9	331,810	56,103	**0,000**
	Residual	16110,516	2724	5,914		
	Total	19096,802	2733			

Table 9- ANOVA

Taking into account the data in Table 9, it appears that the p-value is approximately null (sig≈0.000), i.e., the null hypothesis is rejected, therefore there is at least one independent variable with significant effect on the dependent variable "Eco_Inov".

Coeficients						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1,558	0,137		11,381	0,000
	ENEREG	0,133	0,069	0,051	1,931	0,054
	ENETX	0,040	0,069	0,016	,579	0,563
	ENREGF	0,178	0,074	0,069	2,402	0,016
	ENGRA	**-0,134**	**0,057**	**-0,052**	**-2,348**	**0,019**
	ENDEM	**0,345**	**0,058**	**0,134**	**5,946**	**0,000**
	ENREP	**0,371**	**0,065**	**0,132**	**5,665**	**0,000**
	ENAGR	0,144	0,058	0,054	2,477	0,013
	ENCOST	**0,255**	**0,056**	**0,094**	**4,576**	**0,000**
	ENREQU	0,121	0,050	0,048	2,388	0,017

Table 10- Coeficients

Analyzing the absolute values of the standardized coefficients in Table 10, it appears that the variables ENDEM, EMREP and ENCOST are the ones that have greater

contributions to explain what leads firms to adopt eco-innovations. Therefore, it is safe to say that what is most important for firms to adopt eco-innovation is the market demand for environmental innovations, improving the firm reputation and the high costs of energy, water or materials.

It can also be seen from the model that the variable ENGRA, i.e., public administration support, subsidies and other financial incentives, negatively influences firms to adopt eco-innovation. As not all variables are significant, the Stepwise method discussed below is performed. In this method the variables are introduced step by step, according to their contribution to the model.

Model	Variables Entered	Designation
1	ENEREP	Improve the firm reputation
2	ENDEM	Current or expected market demand for environmental innovations
3	ENCOST	High cost of energy, water or materials
4	ENREGF	Existing environmental regulations or taxes expected in the future
5	ENAGR	Voluntary actions or initiatives for environmental good practice within your sector
6	ENEREG	Existence of environmental regulations

Table 11- Variables chosen by the Stepwise method

Table 11 shows that only six of the eight existing variables entered to the model, this means that the existence of environmental taxes, charges or fees (ENETX) and public administration support, subsidies or other financial incentives for environmental innovations (ENGRA) probably do not contributed to the model.

Model Summary					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
6	0,392	0,154	**0,152**	2,43465	**2,057**

Table 12- Stepwise model summary

In the model, the adjusted R^2 is approximately 15.2%, which means that the independent variables explain about 15.2% of the total variance of the dependent variable. Compared to the Enter method, a similarity of values can be seen, which may mean that the variables that were removed from the model did not contribute to explain the dependent variable (Table 12).

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
6	Regression	2932,490	6	488,748	82,454	**0,000**
	Residual	16164,312	2727	5,928		
	Total	19096,802	2733			

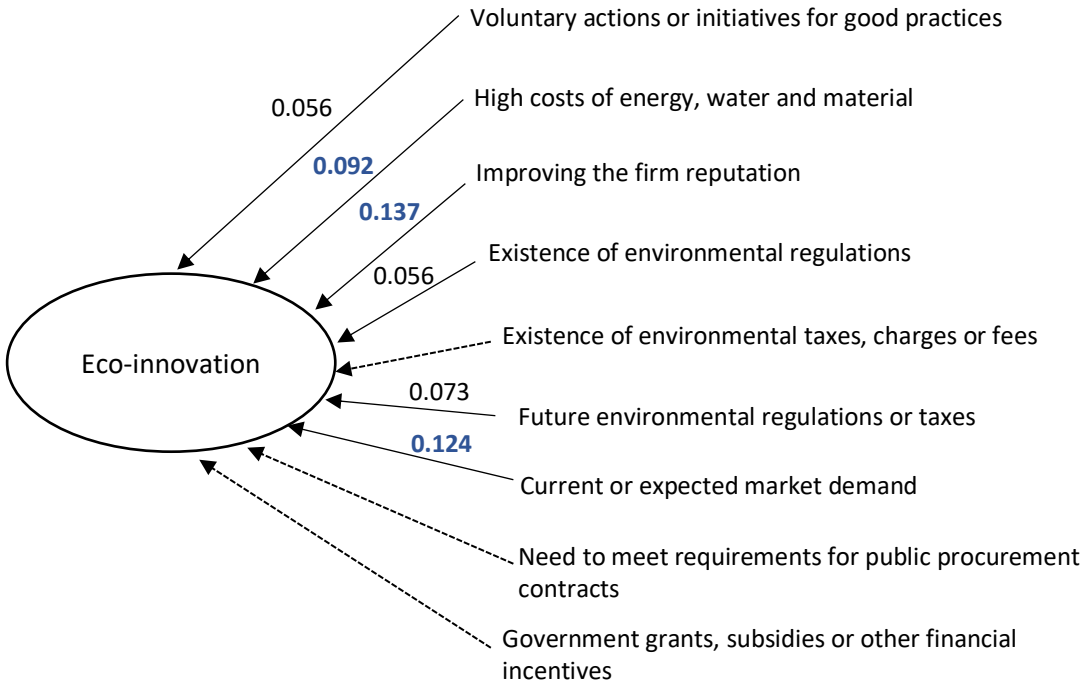
Table 13- ANOVA Stepwise

As in the Enter method, it is verified that the p-value is approximately null (sig≈0.000), i.e., the null hypothesis is rejected, therefore there is at least one independent variable with significant effect on the dependent variable "Eco_Inov" (Table 13).

Coeficients								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
6	(Constant)	1,562	0,137		11,411	0,000		
	ENREP	**0,384**	**0,065**	**0,137**	**5,888**	**0,000**	**0,571**	**1,751**
	ENDEM	**0,321**	**0,055**	**0,124**	**5,860**	**0,000**	**0,689**	**1,452**
	ENCOST	**0,250**	**0,055**	**0,092**	**4,539**	**0,000**	**0,748**	**1,336**
	ENREGF	0,189	0,066	0,073	2,861	0,004	0,477	2,095
	ENAGR	0,150	0,058	0,056	2,592	0,010	0,665	1,504
	ENEREG	0,148	0,066	0,056	2,243	0,025	0,498	2,007

Table 14- Stepwise Coeficients

The results obtained through this method (Table 14) go against the Enter method, verifying once again that the variables ENDEM, ENREP and ENCOST are the ones that most contribute for firms to adopt eco-innovation, i.e., the demand current or expected in the market for environmental innovations, the improvement of the firm reputation and the high costs of energy, water or minerals. These results lead to **H_{3b}, H_{3c}** and **H_{3g}** being confirmed. The hypotheses **H_{3a}, H_{3d}** and **H_{3e}** have been confirmed, however, they are not the ones that most contribute to the decision-making of firms to adopt eco-innovation practices. On the other hand, the hypotheses **H_{3f}** and **H_{3h}** have not been confirmed (Scheme 5).



Scheme 5- Linear Regression results (Blue values are the most important factors for firms to adopt eco-innovations; Dashed are the hypotheses that have not been statistically confirmed).

Analyzing the tolerance and VIF's values present in Table 14, the absence of multicollinearity is verified, since the tolerance values are not close to 0 and the VIF's are less than 5.

Collinearity Diagnostics										
Model	Dimension	Eigenvalue	Condition Index	Variance Proportions						
				(Constant)	**ENREP**	**ENDEM**	**ENCOST**	**ENREGF**	**ENAGR**	**ENEREG**
6	1	**6,178**	**1,000**	0,00	0,00	0,01	0,00	0,00	0,00	0,00
	2	**0,251**	**4,966**	0,05	0,00	0,78	0,03	0,01	0,02	0,01
	3	**0,198**	**5,579**	0,01	0,03	0,07	0,01	0,32	0,13	0,10
	4	**0,130**	**6,901**	0,06	0,02	0,05	0,46	0,03	0,44	0,01
	5	**0,097**	**7,995**	0,48	0,05	0,02	0,48	0,05	0,20	0,04
	6	**0,078**	**8,874**	0,23	0,88	0,05	0,01	0,00	0,22	0,00
	7	**0,068**	**9,551**	0,16	0,01	0,03	0,01	0,59	0,00	0,84

Table 15- Multicollinearity Tests

Looking at the values in Table 15 there is no multicollinearity since the Eigenvalues are relatively far from 0 and the Condition Index values are less than 15.

Model Summary					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
6	0,392	0,154	**0,152**	2,43465	**2,057**

Table 16- Multicollinearity Model Summary

The adjusted R^2 value remains the same as the previous model and the Durbin-Watson value also remains close to 2, so there is no evidence to conclude that the residues are correlated (Table 16).

ANOVA						
Model		Sum of Squares	Df	Mean Square	F	Sig.
6	Regression	2932,490	6	488,748	82,454	**0,000**
	Residual	16164,312	2727	5,928		
	Total	19096,802	2733			

Table 17- Multicollinearity ANOVA

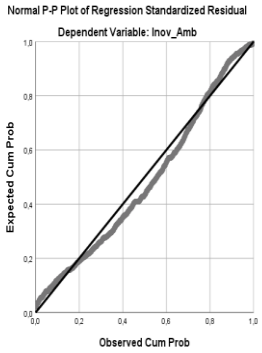
Since the p-value in ANOVA test in Table 17 remains approximately null, the model remains highly significant.

In order to verify that the model meets the assumptions, the analysis of the residuals is considered. This analysis begins with the study of the normality of the residuals, for this purpose the One-Sample Kolmogorov-Smirnov test is performed.

One-Sample Kolmogorov-Smirnov Test		
		Eco_Inov
N		4167
Normal Parameters	Mean	2,7507
	Std. Deviation	2,92415
Most Extreme Differences	Absolute	0,182
	Positive	0,182
	Negative	-0,173
Test Statistic		0,182
Asymp. Sig. (2-tailed)		**0,000**

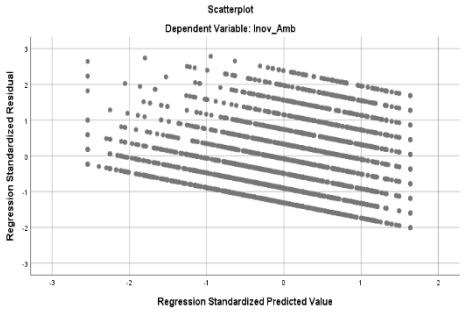
Table 18- One-Sample Kolmogorov-Smirnov Test

When analyzing this test, shown in Table 18, it appears that the p-value is approximately null, so the null hypothesis is rejected, i.e., the normality of the residuals is not verified. However, as the sample is large, it is assumed a normal distribution using CLT.



Graphic 1- Normal probability of residuals

In addition, looking at the PP-Plot in Graphic 1, it appears that the residuals approximately fallow a normal distribution, since the points are close to the diagonal.



Graphic 2- Scatterplot

Graphic 2 shows horizontal lines due to the errors obtained when rounding up the values predicted by the regression model. However, the dispersion of residuals around the average value (zero) is more or less random.

Thus, the model generally fulfills the assumptions, so it can be considered that it is a valid model. Figure 2 summarizes the results inherent to the research hypotheses.

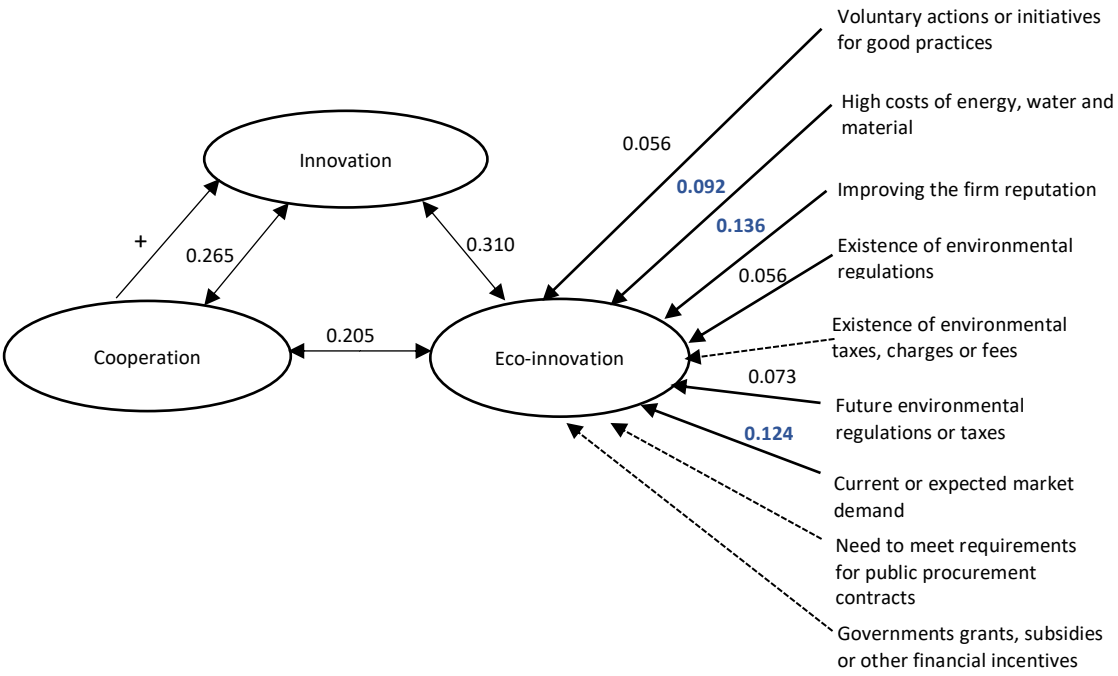


Figure 2- Study results

5. Conclusion

According to the Oslo Manual, innovation consists in the implementation of a product (good or service), process, marketing method or organizational method, whether new or improved (OECD, 2005).

Bearing in mind the objectives of this study, and through statistical analyzes it was possible to verify that the variables contained in the literature are relevant, but insufficient to explain all the effective environmental benefits with innovation.

In view of the MANOVA statistical analysis, it was possible to verify that the cooperation variable has a significant influence on at least three types of innovation in line with (Miotti & Sachwald, 2003). This means that as cooperation in firms increases, there is a greater likelihood of increasing product, process and marketing innovations.

The literature stated that there was a relationship between cooperation, innovation and eco-innovation, and for that we used an association between variables to verify this relationship.

Regarding the association of variables, it can be seen that total innovation, total cooperation, and eco-innovation, despite having weak to moderate correlations, all of them were significant, so it can be statistically stated that there is a relationship between these variables according with the literature, for example Ayuso et al., (2011). This means that as cooperation increases in firms, as was seen in MANOVA, the tendency to increase innovation is higher and, in turn, the likelihood of firms adopting eco-innovations increases.

In relation to the factors that most contribute for firms to opt for eco-innovations used in the multiple linear regression models it was possible to verified that they are the current or expected demand in the market for environmental innovations (Kesidou & Demirel, 2012), the improvement of reputation of the firm (Hojnik et al., 2018) and the high costs of energy, water and materials (Ghisetti & Rennings, 2014), in line with the authors studying this theme. With this, it is possible to verify that the firms direct the adoption of eco-innovation for purely strategic motivations and not exactly to the environmental concern.

This study presents several contributions, both from a theoretical and practical perspective. In theoretical terms, cooperation with partners increases the innovation in products / services, processes and marketing in firms. A firm that cooperates and that simultaneously innovates is more willing to adopt eco-innovations. Finally, eco-innovation ends up being related to organizational objectives, for example the current or expected market demand, the firm reputation and the high costs of energy, water and materials.

In practical terms, managers must be aware that cooperating with different stakeholders are better able to innovate and therefore have access to new opportunities in the market. At the same time that these new possibilities (cooperation and innovation) open up, they will be in a position to adopt eco-innovations. Finally, firms

that are concerned with introducing eco-innovations associate them with purely strategic motivations, namely in terms of reputation, costs and demand.

Although it is possible to draw conclusions about this study, it has several limitations. The database chosen, CIS 2014, has few questions that allow answers on an ordinal scale, i.e., most of the questions are for "Yes" and "No" answers, which is not conducive to the analysis, being essential the creation of other variables.

For future research, since eco-innovation is a topic with great relevance, a relative study applied at international level is suggested in order to make a comparison between Portugal and other cultures. Since the questions related to eco-innovations correspond to dummy variables on the survey used on this study, it will be interesting to apply a new questionnaire involving variables on a 7-point Likert scale to explore if there is a big difference in the results.

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Appendix 1- Sample description

Statistics		
Total_Inov		
N	Valid	7083
	Missing	0
Mean		2,2908
Median		1,0000
Mode		**0,00**
Std. Deviation		2,90548
Skewness		**1,314**
Std. Error of Skewness		0,029
Kurtosis		**0,979**
Std. Error of Kurtosis		0,058
Minimum		**0,00**
Maximum		**12,00**

Table 19- Total Innovation descriptive statistics

Total_Inov					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0,00	**3142**	**44,4**	44,4	44,4
	1,00	660	9,3	9,3	53,7
	2,00	787	11,1	11,1	64,8
	3,00	578	8,2	8,2	72,9
	4,00	476	6,7	6,7	79,7
	5,00	355	5,0	5,0	84,7
	6,00	335	4,7	4,7	89,4
	7,00	210	3,0	3,0	92,4
	8,00	176	2,5	2,5	94,9
	9,00	132	1,9	1,9	96,7
	10,00	102	1,4	1,4	98,2
	11,00	77	1,1	1,1	99,3
	12,00	53	0,7	0,7	100,0
	Total	7083	100,0	100,0	

Table 20- Frequency table for the variable Total_Inov

Statistics		
Total_Coop		
N	Valid	891
	Missing	6192
Mean		3,70
Median		2,00
Mode		**1**
Std. Deviation		3,455
Skewness		**2,456**
Std. Error of Skewness		0,082
Kurtosis		**9,030**
Std. Error of Kurtosis		0,164
Minimum		**1**
Maximum		**28**

Table 21- Total Cooperation descriptive statistics

Total_Coop					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**1**	**248**	**3,5**	27,8	27,8
	2	202	2,9	22,7	50,5
	3	106	1,5	11,9	62,4
	4	106	1,5	11,9	74,3
	5	48	0,7	5,4	79,7
	6	39	0,6	4,4	84,1
	7	36	0,5	4,0	88,1
	8	27	0,4	3,0	91,1
	9	25	0,4	2,8	93,9
	10	12	0,2	1,3	95,3
	11	8	0,1	0,9	96,2
	12	7	0,1	0,8	97,0
	13	5	0,1	0,6	97,5
	14	6	0,1	0,7	98,2
	15	5	0,1	0,6	98,8
	16	4	0,1	0,4	99,2
	18	1	0,0	0,1	99,3
	19	1	0,0	0,1	99,4
	20	1	0,0	0,1	99,6
	22	1	0,0	0,1	99,7
	23	1	0,0	0,1	99,8
	28	2	0,0	0,2	100,0
	Total	891	12,6	100,0	

Table 22- Frequency table for the variable Total Cooperation

Statistics		
	Eco_Inov	
N	Valid	4167
	Missing	2916
Mean		2,7507
Median		2,0000
Mode		**0,00**
Std. Deviation		2,92415
Skewness		**0,876**
Std. Error of Skewness		0,038
Kurtosis		**-0,327**
Std. Error of Kurtosis		0,076
Minimum		**0,00**
Maximum		**10,00**

Table 23- Eco-innovation descriptive statistics

Eco_Inov					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**0,00**	**1433**	**20,2**	34,4	34,4
	1,00	472	6,7	11,3	45,7
	2,00	459	6,5	11,0	56,7
	3,00	397	5,6	9,5	66,3
	4,00	306	4,3	7,3	73,6
	5,00	283	4,0	6,8	80,4
	6,00	230	3,2	5,5	85,9
	7,00	198	2,8	4,8	90,7
	8,00	141	2,0	3,4	94,0
	9,00	132	1,9	3,2	97,2
	10,00	116	1,6	2,8	100,0
	Total	4167	58,8	100,0	

Table 24- Frequency table for the variable Eco_Inov

Statistics					
		P_S_Inov	Proc_Inov	Org_Inov	Mark_Inov
N	Valid	7083	7083	7083	7083
	Missing	0	0	0	0
Mean		0,45	0,67	0,5382	0,6295
Median		0,00	0,00	0,0000	0,0000
Mode		**0**	**0**	**0**	**0**
Std. Deviation		0,685	0,927	0,94186	1,09296
Minimum		**0**	**0**	**0**	**0**
Maximum		**2**	**3**	**3**	**4**

Table 25- Descriptive Statistics for partial Innovation

Appendix 2- MANOVA

Dependent Variable	Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
P_S_Inov	Intercept	2,000	0,466	4,292	0,000	1,085	2,915
	[Total_Coop=1]	-1,109	0,468	-2,370	0,018	-2,027	-0,191
	[Total_Coop =2]	-0,866	0,468	-1,850	0,065	-1,785	0,053
	[Total_Coop =3]	-0,868	0,470	-1,845	0,065	-1,791	0,055
	[Total_Coop =4]	-0,774	0,470	-1,645	0,100	-1,697	0,150
	[Total_Coop =5]	-0,708	0,476	-1,489	0,137	-1,642	0,225
	[Total_Coop =6]	-0,769	0,478	-1,610	0,108	-1,707	0,168
	[Total_Coop =7]	-0,694	0,479	-1,451	0,147	-1,634	0,245
	[Total_Coop =8]	-0,741	0,483	-1,534	0,125	-1,689	0,207
	[Total_Coop =9]	-0,560	0,484	-1,156	0,248	-1,510	0,390
	[Total_Coop=10]	-0,500	0,503	-0,993	0,321	-1,488	0,488
	[Total_Coop=11]	-0,750	0,521	-1,440	0,150	-1,772	0,272
	[Total_Coop=12]	-0,429	0,528	-0,811	0,418	-1,466	0,608
	[Total_Coop=13]	-0,600	0,551	-1,088	0,277	-1,682	0,482
	[Total_Coop=14]	-1,000	0,538	-1,859	0,063	-2,056	0,056
	[Total_Coop=15]	-1,400	0,551	-2,539	0,011	-2,482	-0,318
	[Total_Coop=16]	-0,750	0,571	-1,314	0,189	-1,870	0,370
	[Total_Coop=18]	-1,000	0,807	-1,239	0,216	-2,584	0,584
	[Total_Coop=19]	-1,000	0,807	-1,239	0,216	-2,584	0,584
	[Total_Coop=20]	-1,000	0,807	-1,239	0,216	-2,584	0,584
	[Total_Coop=22]	-1,000	0,807	-1,239	0,216	-2,584	0,584
	Total_Coop=23]	-6,586E-14	0,807	0,000	1,000	-1,584	1,584
	[Total_Coop=28]	0	.	.	.	.	.
Proc_Inov	Intercept	3,000	0,638	4,705	0,000	1,749	4,251
	[Total_Coop =1]	-1,762	0,640	-2,752	0,006	-3,019	-0,506
	[Total_Coop =2]	-1,406	0,641	-2,194	0,028	-2,664	-0,148
	[Total_Coop =3]	-1,396	0,644	-2,169	0,030	-2,659	-0,133
	[Total_Coop =4]	-1,330	0,644	-2,067	0,039	-2,593	-0,067
	[Total_Coop =5]	-1,146	0,651	-1,761	0,079	-2,423	0,131
	[Total_Coop =6]	-1,128	0,654	-1,726	0,085	-2,411	0,155
	[Total_Coop =7]	-1,167	0,655	-1,781	0,075	-2,452	0,119
	[Total_Coop =8]	-1,296	0,661	-1,962	0,050	-2,593	0,001
	[Total_Coop=9]	-0,760	0,663	-1,147	0,252	-2,061	0,541
	[Total_Coop=10]	-0,750	0,689	-1,089	0,276	-2,102	0,602
	[Total_Coop=11]	-1,500	0,713	-2,104	0,036	-2,899	-0,101
	[Total_Coop=12]	-1,000	0,723	-1,383	0,167	-2,419	0,419
	[Total_Coop=13]	-0,600	0,754	-0,795	0,427	-2,081	0,881
	[Total_Coop=14]	-1,667	0,736	-2,264	0,024	-3,112	-0,222

	[Total_Coop=15]	-1,200	0,754	-1,591	0,112	-2,681	0,281
	[Total_Coop=16]	-0,500	0,781	-0,640	0,522	-2,033	1,033
	[Total_Coop=18]	-2,000	1,104	-1,811	0,070	-4,168	0,168
	[Total_Coop=19]	-3,000	1,104	-2,716	0,007	-5,168	-0,832
	[Total_Coop=20]	-1,000	1,104	-0,905	0,365	-3,168	1,168
	[Total_Coop=22]	-2,000	1,104	-1,811	0,070	-4,168	0,168
	[Total_Coop=23]	-7,810E-14	1,104	0,000	1,000	-2,168	2,168
	[Total_Coop=28]	0	.	.	.	.	.
Org_Inov	Intercept	2,000	0,815	2,454	0,014	0,400	3,600
	[Total_Coop=1]	-1,060	0,818	-1,296	0,195	-2,667	0,546
	[Total_Coop=2]	-0,723	0,819	-0,882	0,378	-2,330	0,885
	[Total_Coop=3]	-0,623	0,823	-0,757	0,449	-2,237	0,992
	[Total_Coop=4]	-0,840	0,823	-1,021	0,308	-2,454	0,775
	[Total_Coop=5]	-0,500	0,832	-0,601	0,548	-2,133	1,133
	[Total_Coop=6]	-0,308	0,836	-0,368	0,713	-1,948	1,333
	[Total_Coop=7]	-0,444	0,837	-0,531	0,596	-2,088	1,199
	[Total_Coop=8]	-0,407	0,845	-0,482	0,630	-2,065	1,251
	[Total_Coop=9]	-0,120	0,847	-0,142	0,887	-1,783	1,543
	[Total_Coop=10]	-0,250	0,880	-0,284	0,777	-1,978	1,478
	[Total_Coop=11]	-0,750	0,911	-0,823	0,411	-2,539	1,039
	[Total_Coop=12]	0,571	0,924	0,618	0,537	-1,243	2,385
	[Total_Coop=13]	0,800	0,964	0,830	0,407	-1,093	2,693
	[Total_Coop=14]	-0,500	0,941	-0,531	0,595	-2,347	1,347
	[Total_Coop=15]	-0,200	0,964	-0,207	0,836	-2,093	1,693
	[Total_Coop=16]	1,000	0,998	1,002	0,317	-,959	2,959
	[Total_Coop=18]	-5,557E-14	1,412	0,000	1,000	-2,771	2,771
	[Total_Coop=19]	-2,000	1,412	-1,417	0,157	-4,771	0,771
	[Total_Coop=20]	1,000	1,412	0,708	0,479	-1,771	3,771
	[Total_Coop=22]	-2,000	1,412	-1,417	0,157	-4,771	0,771
	[Total_Coop=23]	1,000	1,412	0,708	0,479	-1,771	3,771
	[Total_Coop=28]	0	.	.	.	.	.
Mark_Inov	Intercept	4,000	0,958	4,175	0,000	2,119	5,881
	[Total_Coop=1]	-3,161	0,962	-3,286	0,001	-5,049	-1,273
	[Total_Coop=2]	-2,515	0,963	-2,612	0,009	-4,405	-0,625
	[Total_Coop=3]	-2,623	0,967	-2,712	0,007	-4,521	-0,724
	[Total_Coop=4]	-2,566	0,967	-2,653	0,008	-4,464	-0,668
	[Total_Coop=5]	-2,479	0,978	-2,535	0,011	-4,399	-0,560
	[Total_Coop=6]	-2,385	0,982	-2,427	0,015	-4,313	-0,456
	[Total_Coop=7]	-2,444	0,984	-2,483	0,013	-4,377	-0,512
	[Total_Coop=8]	-2,593	0,993	-2,611	0,009	-4,542	-0,644
	[Total_Coop=9]	-1,760	0,996	-1,767	0,078	-3,714	0,194
	[Total_Coop=10]	-1,833	1,035	-1,771	0,077	-3,865	0,198
	[Total_Coop=11]	-2,500	1,071	-2,334	0,020	-4,603	-0,397
	[Total_Coop=12]	-1,714	1,086	-1,578	0,115	-3,847	0,418

[Total_Coop=13]	-1,600	1,134	-1,411	0,159	-3,825	0,625
[Total_Coop=14]	-2,333	1,106	-2,109	0,035	-4,505	-0,162
[Total_Coop=15]	-2,400	1,134	-2,117	0,035	-4,625	-0,175
[Total_Coop=16]	-2,250	1,174	-1,917	0,056	-4,553	0,053
[Total_Coop=18]	-4,000	1,660	-2,410	0,016	-7,257	-0,743
[Total_Coop=19]	-4,000	1,660	-2,410	0,016	-7,257	-0,743
[Total_Coop=20]	-1,000	1,660	-0,603	0,547	-4,257	2,257
[Total_Coop=22]	-4,000	1,660	-2,410	0,016	-7,257	-0,743
[Total_Coop=23]	-2,000	1,660	-1,205	0,228	-5,257	1,257
[Total_Coop=28]	0	.	.	.	.	.

Table 26- Post Hoc Tests

The role of eco-innovation in internationalized firm's performance

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Abstract

Purpose–Reasons/aims of paper: Eco-innovation has acquired a greater importance due to the current condition of the environment, leading to people's concern to purchase more environmentally sustainable products (Govindan, Diabat & Shankar, 2015; Hojnik et al., 2018). This study aims to explore the influence of internationalization and eco-innovation on the firm´s performance, as well as the influence of cooperation on eco-innovation.

Research–Methodology: This study is based on primary data from 102 internationalized firms in Portugal belonging to the footwear, furniture, metalworking and textile sectors. Data were collected using an online questionnaire adapted from (Hojnik et al., 2018) and (CIS, 2016). The conceptual model was tested using the software SmartPLS by PLS-SEM (Partial Least Squares Structural Equation Modeling) method.

Findings-Conclusions: The results of this study show that, in addition to influencing the firm´s performance, internationalization is also influenced by eco-innovation practices. On the other hand, it was not possible to present statistical evidence to show the influence of internationalization and cooperation on eco-innovation.

Research limitations: It is a study applied only to Portuguese firms with international sales, so we are limited in geographic terms. Another limitation is the impossibility of knowing the cooperation partners and, as such, it was necessary to use a dummy variable to measure cooperation.

Practical implications-Applications to practice: – As regulatory issues are greater due to the growing concern for the environment, this study aims to help firms realize the advantages they gain by acquiring more sustainable practices and thus increasing their competitive advantage when entering new markets.

Originality: This study makes it possible to clarify whether eco-innovation and internationalization are indeed important to improve the performance of firms. In addition, it allows us to understand whether eco-innovation can be influenced by internationalization and cooperation with regard to internationalized Portuguese firms.

Keywords: Sustainability; Internationalization; Firm performance; Cooperation

1. Introduction

The current condition of the environment is causing concerns in business and economies about future sustainability. In addition, the scarcity of resources and the increase in population are becoming increasing importance issues and, therefore, the conservation of environmental quality is essential (Govindan, Diabat & Shankar, 2015).

As such, there is a growing consumer demand for environmentally friendly products and services and the adoption of eco-innovations by consumers and firms is on the rise (Hojnik et al., 2018).

Eco-innovation is defined as “the production, assimilation or exploitation of a product, production process, service or management or business method that is new to the organization (developing or adopting) 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, 2020).

Eco-innovation brings numerous benefits that are not limited to improving environmental performance but also that firms obtain many monetary and economic advantages (Juniati et al., 2019). Although eco-innovation generates significant benefits for the firms economic performance, there are different factors that lead to the decision to adopt it. They can result from the desire to improve the firm’s reputation, reduce costs, respond to market demand, enter new markets, fight competition, do the “right” thing or comply with regulations (Hojnik et al., 2018).

Internationalization is thus recognized as the new driver of eco-innovation. Therefore, firms enter foreign markets to obtain opportunities and increase competitiveness. Internationalization drives firms to implement eco-innovation practices through two channels of influence. To begin with, there is a worldwide demand for environmentally sustainable technologies, products and production services (Doranova, Veen & Hinojosa, 2013). The other channel of influence is attributed to international regulations. For example, the so-called "green barriers" prevent firms from operating in certain foreign markets unless they meet all the ecological needs of consumers (Zhu, Sarkis & Lai, 2007).

The presence of internationalization combined with eco-innovation allows firms to achieve greater performance and greater competitiveness. They help firms to expand into new markets and achieve efficiency and effectiveness. However, it is crucial that firms cooperate with their consumers, suppliers in order to result in a further development of eco-innovation, since it makes a more efficient use of external sources obtained from acquired knowledge (Scandelius & Cohen, 2016; Ghisetti et al., 2015). Cooperation is therefore important for successful implementation of eco-innovation practices (León-Bravo et al., 2017).

It is possible to recognize the importance of internationalization and eco-innovations to achieve the firm's performance, however there are few studies relating eco-innovation and internationalization (Suárez-Perales et al., 2017).

Therefore, the main objective of this study is to explore the influence of internationalization and eco-innovation on the firm's performance, as well as the influence of cooperation on eco-innovation.

This study is divided into six parts, in the first part an introduction to the study is presented, the second part presents a literature review on the main variables under study, the hypotheses to be tested. The third part presents the methodology adopted for the development of this study, in order to answer the objectives to be analyzed as well as the techniques to use. The fourth part presents the main results of the study and in the fifth part a discussion of these results is developed. Finally, the main conclusions of the study are presented, as well as the main limitations and possible future investigations.

2. The link between internationalization, eco-innovation, cooperation and performance – a literature review

Internationalization provides numerous learning opportunities for firms to develop the knowledge and skills needed to introduce product, process and system eco-innovations (Boermans & Roelfsema, 2015; Williams & Shaw, 2011). This can be defined as the expansion of firms in terms of research and development (R&D), production, sales and other business activities for foreign markets (Hollensen, 2011).

To explain the relationship between internationalization and eco-innovation, the present study uses the organizational perspective learning, as it was used in the study of Hojnik, Ruzzier and Manolova (2018). This theory suggests that firms learn after realizing the need to integrate schedules, frameworks and strategies integration as a result of people's actions, demands and experiences (Cohen & Levinthal, 1990) and that firms learn from past experiences (Levitt & March, 1988).

In the internationalization process, firms learn by meeting the needs of foreign customers, their demands and in the process, they have a better understanding of foreign markets, competitions, regularities and technological gaps (Juniati et al. 2019).

Knowledge acquisition is one of the key factors affecting a firms international behavior (Pla-Barber & Alegre, 2014), and the expansion of this vital characteristic of internationalization that improves organizations rate of adjustments, skills sets and competitiveness through their capabilities of catering the needs of widespread market and customers (Villar, Alegre & Pla-Barber, 2014).

According to the authors (e.g. Suárez-Perales et al., 2017; Chiarvesio et al., 2015; Cainelli et al., 2012) few studies have been carried out relating eco-innovation and internationalization, however some research results can be presented, as describe after.

According to Hojnik et al. (2018), internationalization in addition to promoting better economic performance, also leads to the adoption of eco-innovation. De Marchi (2012) also showed a positive relationship between internationalization strategy and eco-innovation. Most of the time, internationalization has led firms to adopt more sustainable behaviors (Cainelli, Mazzanti & Montresor, 2012).

Strategic actions related to internationalization are usually accompanied by proactive attitudes in what concerns environmental issues (Suárez-Perales et al., 2017).

For Porter and Linde (1995), firms that operate in global markets learn more, especially with foreign partners, with customers and even with competitors (Chiarvesio, De Marchi & Di Maria, 2015). In this sense, Guoyou et al. (2013) identified that for developing countries (in the study in question, China) foreign customers play an important role in the adoption of eco-innovation strategies in processes and products by firms.

Empirical evidence has shown that internationalization provides firms with greater knowledge about best environmental practices, eco-innovation and better financial performance (Hojnik et al. 2018; Rexhäuser & Rammer, 2014).

Exports, for example, tend to generate spillovers of knowledge for domestic firms, especially with regard to the adoption of "greener" practices and better environmental performance. Thus, exporting firms are more innovate than non-exportorting firms (Cassiman & Golovko, 2011) since the acquisition of knowledge through export improves the innovation capacity of firms (Shearmur, Doloreux & Laperrière, 2015).

When internationalizing, firms learn to comply with environmental regulations in the foreign markets in which they operate (Cainelli, Mazzanti & Montresor, 2012). Ratten (2018) identified that firms, acting in an eco-innovative way, improved their performance in the international market.

Thus, it can be assumed that both, internationalization and eco-innovation, allow firms to improve their environmental, operational, economic and greater learning, opening new business opportunities and favoring their growth (Hojnik et al., 2018).

The study by Hojnik et al. (2018) with small and medium-sized Slovenian firms identified that, among the firms surveyed, the largest and those with certifications (i.e., ISO14001 certification) were more eco-innovative than the rest. In other words, the authors showed that the size of firms influences the adoption of eco-innovation (De Marchi & Grandinetti, 2012) and that certifications drive technological and environmental improvements (Leenders & Chandra, 2013).

Luan et al. (2016) found that more internationalized firms are also more likely to have green certifications and international experience positively influences the adoption of proactive environmental strategies (Aguilera-Caracuel, Hurtado-Torres & Aragon-Correa, 2012). Considering the approaches presented, it is possible to formulate the following hypothesis:

Hypothesis 1: Internationalization positively influences the adoption of eco-innovation.

One of the main reasons that encourages firms to internationalize is to obtain positive results between the degree of internationalization and financial performance. To evaluate this relationship, several studies were carried out with different research methodologies with contradictory results (positive or negative) (Li, 2007; Glaum & Oesterle, 2007).

Most of the empirical evidence shows that the greater the degree of internationalization, the greater the performance of the firm (Grant, Jammine & Thomas, 1988; Contractor, Kundu & Hsu, 2003; Boermans & Roelfsema, 2015).

Grant (1987) argues that what determines positive performance are the benefits that the firm has in going international. Internationalization allows firms to benefit from

economies of scale, recover their investments more quickly and improve their effectiveness and efficiency (Hojnik et al. 2018).

Juniati et al. (2019) claim that the increased knowledge and skills development in the process of internationalization benefits organizations by augmenting employees expertise and results in improved performance.

Pangarkar (2008) also established that degree of internationalization brings positive impact on firm's performance. However, other studies show a negative relationship or no significant relationship (Buckley, Dunning & Pearce, 1978; Brewer, 1981; Collins, 1990) between these two concepts.

According to Hojnik et al. (2018) the mixed results obtained from the different studies indicate that the connection between internationalization and firm performance is not always simple and can be mediated. And following the logic of the mediation effect, it is possible to propose a positive effect of internationalization on the firm economic performance. It is thus possible to define a new hypothesis:

Hypothesis 2: Internationalization positively influences the firm performance.

The environmental effort to introduce eco-innovations and establish a sustainable relationship with the Planet can be rewarded by the improving the economic performance of firms (Cheng et al., 2014; Hojnik et al., 2018).

Firms through time have recognized that eco-innovation does not have be just a cost to the firm, on the contrary, it can present a new business opportunity or the exploration of a niche market (Hojnik & Ruzzier, 2016).

There is no consensus in the literature regarding the relationship between eco-innovation and firm performance (Przychodzen & Przychodzen, 2015). On the one hand, green innovation is can affect performance through two distinct mechanisms, such as market differentiation and cost reduction (Aguilera-Caracuel & Ortiz-de-Mandojana, 2013).

Doranova et al. (2013) claim that the development of ecological innovation presents a business opportunity, leading to cost reduction and improving the ability to take advantage of new growth opportunities. Suryanto et al. (2018) also stated that the increase in eco-innovations brings stability and improvements in the firm performance.

Eco-innovation is strategy that seeks to satisfy consumers and increasing business performance (Capitanio, Coppola & Pascucci, 2010). Thus, being greener can improve competitiveness (Sáez-Martínez et al. 2016) and firms can gain a competitive advantage by reducing costs and increasing revenues (Ambec & Lanoie, 2008).

Zhang, Rong and Ji (2019) revealed a significant and positive relationship between eco-innovation and firm performance. It is possible to affirm a positive association between

all three eco-innovation types[6] (product, process and organizational eco-innovation) and firm performance (Cheng et al. 2014; Hojnik et al. 2018).

On the other hand, studies have shown that green firms do not experience better performance than environmentally neutral firms (Fernando et al. 2010) and eco-innovation can have a negative effect in the short term followed by a positive effect (Ramanathan et al. 2010; Horváthová, 2012).

Thus, time is an important variable to better understand the impacts of innovation on performance (Rezende et al., 2019) but the effect of eco-innovation on firm performance is not only influenced by it, but also by the type of eco-innovation (Hojnik et al., 2018).

Nevertheless, most of the literature points to a positive effect between eco-innovation and performance, so a new hypothesis can be formulated:

Hypothesis 3: Eco-innovation positively influences the firm performance.

In the other hand, cooperation has increasingly been recognized for its importance in developing the innovative capabilities of firms (Faems, Looy & Debackere, 2005). Firms can cooperate with entities such as consumers, suppliers, customers, universities, research institutes, technological laboratories and even potential competitors (De Marchi, 2012; Souto & Rodriguez, 2015; Ryszko, 2016).

Duysters et al.(1999) claim that cooperating has become a necessity, since one of the conditions for forming cooperative relationships is the scracity or lack of resources. In the view of Hillebrand and Biemans (2003), cooperation serves for firms to achieve a competitive advantage.

Cunico et al. (2017) claim that firms do not only possess the skills necessary for an effective eco-innovation strategy, they need cooperation with other organizations. Cooperation thus increases the probability of becoming an eco-innovator because it makes more efficient use of the acquired external sources of knowledge that eco-innovation needs (Ghisetti, Marzucchi & Montresor, 2015).

Good communication with all the agents involved results in a more advanced cooperation that results in further development of eco-innovation in the firm (Scandelius & Cohen, 2016). According to Lozano (2008), cooperation contributes to greater eco-innovation practices in firms.

In the context of sustainability, cooperation mechanisms facilitate the coordination of various intangible assets, such as know-how, which makes it difficult for its competitors to imitate (Plaza-Úbeda et al., 2009).

[6] Three-dimensional concept of implementing eco-innovation according to the respective eco-innovation definitions of Kemp and Pearson (2008) and OECD (2009).

León-Bravo et al. (2017) highlight the importance of the cooperative relationship for a successful implementation of sustainable practices, and therefore identifying the partners in the cooperative relationship and the underlying objectives are key factors.

Likewise, Garcés-Ayerbe et al. (2019) shows that cooperation also supports the development of the ecological innovation strategy. Taking into account the information it is possible to formulate a new hypothesis:

Hypothesis 4: Cooperation positively influences eco-innovation

Taking into account the arguments mentioned above, it is possible to affirm the existence of a positive relationship between internationalization and eco-innovation, a positive relationship between eco-innovation and firm performance and, finally, a positive relationship between cooperation and eco-innovation.

In other words, there is a mediated relationship between internationalization, eco innovation, firm performance and cooperation (Hojnik et al., 2018; Garcés-Ayerbe et al., 2019). Mediation seeks to establish or test how variable X (predictor) influences variable Y (outcome) throuhg a model in which one or more intervening variables M (meditors) are located between X and Y (Hayes, 2017).

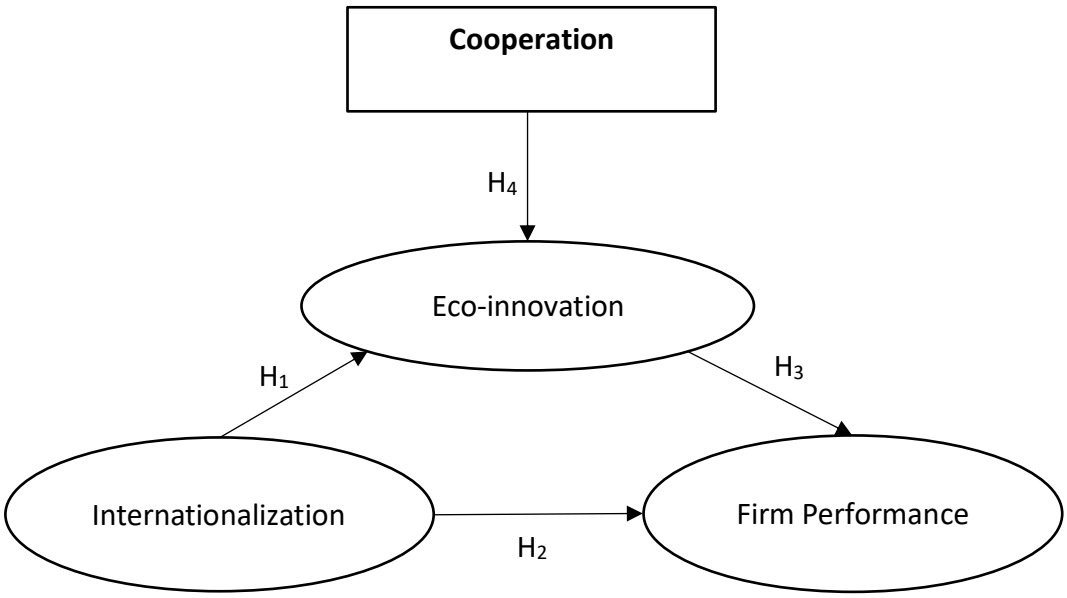

Figure 3- Conceptual model proposed (adapted from Hojnik et al., (2018)).

Figure 3 shows the conceptual model of this study, where eco-innovation has a mediating role between cooperation and firm performance (H_4 and H_3) and between internationalization and firm performance (H_1 and H_3). The model also includes direct effect of the internationalization in firm performance (H_2), as suggested in literature.

3. Research Metodology

3.1. Data collection

In order to study the applicability of the conceptual model, suggested in literature and presented in Figure 3, this study is based on primary data from 102 internationalized firms in Portugal, representing a sample of micro, small, medium and large firms. Data was collected through an online questionnaire adapted from (Hojnik et al., 2018) and (CIS, 2016)[7].

This questionnaire is divided into seven sections, where the first three parts represent eco-innovation, the fourth represents internationalization, the fifth and sixth represent the firm performance and cooperation and the last section is dedicated to firm information.

To select the sample, it was the Sabi portuguese database[8], and the criteria were as follows:

(1) The firms belong to the Footwear, Metalworking, Textile and Furniture sectors because in recent years they have been the most internationalized[9] and because they are the most relevant in Tâmega and Sousa[10] (Silva, Dias, Lobão & Sardo, 2019).

(2) Firms must have international activities.

In view of these criteria, the invitation to participate in this study was sent via email to 3603 firms with a brief presentation of the study and the link to the website with the online questionnaire. The study was conducted between May and August 2020 and 102 valid answers were obtained (response rate = 2.83%).

We tested the study´s conceptual model, presented in Figure 3, using the software SmartPLS by PLS-SEM (Partial Least Squares Structural Equation Modeling) method.

3.2. Sample characteristics

A micro firm is a firm that employs less than 10 employees (1-9), a small firm is a firm that employs less than 50 employees (10-49), a medium firm is a firm that fewer than 250 employees (50-249) and a large firm is a firm that employs 250 or more employees (250 or more) (Commission, 2003).

[7] Appendix 2
[8] Link to Sabi portuguse database https://sabi.bvdinfo.com/version-202094/Search.QuickSearch.serv?_CID=1&context=IYYH9WQQ7G8R6GU
[9] According to PORDATA data: https://www.pordata.pt/DB/Portugal/Ambiente+de+Consulta/Tabela
[10] ESTG belongs to this geographical area

Characteristics		Number of firms	% of firms
Size	Micro (1-9)	34	33.3%
	Small (10-49)	47	46.1%
	Medium (50-249)	17	16.7%
	Large (250 or more)	4	3.9%
Sector	Footwear	30	29.4%
	Metalworking	30	29.4%
	Textile	23	22.5%
	Furniture	19	18.6%
Total		102	100%

Table 27- Distribution of size and sectors of sample

Our sample consists of 34 micro firms (33.3%), 47 small firms (46.1%), 17 medium firms (16.7%) and 4 large firms (3.9%). Of the four sectors selected (metalworking, textile, footwear and furniture) for the decision of firms, our sample consists mainly of firms in the footwear sector (30) and metalworking (30) as illustrated in Table 27.

3.3. Measures

To test the hypotheses defined in Section 2, we constructed three latent variables (eco-innovation, internationalization and firm performance) and a single variable (cooperation), using multi-item scales as illustrated in Table 28. The validity and reliability of the measures were supported by literature in particular by CIS (2016) and Hojnik et al. (2018).

Variables	Measures	Literature	Question of questionnaire
Eco-innovation	7 point Likert scale ranging form 1 = totally disagree to 7 = tolly agree	(Hojnik et al., 2018)	1 2 3
Internationalization	Number of foreign countries in which the firm currently sellts its products/service, share of sales in the foreign market and total number of operation modes	(Hojnik et al., 2018)	4
Firm Performance	7 point Likert scale ranging form 1 = very negative to 7 = very positive	(Hojnik et al., 2018)	6
Cooperation	Dummy variable	(CIS, 2016)	5

Table 28- Measurement of the variables

As mentioned previously, eco-innovation can be divided into three types (product, process and organizational), hence in the questionnaire, product eco-innovation is represented by the first section consisting of 7 items, process eco-innovation is represented by the second section and organizational eco-innovation is represented by the third section, both composed of 15 items.

Internationalization is represented in the questionnaire by section four, made up of 5 questions, cooperation by section five made up of 2 questions and finally the firm performance by section six, made up of 4 items.

4. Results

4.1. Exploratory Factor Analysis and Multicollinearity

Initially, all items were included in SmartPLS. Through the exploratory factor analysis, carried out in the factor weighting scheme in the PLS algorithm, items with factor loadings less than 0.7[11] were removed (Field, 2009) except for one (total number of operation modes) because the indicator is relevant (Hojnik et al., 2018). To avoid multicollinearity problems, items with VIF's greater than 5[12] were removed (Hair, Ringle & Sarstedt, 2011). After verifying the adequacy of the data, was performed the PLS algorithm and bootstrapping obtained the results in Table 29.

4.2. Data adequacy

Our hypotheses were tested using PLS-SEM. One of the assumptions for using this method is the sample size in relation to the assessment of relationships. Chin (1998), states that the sample size must be 10 times larger than: (1) the block with the larger number of indicators or (2) the dependent variable with the largest independent variables impacting it. In our model, (1) is equal to 5 (eco-innovation) and (2) is equal to 1 (eco-innovation) and 2 (firm's performance). The minimum size of our sample must be 50 and our sample has 102 cases, i.e., the data adequacy is accepted.

4.3. Reflective Outer Model Evaluation

For reflective models, it is necessary to evaluate the indicator's reliability, convergent validity, composite reliability and discriminant validity (Benitez, Henseler, Castillo & Schuberth, 2019). A bootstrap was performed for 5000 resamples where a one-tailed test was used with a significance level of 0.05. Furthermore, we retained above 0.707 (Benitez et al., 2019) except for the variable previously mentioned, since the literature indicates that this item is important to measure intrenationalization (Hojnik et al., 2018).

[11] 27 items have been removed
[12] 5 items have been removed

The composite reliability of all the constructs is greater than 0.70 (CR ≥ 0.7), indicating acceptable reliability (Hair, Black, Babin & Anderson, 2009). With regards convergent validity, we conclude that all the construct display an AVE above 0.5 (in line with Fornell & Larcker, 1981). The square roots of each AVE is greater than the correlations between the constructs and the greater hetero-trait-mono-trait ratio (HTMT) (Henseler, Hubona & Hubona, 2016) which means that discriminant validity has been established. All of these data are present in the Table 29 and Table 33[13].

Variable	Outer Loadings	Quality Criteria		
		AVE	CR	VIF
1. Eco-innovation				
The firm is improving and designing environmentally friendly packaging (e.g., use fewer paper and plastic materials) for existing and new products.	0.840			2.607
The firm deliberately evaluates whether the product is easy to recycle, reuse and decompose for conducting the product development or design.	0.898	0.711	0.925	3.114
Recycle, reuse and remanufacture of material.	0.804			2.128
Use of cleaner technology to generate savings and prevent pollution (e.g., energy, water and waste).	0.786			2.117
Our firm management often uses novel systems to manage eco-innovation.	0.883			2.550
2. Firm Performance				
Sales	0.914	0.818	0.947	4.268
Market Share	0.933			4.439
New market opportunities	0.923			4.500
Employee Satisfaction	0.843			2.131
3. Internationalization				
Number of foreign countries in which firm currently sells its products/services	0.960	0.509	0.720	1.492
Share of sales on foreign markets in 2019.	0.736			1.431
Total number of operation modes.	0.250			1.064
4. Cooperation				
Our firm cooperated in the scope of eco-innovation activities with other firms during the period from 2017 to 2019.	n.a.	n.a.	n.a.	n.a.

Note: AVE = Average Variance Extracted; CR = Composite Reliability; VIF = Variation Inflation Factor. n.a. not applicable (single-item).

Table 29- Measurement Model Evaluation

4.4. Structural Model Evaluation

For the evaluation of the structural model, it is necessary to evaluate the values of the coefficient of determination (R^2), the effect size (f^2) and path coefficients with their respective t-values and significance levels (Hair, Sarstedt, Pieper & Ringle, 2012). Table 30 displays all these parameters. The overall approximate model fits (SRMR) is below

[13] Appendix 1

the recommended value of 0.10 according to the PLS tutorial[14], being considered a good fit. The path coefficients range from 0.059 to 0.497 with different levels of significance. The R^2, when adjusted for the number of variables in the model, decreases from 0.014 to -0.006 for eco-innovation, and 0.341 to 0.328 for firm performance.

Relationships	Path Coeficient	t-value	p-value	f^2
Cooperation→Eco-innovation	0.093^{ns}	0.990	0.161	0.009
Eco-innovation→Firm Performance	0.497^{***}	6.510	0.000	0.373
Internationalization→Eco-innovation	0.059^{ns}	0.435	0.332	0.003
Internationalization→Firm Performance	0.271^{**}	2.694	0.004	0.111
Construct	**R^2**		**R^2 adjusted**	
Eco-innovation	0.014		-0.006	
Firm Performance	0.341		0.328	
Model Assessement	**Satured Model**		**Estimated Model**	
SRMR	0.075		0.084	

Note: f^2 = effect size; R^2 = construct's explained variance; SRMR = standardized root mean square. *Saturated Model* represents the correlations between all the latent variables, while the *estimated model* is based on a total effect scheme. Coefficients significant at p-values: + p < 0,050; * p < 0,010; ** p < 0,005; *** p < 0,001; n.s. Not significant based on t (4999), one-tailed test.

Table 30- Structural Model Evaluation

Effects	Path Coeficients	t-value	p-value
Specific indirect effects:			
Cooperation→Eco-innovation→Firm Performance	0.046^{ns}	0.919	0.179
Internationalization→Eco-innovation→Firm Performance	0.029^{ns}	0.426	0.335
Total indirect effects:			
Cooperation→Firm Performance	0.046^{ns}	0.919	0.179
Internationalization→Firm Performance	0.029^{ns}	0.426	0.335
Total effects (indirect plus path)			
Cooperation→Eco-innovation	0.093^{ns}	0.990	0.161
Cooperation→Firm Performance	0.046^{ns}	0.919	0.179
Eco-innovation→Firm Performance	0.497^{***}	6.510	0.000
Internationalization→Eco-innovation	0.059^{ns}	0.435	0.332
Internationalization→Firm Performance	0.300^{**}	2.759	0.003

Note: t-values thresholds at one-tailed test of alpha = 0,05 and 5000 resamples: t (0,05; 4999) =1,645; t (0,01; 4999) = 2,327; t (0,005; 4999) = 2,576; t (0,001; 4999) = 3,091. Coefficients significant at p-values: + p < 0,050; * p < 0,010; **p < 0,005; *** p < 0,001; n.s. Not significant based on t (4999), one-tailed test.

Table 31- Total and indirect effects

5. Discussion

The results presented in Table 30 and Table 31 support some hypotheses formulated in this study. With regards to the relationship between internationalization and eco-innovation, despite the literature claims that the most internationalized firms are the ones that most acquire eco-innovation (e.g. Luan et al., 2016; Hojnik et al., 2018),

[14] Accessed on https://www.smartpls.com/documentation/algorithms-and-techniques/model-fit (18/08/2020)

through the results (H_1: β = 0.059; p = 0.332) we do not find support for H_1. The results suggest that internationalization does not have a direct effect on eco-innovation.

These results can be explained for two reasons. The first is that the internationalization construct was measured using an with factor loading below 0.7. However, it was mantained on the analysis, since Hojnik et al. (2018) highlight that, such indicator, is very important for explain internationalization. And second, eco-innovation was measured using only 5 items that, although these indicators were used to measure eco-innovation in previous studies (e.g. Hojnik et al., 2018; Chen, 2008; Cheng & Shiu, 2012), they may not have been the most relevant items for this sample and, therefore, have affected the results.

The hypothesis that relates internationalization with firm performance (H_2) is supported (H_2: β = 0.271; p < 0.005). The results indicate that internationalized firms are more likely to obtain a better performance. Internationalization allows firms to benefit from economies of scale and recover their investments more quickly (Hojnik et al., 2018). In addition to all the knowledge that the firm acquires in an internationalization process allows to improve results and consequently improve the firm's performance (Juniati et al., 2019).

The H_3 - eco-innovation positively influences the firm performance - is also confirmed (H_3: β = 0.497; p < 0.001). This suggests that the adoption of eco-innovation will entail higher returns, enchancing firm performance, this result is an accordance with literature.

Eco-innovation is seen as a business opportunity thal allows to explore a market niche (Hojnik & Ruzzier, 2016). The development of green innovations leads to cost reduction and allows firms to obtain greater advantages in terms of growth (Doranova et al., 2013). Therefore, the increase in eco-innovation brings stability and improves firm performance (Suryanto et al., 2018).

Finally, H_4 - cooperation positively influences eco-innovation - is not confirmed (H_4: β = 0.093; p = 0.161). Although the literature states that firms cooperating will increase eco-innovations, the results suggest that cooperation does not have a direct effect on eco-innovation, for portuguese internationalized firms.

Analyzing the meddiating effect of eco-innovation, we conclude that it is influence is not statistically significant neither for the relationship between cooperation and firm performance (β = 0.046; p = 0.179), neither for internationalization and firm performance (β = 0.029; p = 0.335) (Table 31).

Although the literature refers that mediating effect may exist (e.g. Hojnik et al., 2018), we found no support for such interaction. The Table 32 shows the synthesis with the hypotheses and whether they are supported or not.

Hyphoteses	Supported or Not supported
H_1: Internationalization positively influences the adoption os eco-innovation	Not supported
H_2: Internationalization positively influences the firm performance	Supported
H_3: Eco-innovation positively influences the firm performance	Supported
H_4: Cooperation positively influences eco-innovation	Not supported

Table 32- Supported or not supported hypotheses

These results are also illustrated in Figure 4.

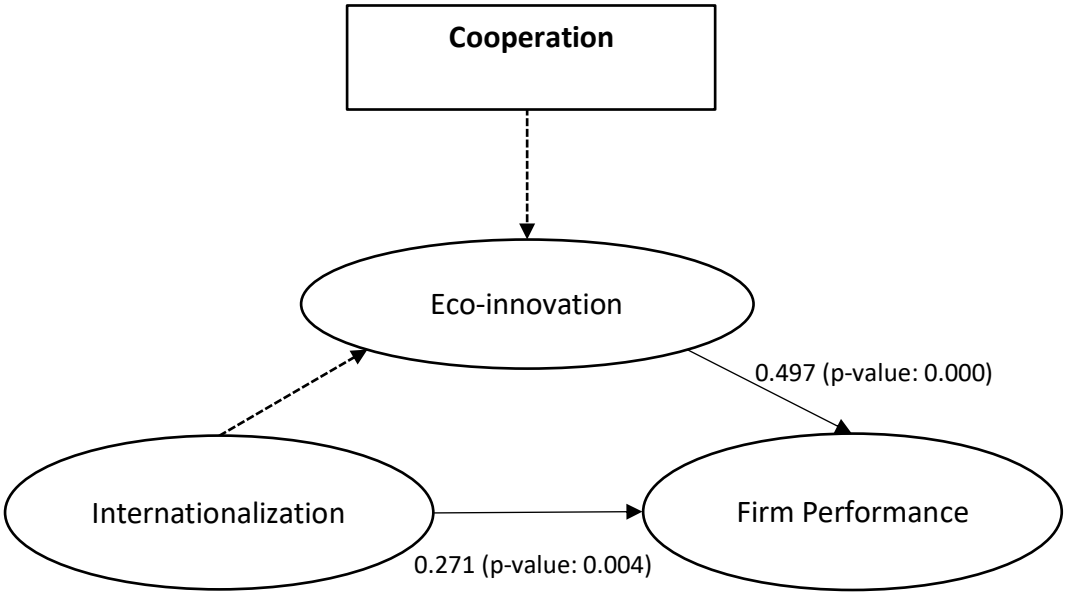

Figure 4- Study results

6. Conclusions

Globalization has increasingly caused competitiveness among firms and one way to try to increase their performance and manage to survive is to internationalize. Internationalization offers countless learning opportunities for firms to develop the knowledge necessary to introduce eco-innovations (Williams & Shaw, 2011; Boermans & Roelfsema, 2015).

Eco-innovation can be defined with the manufacture, application or modification of a good, service, process, business layouts, management and approaches considered innovative for organizations and consumers, resulting in environmental risk, pollution and negative impacts of the use of resources, including energy compared to relevant alternatives (Saudi et al., 2019).

The main conclusions reveal that internationalization has a direct effect on the firm's performance. This means that internationalization helps firms to obtain the necessary knowledge so that they can improve their performance and consequently obtain a higher profit.

On the other hand, although the literature states that internationalization has an influence on eco-innovation, in this study, it was not possible to present statistical evidence to show this relationship. This means that, in the case of this sample, due to the concern that firms have in increasing profits tend to invest on internationalization instead ecological issues.

In addition, the analysis suggests that eco-innovation is important for improving firm performance, i.e., a firm that adopts eco-innovation practices is more likely to improve its performance than those that do not use any eco-innovation.

It was not possible to present statistical evidence to show that cooperation has a direct effect on eco-innovation, despite the literature revealing this relationship. This can be explained because in this study, the cooperation variable is a dummy variable and does not capture all its dimensions. In addition, it was not possible to present empirical evidence of a mediating effect of eco-innovation.

This study presents several contributions, both from a theoretical and practical perspective. In theoretical terms, as mentioned by Suárez-Perales et al. (2017), there are few studies that relate internationalization and eco-innovation, besides that this study responds to a gap in the literature because there is no study using the four variables (eco-innovation, cooperation, internationalization and firm performance) simultaneously.

In practical terms, as regulatory issues are greater due to the growing concern for the environment, this study aims to help firms realize the advantages they gain by acquiring more sustainable practices and thus increasing their competitive advantage when entering new markets.

This research point some limitations. First, it is a study applied only to Portuguese firms with international sales, so we are limited in geographic terms but this is also a strenght. Second, if the sample were larger, it will be possible to increase the generability of the findings, especially if we applied the questionnaire to other sectors.

Another limitation is the impossibility of knowing the cooperation partners and as such it was necessary to use a dummy variable to measure cooperation. It would be interesting to use a likert scale from 1 to 7 where firms assess the degree of importance of each type of partner. Finally, there is still no study that lists the four variables in this study (eco-innovation, internationalization, firm performance and cooperation), so the existing literature is still scarce.

For future investigations it would be interesting to apply these studies to other countries to compare the results. The application to the other sectors, as well as for internationalized firms, could be also interesting in order to see if sector and internationalization influence the results for to concept model proposed.

Another issue of interest would be to understand what the implications of the policies applied by governments with regard to sustainability, called "green transitions", will have on eco-innovation practices in the future for firms.

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Appendix 1

Variables	Fornell & Larcker Criterion			
	Cooperation	**Eco-innovation**	**Firm Performance**	**Internationalization**
Cooperation	*n.a.*			
Eco-innovation	0.103	*0.843*		
Firm Performance	0.301	0.518	*0.904*	
Internationalization	0.167	0.074	0.388	*0.713*

The italic numbers on the diagonal are the square root of the AVE. Off-diagonal values are correlations among constructs/variables. The variables cooperation is not included in this analysis because they are single-item. n.a. not applicable (single-item).

Table 33- Fornell and Larcker Criterion

Appendix 2
Questionnaire Eco-innovation

This questionnaire is intended to collect data within the scope of a dissertation of the Masters in Management and Internationalization of Companies of the School of Technology and Management (ESTG) of the Polytechnic Institute of Porto, with the theme "The role of eco-innovation in internationalized firm's performance ". The participation in this survey by questionnaire is completely voluntary.

The data collected is intended for research purposes only, thus ensuring confidentiality and anonymity. The average time to answer this questionnaire is about 5 minutes.

We appreciate your cooperation.

Section 1 - Product Eco-innovation									
Please indicate to what extent you agree or disagree with the following statements (1-totally disagree to 7-totally agree).									
1- Has your firm ever taken the following action when developing or designing the product:									
1.1- The firm is using less or non-polluting/toxic materials (i.e., using environmentally friendly material).	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
1.2- The firm is improving and designing environmentally friendly packaging (e.g., using less paper and plastic materials) for existing and new products.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
1.3- The firm is recovering the firm end-of-life products and recycling.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
1.4- The firm is using eco-labeling.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
1.5- The firm chooses product materials that consume the least amount of energy and resources for conducting the product development or design.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
1.6- The firm uses the smallest possible amount of materials to comprise the product for conducting the product development or design.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
1.7- The firm deliberately evaluates whether the product is easy to recycle, reuse and decompose for	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*

conducting the product development or design.

Section 2 - Process Eco-innovation

Please indicate to what extent you agree or disagree with the following statements (1-totally disagree to 7-totally agree).

2 - Has your firm ever taken the following action in the production process:

2.1- Low energy consumption such as water, electricity, gas, and petrol during production/use/disposal.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
2.2- Recycle, reuse, and remanufacture material.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
2.3- Closed water loops, reuse of water.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
2.4- Recycle, reuse, and remanufacture of waste.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
2.5- Waste treatment.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
2.6- Decreasing use of solvents or replacing them with substitutes.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
2.7- Use of cleaner technology to generate savings and prevent pollution (such as energy, water, and waste).	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
2.8- The manufacturing process of the firm effectively reduces the emission of hazardous substances or waste.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
2.9- The manufacturing process of the firm reduces the use of raw materials.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
2.10- Reduced CO_2 emissions.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
2.11- Reduced other air emissions (e.g. SOx, NOx).	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
2.12- Reduced water pollution.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
2.13- Reduced soil pollution.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
2.14- Reduced noise pollution.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
2.15- Replaced materials with less hazardous substitutes.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*

Section 3 - Organizational Eco-innovation

Please indicate to what extent you agree or disagree with the following statements (1-totally disagree to 7-totally agree).

3 - Has your firm ever taken the following action in the production process:

3.1- Our firm management often uses novel systems to manage eco-innovation.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
3.2- Our firm management often collects information on eco-innovation trends.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
3.3- Our firm management often actively engages in eco-innovation activities.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
3.4- Our firm management often communicates eco-innovation information with employees.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
3.5- Our firm management often invests a high ratio of R&D in eco-innovation.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
3.6- Our firm management often communicates experiences to various departments involved in eco-innovation.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
3.7- The firm uses an environmental management system.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
3.8- The firm publishes an environmental policy.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*

3.9- The firm has specific targets for environmental performance.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
3.10- The firm publishes an annual environmental report.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
3.11- The firm applies environmental considerations to purchasing decisions.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
3.12- The firm provides employee environmental training.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
3.13- The firm uses life cycle analysis.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
3.14- Our firm management often uses novel systems to manage eco-innovation.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*
3.15- Our firm management often collects information on eco-innovation trends.	*Totally disagree*	1	2	3	4	5	6	7	*Totally agree*

Section 4-Internationalization

4.1- Is your firm currently operating on foreign markets?	YES	NO

4.2- In what international activities is your firm currently engaged? (check as many as apply)

☐ Import
☐ Direct export
☐ Export through intermediary
☐ Foreign direct investment
☐ Joint venture
☐ Contract
☐ License product/service
☐ Franchising
☐ other *(please specify):* _____

4.3- How old was your firm when it started to operate on foreign markets?

☐ 0
☐ 1-3
☐ 4-6
☐ 7-10
☐ 11-20
☐ 21 or more
☐ We have not yet begun operating on foreign markets

4.4- In how many countries does your firm currently sell its products/services?

☐ 0
☐ 1
☐ 2-3
☐ 4-5
☐ 6-10
☐ 11-15
☐ 16-20
☐21 or more

4.5- What was your firm share of sales on foreign markets in the year 2019?

☐ 0%
☐ 1-10%
☐ 11-20%
☐ 21-30%
☐ 31-50%
☐ 51-70%
☐ 71-90%
☐ 91-100%

Section 5 - Cooperation

5.1- During the three years 2017 to 2019, did your enterprise cooperate on any of your eco-innovation activities with other enterprises or organizations? If YES- continue with the next question, otherwise skip the questions is between until question "Firm Performance"	YES	No

5.2- Please indicate the type of eco-innovation cooperation partner by location

Type of co-operation partner	**Portugal**	**Other Europe**	**All other countries**
A. Other enterprises within your enterprise group			

B. Suppliers of equipment, materials, components, or software			
C. Clients or customers from the private sector			
D. Clients or customers from the public sector			
E. Competitors or other enterprises in your sector			
F. Consultants or commercial labs			
G. Universities or other higher education institutes			
H. Government, public or private research institutes			

Section 6 - Firm Performance

6- Please specify the effects of your firm environmental activities on the following factors (1-very negative to 7-very positive):

6.1- Sales	*Very negative*	1	2	3	4	5	6	7	*Very positive*
6.2- Market share	*Very negative*	1	2	3	4	5	6	7	*Very positive*
6.3- New market opportunities	*Very negative*	1	2	3	4	5	6	7	*Very positive*
6.4- Employee satisfaction	*Very negative*	1	2	3	4	5	6	7	*Very positive*

Section 7 - Firm Data

7.1- When was your firm established? _____

7.2- In what industry does your firm operate?

☐ Footwear
☐ Metalworking
☐ Textile
☐ Furniture
☐ Other (please specify): ……

7.3- Size of your firm (number of full-time employees):

☐ 0-9
☐ 10-49
☐ 50-249
☐ 250 or more

7.4- Size of your firm (overall sales in 2019):

☐ below 400,000 EUR
☐ 400,000 EUR – 800,000 EUR
☐ 800,000 EUR – 1,600,000 EUR
☐ 1,600,000 EUR – 4,000,000 EUR
☐ 4,000,000 - 20,000,000 EUR
☐ above 20,000,000 EUR

Conclusion

To answer the objectives of this research, two studies were carried out.

The first study "Cooperation, Innovation and Environmental Sustainability: Portuguese Firms Research" answered the following specific research objective: (1) To verify what is the influence of cooperation in innovation as well as the relationship of these variables in eco-innovation. The literature shows that to increase product innovation, firms need to improve their cooperation with their partners. On the other hand, they need to learn to manage the knowledge they acquire through cooperation, otherwise they will not get new ideas for innovation and will not be able to develop eco-innovations.

In order to answer the objective, MANOVA was used to verify the influence that cooperation has on innovation, and there is statistical evidence that cooperation is essential to increase innovation within firms. To verify the relationship between cooperation, innovation and eco-innovation, an association between variables was used, and it was found that the three variables have significant correlations and it can be said that there is a statistically relationship between these variables.

This article aims to answer one more specific objective: (2) To verify which factors influence firms to adopt eco-innovation and which are relevant. The literature shows that there are countless factors that lead firms to adopt eco-innovations that are not based only on environmental concerns e.g. voluntary actions or initiatives for good practices, existence of environmental regulations, among others.

In this article to investigate which factors most contribute to firms adopting eco-innovations, a linear regression analysis was used, and there is statistical evidence to affirm that the most relevant factors for firms to adopt eco-innovations are the current or expected demand in the market for environmental innovations, the improvement of reputation of the firm and the high costs of energy, water and materials. Thus, the reasons for eco-innovation are more related with firm's image then with sustainability concerns.

The second study "The role of eco-innovation in internationalized firm's performance" responds to the objective number three: (3) Explore the influence of internationalization and eco-innovation on the firm's performance, as well as cooperation on eco-innovation. Literature suggests that the more internationalization there is, as well as greater eco-innovation practices, the likelihood of increasing the firm's performance is greater. On the other hand, increasing cooperation in firms will result in an increase in eco-innovation practices.

Using structural equation modeling (SEM) performed by SmartPLS software, the results show that the firm performance is influenced by internationalization and eco-innovation practices. On the other hand, through this sample, it was not possible to present statistical evidence to show the influence of internationalization and cooperation on eco-innovation.

Responding to the first central question of the study: (1) Cooperation influence innovation, and these variables influence eco-innovation? - In the first article, it is possible to note that cooperation has an influence on innovation, which increases with the knowledge that firms acquire from cooperation with different partners. On the other hand, cooperation and innovation are indeed relevant for firms to adopt eco-innovations.

Regarding to the second question: (2) What factors contribute to firms adopting eco-innovations? - it was possible to conclude that the factors that most contribute for firms to opt for eco-innovations are the current or expected demand in the market for environmental innovations, the improvement of reputation of the firm and the high costs of energy, water and materials.

Finally, with regards to the third question: (3) Internationalization and eco-innovation influence the firm´s performance and cooperation influence eco-innovation? - our study shows that both internationalization and eco-innovation are important to improve the firm performance, that is, a firm that internationalized and adopts eco-innovation practices is more likely to improve its performance than those that do not use any type of eco-innovation and do not have internationalization. On the other hand, it was not possible to present statistical evidence to show the influence of cooperation on eco-innovation.

Contributions of this study

This study presents several contributions, both from theoretical and practical perspective. In theoretical terms, cooperation increases innovation in firms. In addition, a firm that cooperates with several partners and simultaneously innovates, is more likely to adopt eco-innovations.

Eco-innovation is more related to the organizational objectives of firms, for example the firm reputation, the high costs of energy, water and materials and current or expected market demand.

This study responds to a gap in the literature, since there are few studies that relate to eco-innovation and internationalization (Suárez-Perales et al., 2017).

In practical terms, managers must be aware that by cooperating with different stakeholders they are better able to innovate and therefore have access to new business opportunities.

At the same time that these new opportunities (cooperation and innovation) open up, they will be in a position to adopt eco-innovations.

Furthermore, when introducing eco-innovations, firms associate them with purely strategic motivations, namely in terms of reputation, costs and demand.

Finally, managers must realize the advantages they obtain by acquiring more sustainable practices (eco-innovation) contributing to the increase of their competitive advantage when entering new markets.

Limitations and Future Research

During the research process, some limitations were identified. In the first empirical study, the main limitation is the fact that the chosen database, CIS 2014, has few questions that allow answers of an ordinal scale, which is not favorable to analysis, and the creation of new variables was essential.

In the second empirical study, the main limitation is that this study is only applied to Portuguese firms with international sales, so we are limited in geographic terms. Second, the study could be applied to other sectors. Finally, the use of a dummy variable to measure cooperation becomes a limitation, since it cannot capture all its dimensions.

For future research, in relation to the first study, with eco-innovation being a more relevant topic, a study applied at an international level is suggested in order to make a comparison between Portugal and other cultures. As the questions related to eco-innovation correspond to dummy variables, it would be interesting to apply a new questionnaire involving variables and a 7-point Likert scale to explore if there is a big difference in the results.

In view of the second article, it would be interesting to apply this study to other countries to compare the results. Since this study only applies to four sectors, it was also interesting to see if there are other sectors.

Another issue of interest would be to understand what the implications of the policies applied by governments with regard to sustainability, called "green transitions", will have on eco-innovation practices in the future for firms.

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