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When your value proposition is to improve others' energy efficiency: Analyzing the internationalization dilemma of eco-innovations in SMEs

Nuria Calvo [a,*], Ariadna Monje-Amor [a], Oskar Villarreal [b]

[a] University of A Coruña, Faculty of Economics and Business, campus de Elviña s/n, 15071 A Coruña, Spain
[b] University of the Basque Country, Institute of Applied Business Economics of the UPV/EHU, Avda. Lehendakari Aguirre, 83, 48015 Bilbao, Spain

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ABSTRACT

In a scenario of growing demand for energy, technology applications that monitor industrial companies' energy consumption will support the integration of the value chain of suppliers, companies, and clients in a process of eco-innovation. We relate the drivers of eco-innovation to the key factors of internationalization of business models based on supporting industrial companies' energy efficiency. From a dynamic perspective, this study allows us to highlight that an entrepreneur's preestablished personal network, the lack of opportunities in domestic markets, and the fast-changing environment complicate the international growth pattern of eco-innovations.

1. Introduction

We live in a continuously developing world. Development requires energy consumption, which, as it stands, involves greenhouse gas emissions. However, despite numerous warnings issued by researchers over the past 40 years, business has continued as usual (Ripple et al., 2020). All scenarios proposed for the next 30 years predict an increasing percentage of electrical energy in energy consumption; therefore, innovations aimed at increasing efficiency in the production processes could reverse the effects of development in climate change (BP, 2020). Thus far, researchers have studied innovation and environmental sustainability separately. Although there are valuable findings in each line of research, this separation makes it more difficult for firms to choose a suitable sustainable innovation policy to reduce their environmental impact in the long term (Foxon and Pearson, 2008). In terms of environmental sustainability, energy efficiency helps decrease carbon emissions without renouncing economic and financial development (Ziolo et al., 2020). Although some international indexes such as the Thompson Reuters ESG Scores have been designed to measure a firm's performance in environmental, social, and governance dimensions, including data on greenhouse emissions, there is limited research identifying business models that enable this reduction. Business models define how businesses generate value for their customers and stakeholders (Teece, 2010), whereas the term "business model archetype" is used to identify groups of mechanisms and solutions (drivers) that can help develop a long term business model (Bocken et al., 2014). Researchers are still seeking a better understanding of the impact of eco-innovations from not only a social perspective but also a business perspective (Díaz-García et al., 2015).

According to the Eco-innovation Action Plan (European Commission, 2011), an eco-innovation is "any innovation that makes progress toward the goal of sustainable development by reducing impacts on the environment, increasing resilience to environmental pressures or using natural resources more efficiently and responsibly." From a business perspective, Oltra and Saint Jean (2009, p. 567) defined eco-innovation as "innovations that consist of new or modified processes, practices, systems and products which benefit the environment and so contribute to environmental sustainability." In this sense, although studies have analyzed the drivers of eco-innovation (Boons and Lüdeke-Freund, 2013; Díaz-García et al., 2015; Zubeltzu-Jaka et al., 2018), few have delved deeper into the strategic perspective of eco-innovation from an organizational level (Tamayo-Orbegozo et al., 2017). These studies proposed a strategic model of eco-innovation validated in a regional context, but they also called for future research into the functional implementation of eco-innovation to establish new patterns to address some problems found in the collaboration for eco-innovation. This demand is also reinforced in the literature review of eco-innovation by Rodríguez-García et al. (2019) and that of eco-innovative technologies by Kuo and Smith (2018). Thus, there is still a research gap in the analysis of the growth patterns of business models offering eco-

* Corresponding author.
E-mail addresses: nuria.calvob@udc.es (N. Calvo), ariadna.monje@udc.es (A. Monje-Amor), oskar.villarreal@ehu.eus (O. Villarreal).

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innovation as a value proposition for other industries, consistent with the theory of shared value of Porter and Kramer (2011, 2019). In this analysis, we contribute to this demand by studying the collaboration for internationalization of business models supported by eco-innovations.

This study addresses this research gap by raising the following question: *Which factors drive the internationalization of eco-innovation business models?* Based on a conceptual model that relates the drivers of eco-innovation to the key factors of internationalization, we propose a business model archetype and a growth pattern for eco-innovation models in the industrial sector. In a broad literature review, Bossle et al. (2016) reinforced the idea that firms should improve their focus on eco-innovation as an explicit goal of their growth strategies. However, so far, cooperation has been considered an external driver and firms' strategies are yet to focus on the mechanisms to address it. This study contributes to the literature on strategic management by analyzing internal and external drivers that support the value of eco-innovation through the collaboration between supplier and client and international growth based on the open innovation approach (Chesbrough et al., 2006, 2014), the resource-based view of the firm (Barney, 1986; Penrose, 1959; Peteraf and Barney, 2003; Wernerfelt, 1984), and its recent application to new ventures (Martin and Javalgi, 2019; Newbert, 2007).

This study is presented as follows: First, we link the eco-innovation models with the business model archetypes defined by Bocken et al. (2014) and present the main drivers of internationalization in the literature review, according to the Polyhedral Diagnosis of Market Entry Strategy (PODMES) model (Calvo and Villarreal, 2018b). Then, we contextualize the case study by applying technological services to reduce industrial companies' energy consumption. From a business perspective, we relate the findings to the drivers previously identified and propose a growth pattern for eco-innovation models. Finally, we discuss the theoretical contributions and implications for managers and identify the study limitations and suggestions for future research.

2. Literature review and conceptual model

Several external and internal drivers support the interest of companies that invest in eco-innovations (Bossle et al., 2016; De Jesús Pacheco et al., 2018). The awareness of individuals' environmental problems in most developed countries is highlighted as an external driver (Carrillo-Hermosilla et al., 2009; Rennings, 2000; Yalabik and Fairchild, 2011). This awareness can be translated into new consumer behaviors, such as the ability to reject products developed by non-environment-friendly companies and pay more for those developed by environmentally friendly companies (Ketelsen et al., 2020; Liobikienė et al., 2017). Thus, in recent years, companies have increased their efforts to position themselves as environmental supporters in the minds of their potential and current clients. Governments have also reinforced these strategic movements with new legal frameworks that encourage or penalize companies to invest in changing their current polluting activities to reduce their environmental impact (European Commission, 2011; Jaffe and Palmer, 1997). Finally, the pressure of foreign investors and other stakeholders (Díaz-García et al., 2015) also reinforces the firm's investment in reducing its environmental impact to maintain valuable business relations. However, despite the underlying hypothesis that investments in eco-innovation applications increase competitiveness, which compensate for the costs of compliance (Horbach, 2008; Porter and Van der Linde, 1995; Triguero et al., 2013; Vicente et al., 2012), there is not enough empirical evidence to support this statement from a business perspective, especially during economic crisis, when the reduction in the consumer budget changes their preferences and they look for cheaper products, regardless of their environmentally friendly origin (Ketelsen et al., 2020).

Some authors claim that a pro-environmental legal framework has no significant effects on new environmental-friendly investments in some industries where firms must develop innovations requiring significant investments (Brunnermeier and Cohen, 2003; Frondel et al., 2008; Moon, 2017). Therefore, we propose an alternative approach to studying firms' eco-friendly behavior resulting from client and government demands by investigating how firms can compete in the field of eco-innovation in the market of resources before competing in the market of products. This approach is aligned with the theory of shared value (Porter and Kramer, 2011, 2019), which concludes that the firm's efforts in addressing social and environmental requirements in the strategy result in a better competitive position and financial growth. According to this analysis, this shared value could be addressed through cooperation.

The open innovation approach states that no company internally owns all technological resources to innovate and should manage a distributed innovation process based on knowledge flows across organizational boundaries, consistent with the organization's business model (Chesbrough et al., 2006, 2014). According to this approach, Chen et al. (2011) concluded that collaboration with suppliers, clients, and universities could be a better approach for increasing the firms' innovation outcomes. However, the lack of property rights to the relevant resources to support innovations could become a competitive problem for organizations if there is no clear advantage in the management of external collaborations that support the firm's growth pattern.

This study draws on the resource-based view of the firm (Barney, 1986; Wernerfelt, 1984) to explain how firms can leverage strategic resources and alliances. This theory argues that a firm with certain resources (tangible and intangible) and capabilities that are valuable, rare, hard to imitate, and organized to capture value have a competitive advantage (Barney et al., 2021). We connect a firm's resource-based view using a case study that highlights the relevance of international cooperation in the eco-innovation domain, which is the main contribution of the study. We contend that strategic alliances and international cooperation are essential for organizations to sustain their competitive advantage in an expansion process.

From a business perspective, companies should relate the external drivers of eco-innovation (consumer preferences, incentives/penalties of the legal framework, stakeholders' pressure) to internal drivers, supported by an increase in the efficiency of the business model. In this sense, the hybrid strategy implemented to increase market share while simultaneously reducing internal energy consumption and raw materials by investment in eco-innovation applications becomes a relevant internal driver (Horbach, 2008). Frequently, the adoption of eco-innovation models also requires a change in organizational procedures (Carrillo-Hermosilla et al., 2010; Pujari, 2006). These drivers (strategic focus, organizational change) should be connected to the R&D efforts to analyze the potential benefits of adopting any eco-innovation (Mazzanti and Zoboli, 2009).

Bocken et al. (2014) defined three groups of sustainable business model archetypes according to the criteria associated with the drivers of eco-innovation models (Table 1). The first group, the technological business model, includes those archetypes that "design a strategy aimed to maximize raw materials and energy consumption to create new value from recycling or to change artificial for natural processes." This approach is associated with the internal drivers of the eco-innovation models. The second group, the social business model, includes "those archetypes that focus the strategy on connecting the value chain of the firm with the social priorities of the potential clients." This approach relates to the external drivers of the eco-innovation models. Finally, the third group, the organizational business model, includes "those archetypes that not only connect the business model with the social values, but also scale up solutions to extent the model to other industries and social groups." This approach is connected with both internal and external drivers of the eco-innovation models.

Connecting the business perspective with the institutional factors that constrain a firm's behavior in different environments (North, 1990), Davidsson et al. (2017) stated that uncertain situations can play the role

Table 1
Sustainable business model archetypes and drivers of eco-innovation.

Groups	Technological			Social			Organizational	
Archetypes	Maximize material and energy efficiency	Create value from waste	Substitute with renewables and natural processes	Deliver functionality rather than ownership	Adopt a stewardship role	Encourage sufficiency	Repurpose for society/ environment	Develop scale up solutions
Drivers	Internal drivers of eco-innovation • Increase in efficiency • Hybrid strategy • Change in the organizational procedures • R&D investments in eco-innovation applications			External drivers of eco-innovation • Consumer's preferences • Incentives/penalties of legal framework • Stakeholders' pressure			External drivers of eco-innovation	Internal drivers of eco-innovation

of "external enabler" for new firms seeking to capitalize on new opportunities that arise in a situation of unexpected change, as supported by previous role models (Stephen et al., 2005, 2009). Thus, organizations that successfully address the drivers of eco-innovation may be better positioned to grow in environments affected by the new scenario of increasing energy prices.

This study addresses the research gap mentioned earlier by proposing a conceptual model that relates the drivers of eco-innovation to the key factors of internationalization. We use the Bocken et al. (2014) business model archetypes and the PODMES model by Calvo and Villarreal (2018b) as a tool to integrate the main theoretical approaches in the literature on internationalization (see Fig. 1). The PODMES model helps analyze the profile of a firm wishing to enter international markets, and it works as an analytical tool to understand an organization's behavior in an international context. According to this approach, our conceptual model connects the main drivers of eco-innovation and key factors of internationalization.

In this conceptual model, we relate the drivers of eco-innovation to the pattern of internationalization in the business model archetypes in the following propositions of study:

Proposition 1 (P1). The entrepreneur's previous networks accelerate the internationalization of business archetypes supported by eco-innovations.

This proposition relates the internal driver of eco-innovation "the firm's focus for the increase of efficiency" to the factor of internationalization *network environments*. We follow the model of Oviatt and McDougall (2005), who stated that the entrepreneur plays a mediating role in the internationalization process and concluded that the entrepreneur's social capital moderates the firm's international focus. The entrepreneur leverages the available knowledge and the established network that he/she has across national borders. In this sense, weak ties between actors in a sector determine an entrepreneur's decision to enter an international market if he/she has a previous alliance. According to these authors, the size of an entrepreneur's network accelerates the internationalization of business. However, this study considers an entrepreneur's network as a driver rather than a moderating factor for internationalization (Elfring et al., 2021). The entrepreneur's networks with other entrepreneurs often offer support strategies for coping with uncertainty and benefiting from a rapidly changing environment

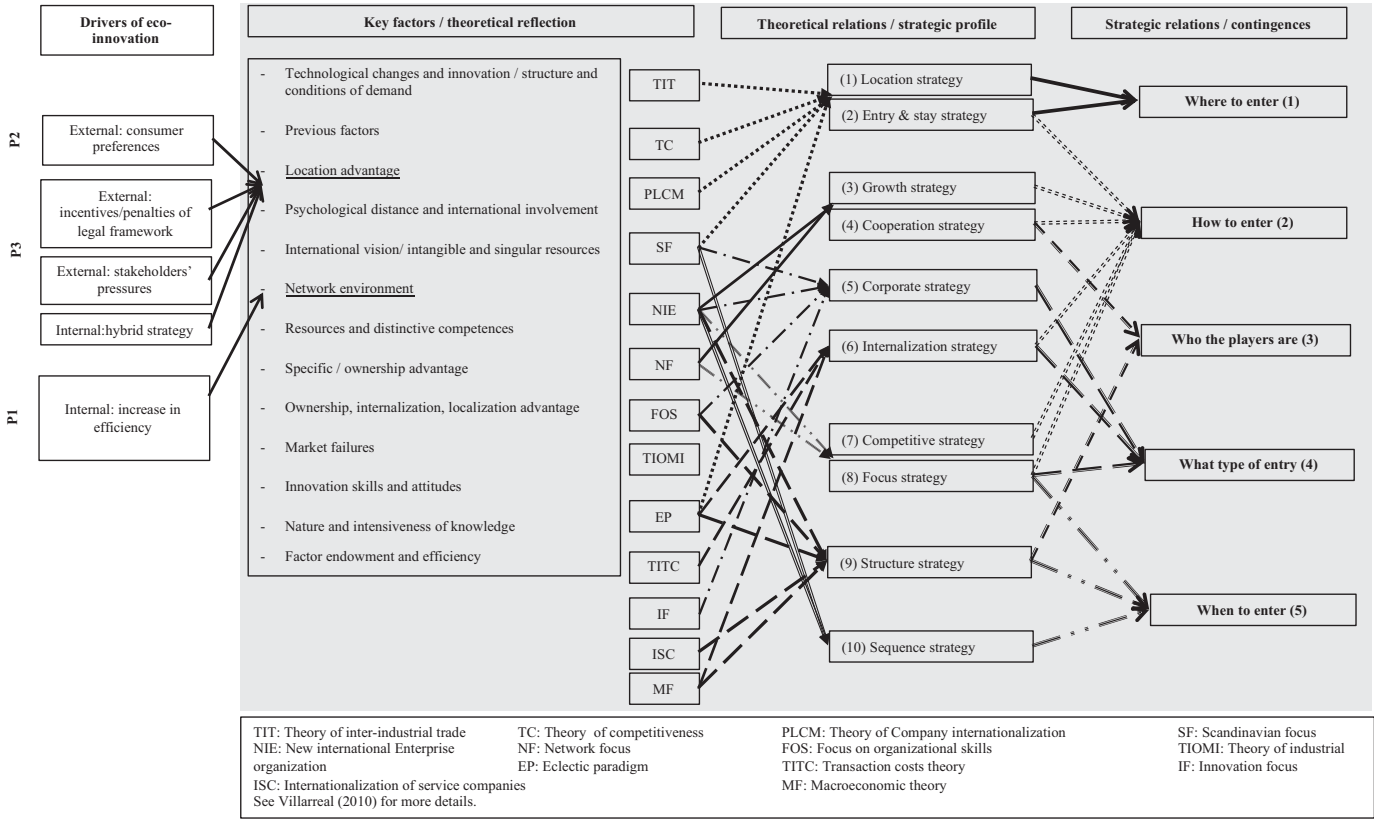

Fig. 1. Conceptual framework: growth patterns of eco-innovations.

(McMullen and Shepherd, 2006). Johanson and Vahlne (2009) found that internationalization was the result of network positioning in a foreign market. Ciravegna et al. (2014) discovered that businesses that identify their initial clients in international networks ahead of time are more likely to internationalize. Ellis (2000) demonstrated that foreign business opportunities are frequently acquired through existing human connections rather than deliberately gathered through market research. Entrepreneurs usually invest in growth patterns in countries where building networks with other entrepreneurs is easier (van der Borgh et al., 2012). Therefore, having professional networks is considered a main driver of the accelerated pattern of internationalization of born-global firms (Calvo and Villarreal, 2018a).

Hence, our proposition states that a firm will accelerate internationalization of an eco-innovation if the entrepreneur can increase the efficiency of this strategic approach by leveraging a previous link between the firm and the stakeholders, compared with competitors.

Proposition 2 (P2). The existing opportunities in the domestic markets reduce the availability of the entrepreneur to internationalize business archetypes supported by eco-innovations.

This proposition connects the external driver of eco-innovation "consumer preferences" with the factor of internationalization "location advantage." Previous studies (Fan and Phan, 2007; Taylor and Jack, 2013) have concluded that entrepreneurs undervalue the opportunities for growth in international markets when there are opportunities available in domestic markets. However, entrepreneurs use uncertainty to judge differently from other people (Foss et al., 2008; Klein et al., 2020) because of their better potential for reaction compared with managers of established companies. In this sense, the higher dynamism of markets becomes an "external enabler" of entrepreneurial behavior (Davidsson, 2015; Davidsson et al., 2017).

Proposition 3 (P3). The legal complexity and dynamism of markets accelerate the internationalization of business archetypes supported by eco-innovations.

Finally, this proposition connects the external drivers of eco-innovation "the existence of legal incentives and stakeholders' pressures" and the internal driver of "hybrid strategy of the firm" with the factor "location and focus of internationalization." Some studies have connected the effect of the economic crisis on the firm's growth (Devece et al., 2016; Hundt and Sternberg, 2014). However, the conceptual framework of the relationship between a new firm's growth and context during crisis is still scarce and needs more empirical evidence based on high-dynamism markets (Agarwal and Audretsch, 2020; Akpan et al., 2021; Herbane, 2010; Klein et al., 2020). In this sense, although some authors (Andersson, 2004; Knight and Cavusgil, 2004; Rialp et al., 2005) have stated that firms accelerate their internationalization processes in high-tech industries when they can achieve a good position based on a differentiation strategy and Stephen et al. (2005, 2009) highlighted the effect of role models and legal institutions on the increase in the number of new ventures, no concluding results were found about the role of legal and social incentives and competitive strategy in the internationalization of eco-innovation.

3. Methods

We followed a three-stage method. First, we constructed a conceptual model that relates the main drivers of eco-innovation to the key factors and patterns of internationalization supported by literature, and then defined three propositions of study. In the second stage, we applied the propositions of the study to a case study illustrative of the business model of eco-innovation, following a design supported by a single holistic case study (Villareal and Landeta, 2010) that was previously applied in the fields of strategic management and open innovation (Calvo and Villarreal, 2018a; Chesbrough et al., 2014; Dodgson et al., 2006; Matricano et al., 2019; Villarreal and Calvo, 2015; Wilson and Vlosky, 1997). The design follows the most relevant contributions to this methodology (Dooley, 2002; Eisenhardt, 1989; Maxwell, 1996; Miles and Huberman, 1994; Yin, 2009, 2011) and assumes the instrumental role of the case study in facilitating the readers' understanding of the theoretical interrelations through an in-depth study of a particular situation (Stake, 1995). Hence, we proposed a sustainable business model archetype that can support the internationalization of eco-innovation.

We selected the case study (CO2 Smart Tech) based on the criteria of sampling and organization readiness recommended by Patton (1990). The study followed "theory-based or operational construct sampling" and met the conditions of "intensity sampling" by selecting a case that represents the phenomenon under study (business model of eco-innovation). Other criteria included were "the role of critical case" (filling the gaps in the literature of eco-innovation), "the identification of relevant context," and "the combination or multipurpose" (based on methodological and data triangulation of different sources of evidence for the same facts). We collected documentary information and archives from internal and external sources, conducted open interviews with informants from different levels of the firm, and performed direct observation of physical, technological, and cultural artifacts. We used multiple sources of evidence to support the construct validity of the research proposals (Yin, 2009).

We collected information from secondary sources and conducted three 2-h interviews with the main founders and the current general manager (and partner of the firm), the other with the commercial manager, and the last with one of the technicians. Written informed consent was obtained to publish the details of the study participants who had voluntarily participated in the research before starting the study. The study on the CO2 Smart Tech growth model was conducted from November 2017 to June 2018. As a starting point, the general manager and the principal investigator signed a formal protocol of information exchange. In November 2017, after analyzing industry reports and the firms' financial statements, we conducted a survey for the technical department to understand the business focus and fill the gaps in secondary information. Then, we conducted two observation sessions and visited the facilities in December 2017 and February 2018. All interviews were recorded and codified following the same standards as previously defined to avoid researchers' bias by assigning a coding system based on the identification and multiple-cross checking of the eco-innovation drivers and dimensions of internationalization shown in the conceptual framework. We used a thematic analysis based on the critical incident technique for designing interviews (Braun and Clarke, 2006; Flanagan, 1954). A database was constructed with all gathered data. The coders achieved a level of agreement greater than 75 % (Krippendorff, 2004). These methods ensure the reliability and validity of the study (Maxwell, 1996, 2009; Yin, 2009, 2011; Villarreal, 2017). We present the methodological design in Table 2 and the tests of validity, reliability, and consistency of the data gathering and analysis in Table 3.

4. Contextualization of the case study

4.1. Business focus

CO2 Smart Tech S.A. is a consulting company located in the northwest of Spain (A Coruña). The core value of the firm is based on developing high-tech systems for monitoring the energy consumption by other companies. On May 31, 2010, Alberto Mendez (mechanical engineer) and Mario Rivera (electrical engineer) founded the company.

The business plan designed in 2010 aimed at offering analytical reports of the weekly or yearly energy consumption of other companies. However, the founders realized that their service could be more valuable because, by combining their technology for measuring the energy consumption of the client firms with the expertise of the technical staff of CO2 (electric engineers and computer technicians), their company could offer the client firms a method for monitoring the process of energy

Table 2
Methodological design.

Purpose	To identify the relationship between the drivers of eco-innovation and the internationalization pattern of the company and to provide evidence of the propositions of study.		
Framework	The conceptual model supported by the literature on the drivers of eco-innovation and the PODMES model (Calvo and Villarreal, 2018b), supported by the approaches of open innovation (Chesbrough et al., 2006, 2014), institutional theory (Davidsson et al., 2017; North, 1990) and the resource-based view of the firm (Barney, 1986; Wernerfelt, 1984).		
Unit of study	Unit of study: internationalization behavior of a firm. Level of analysis: holistic. Selection criteria: single case as illustrative of business models focused on eco-innovations. Eco-innovation as the center of the business model, change of ownership and managing director, search for growth vectors.		
Method	Contemporary single case study (simple unit of analysis). Qualitative techniques from a real context.		
Sample	Case selection: ideal (criterion sampling based on the capacity of the case for the analytical generalization of the phenomenon). Holistic single case: CO2 Smart Tech.		
Data gathering (triangulation of evidence)	Documentary evidence and archives	Internal	Strategic reports provided by the founder and general manager of CO2 Smart Tech – Financing projections – Prospects of new eco-innovation developments Technical documents provided by technical staff. Results of the survey conducted with the technical and administrative staff of CO2 Smart Tech.
		External	Financial statements of the company provided by legal authorities Reports and analysis of CO2 published in professional media.
	Interviews		Five face-to-face interviews were conducted with Alberto Mendez (founder of the company), Gustavo Amann (2) (general manager and partner of CO2 Smart Tech), Carlos Pimentel (manager of the sales and marketing department), and Mario Rivera (technical engineer) (4 h and 30 min in recording files).
Process of registration and classification of evidence	Transcription of interviews. Design of the structure of the database of documentary evidence. Selection, categorization, and combination of the evidence.		
Analysis	Identification of connections between the propositions of study supported by the conceptual framework and the evidence gathered from the case study.		
Qualitative rigor of the case study	Constructive validity; internal validity; external validity; consistency.		
Results	Integration of propositions of study and the conceptual model.		
Conclusions and implications	Academic and management implications. Proposal of a business model archetype to support the growth of businesses focused on eco-innovation.		

consumption, *ad hoc*, at each moment of the industrial process, which is the most useful way of identifying the leverage points of energy consumption.

Hence, the new focus of CO2's strategy is to offer clients information about their energy consumption for strategic purposes. CO2 was shifting from simply selling their technology platform (Cost Tem system) as a

Table 3
Tests of validity, reliability, and consistency.

Test	Tactic	Research phase
Constructive validity	Prior analysis of the conceptual context and theoretical framework (*theoretical triangulation*).	Literature review
	Structural design of main conceptual elements based on open innovation (Chesbrough et al., 2006, 2014), and the resource-based view of the firm (Barney, 1986; Penrose, 1959; Peteraf and Barney, 2003; Wernerfelt, 1984) applied to the internationalization of eco-innovations (PODMES theoretical model, Calvo and Villarreal, 2018b).	Research design Evidence gathering
	Use of different methods for gathering the evidence (*methodological triangulation*): - Documentary review. - Multiple in-depth interviews. - Use of physical, technological and cultural artifacts.	Evidence gathering
	- Use of multiple sources of information. (*data triangulation*) to confirm evidence in different sources: - Internal and external, direct (primary) and indirect (secondary). - Varied typology: documentation, files, interviews, questionnaires, databases, real physical context. - Diversity of key informers faced with the same questions. - Critical assessment of evidence compared by source.	Evidence gathering and analysis Design and gathering Gathering and analysis Composition All
	Quasi-simultaneous and unified process of evidence gathering and analysis.	
	Establishment of chain of evidence.	
	Feedback and interactive contact with informers.	
	Review of the case report by key informers.	
	General and instrumental flexibility of the research through cyclical review of the field study and the original structural model.	
Internal validity	Pattern matching (support in theoretical propositions).	Individual and replication analysis
	Creation of explanation (systematic comparison of the structured literature in the theoretical model)	Individual and replication analysis
External validity	Eclectic and inclusive approach to the theoretical perspectives and focuses on innovation.	Research design General design
	Use of rival theories in the original model (*theoretical triangulation*).	Identification of the unit of analysis and selection of case
	Establishment of unit of analysis and selection of the case based on the potential of knowledge on the phenomenon studied.	General design and evidence gathering Individual analysis
	Selection of evidence gathering methods (*methodological triangulation*) and information sources (*data triangulation*) based on the potential for understanding the phenomenon under study.	Composition and conclusions
	Use of key explanatory factors of rival theories in the case.	
	Consideration of the results of the	

(*continued on next page*)

Table 3 (*continued*)

Test	Tactic	Research phase
	research as an initial hypothesis for studies in future lines of research.	
Reliability	Creation of a *study protocol* and monitoring of guidelines as a guide for action.	General design and data gathering
	Preparation of a *database* that will organize, integrate, and synthesize the information obtained from the different sources of evidence.	General design and data gathering
	Ethical commitment to effort, time, dedication, and specific activities of the key informers involved.	General design and data gathering
	Rigorous assessment of ethical aspects in obtaining and analyzing the evidence.	General design, gathering and analysis.
Theoretical-interpretative consistency	Prior understanding of perspectives and terminology of the phenomenon and the context according to key informers (high degree of empathy with the frameworks of reference of the sources of information).	General design and data gathering
	Use of techniques (starting protocol, open questions, semi-structured interviews) that will allow dialectic initiative by key informers.	General design and data gathering
	Systematic critical comparison between the theoretical propositions structured in the theoretical model and those assumed and obtained from the sources of evidence.	Data gathering and analysis
	Critical filtering of the contextual knowledge based on relevant conceptual and theoretical elements established in the theoretical model.	Data gathering and analysis
Contextual consistency	Attention to relevant contextual elements to explaining the phenomenon to be studied, even those not explicitly set out in the original model.	Evidence gathering
	Consideration of the generic environment of the unit of analysis and critical assessment of the evidence based on the (macro) context.	Data gathering and analysis
	Consideration of the specific environment of the case and critical assessment of the evidence based on the (micro) context.	Data gathering and analysis

meter of energy consumption to providing a strategic tool for managing the business process efficiency of the client firms.

The CO2 technicians developed the new application (Fig. 2) for the strategic management of the client firms' energy consumption. The platform offered detailed data by unit cost and product, allowing the management of key performance indicators to track the business procedures and support decisions to increase production efficiency. This application not only showed the energy consumption during the production process but also provided scenarios that linked energy consumption with the client firm's financial behavior.

Fig. 2 shows a representation of the software operation.

With this new approach, CO2 could also offer a service of technical and strategic monitoring once the application was implemented in the client firm. Because CO2 technicians worked remotely, the client firm could monitor its energy consumption in real time, regardless of where the client was located. The percentage of effectiveness was 99.99 % in one year's time.

In 2017, CO2 became a technical partner of a large company, with distribution centers in more than 30 countries. This alliance allowed such a professional connection between the CEO of the client firm and the founder of CO2 that by September 2017, the founder received a recruitment offer from this client firm. By February 2018, the firm developed a control function that allowed client firms to control their facilities through the CO2 website.

Alberto, the founder of CO2, accepted the role of a manager of the energy control department of the client firm, so he had to leave CO2 and sell his stake. At that time, Gustavo Amann, respectively, became the CEO and partner of CO2. Alberto and Gustavo were friends at university, and they had maintained frequent contact during the past 20 years.

Hence, the alliance established in the CO2 network allowed adapting of the capacities of the eco-innovation to the client's business needs; however, at the same time, this alliance puts the firm at risk of intellectual decapitalization owing to its leader's departure.

From a market perspective, the founders of CO2 focused on developing the software in a clear product orientation. According to Alberto Mendez, "this company was born with the vision of the tool we wanted to create but not with the vision of who the users would be or wherever they would be" (Alberto Mendez, founder of CO2 Smart Tech, December 2018).

According to Carlos Pimentel, Sales and Marketing Manager of CO2, "the more complicated or complex the production process is, the better for us. Thus, saving opportunities arise and Cost Tem software is more effective" (Carlos Pimentel, Sales and Marketing Manager of CO2 Smart Tech, February 2017). Therefore, the company should have focused on industrial firms with complex and dispersed productive processes, where efficiency became a strategic issue of competitiveness. In Carlos's words,

> Those with an invoice equal to or superior to ten million euros, which means an approximate energy consumption of 3%. That is, CO2 is interested in companies with a turnover higher than €300,000 (Carlos Pimentel, Sales and Marketing Manager of CO2 Smart Tech, February 2017).

However, by December 2017, only 35 % of client firms belonged to the industrial sector.

4.2. Growth prospects

Owing to previous alliances with their Spanish client firms, CO2 began the internationalization process. The first international project was in Berlin (Germany) as a provider for the Pontegadea company, a Spanish multinational company that manages one of the most important heritage real estates in the world.

Since 2014, CO2 has become the technical partner of Pontegadea for controlling energy consumption of its buildings. "There are only four technicians in the whole company, helped by third-party companies, to control the facilities. Pontegadea does not know what is occurring in its buildings, so it is not able to control the maintenance and the investment" (Alberto Mendez, founder of CO2 Smart Tech, February 2018).

Gestamp, one of the most important Spanish multinational companies in the automotive engineering industry (43,000 employees in 100 plants in 22 countries, a turnover of 8548 million in December 2018), offered to become the American division's technological partner in 2016. This offer implied installation and monitoring of the Cost Tem system in the client firm's facilities in Mexico and the USA for a period of 4 years. For CO2, this assignment meant assuming the most ambitious international project, which could also build their reputation in the Spanish market.

However, the agreement with Gestamp was not easy. The client firm offered advanced financing of the project for only the first of the four years, implying that CO2 just obtained the return on the investment for the first year in advance but not for the remaining three years. In this agreement, the company demanded that CO2 assume the cost of installing the application for the subsequent three years. The client firm

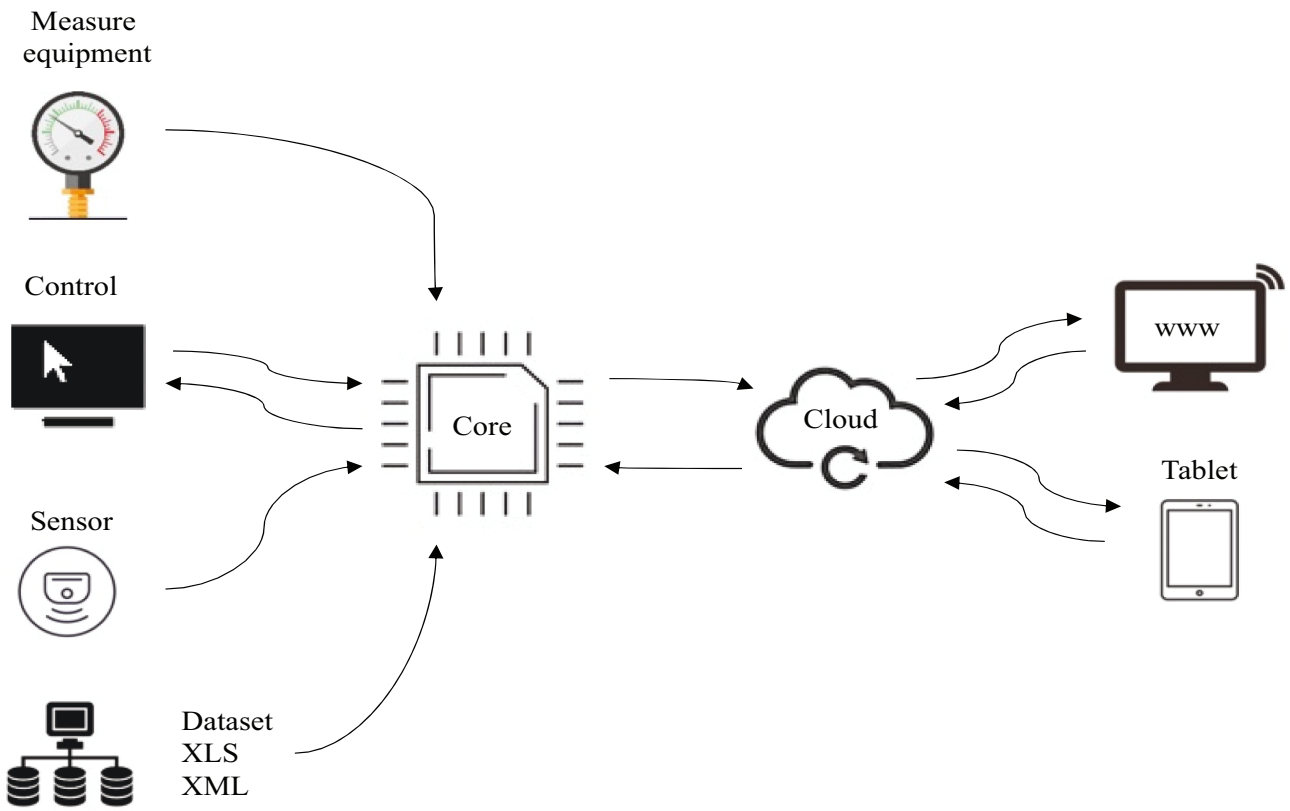

Fig. 2. Operating process of Cost Tem software.

only assumed the compromise of paying the remaining amount at the end of the project.

Regarding this, Gustavo Amann also extended the problem to Gestamp's payment form: "payments are made in dollars, so currency fluctuations can be a drawback" (Gustavo Amann, CEO of CO2, December 2017).

Despite the difficulties, this project was a huge international opportunity for the company, as Gestamp was a big firm that could support CO2's international growth. However, this project broke the company's initial financing policy and increased their level of indebtedness.

As CO2's debt ratio increased to 50.71 % in 2017, it became more vulnerable to external financial risks and increased financial pressure. This alliance also had a direct impact on its financial statements: "This year the Gestamp revenues will contribute to more than 37% of the foreign income. I expect that this foreign income will continue to grow since there is a high probability of Gestamp demanding the installation of the software in two more facilities in 2019" (Gustavo Amann, CEO of CO2, December 2017).

In 2017, the agreements signed with clients had requests for new employees, which increased the financial risk for a small company. CO2 Smart Tech developed its activity in seven foreign countries: Portugal, Germany, Arabic Emirates, USA, El Salvador, Panama, and the Dominican Republic. In the domestic market (Spain), the firm was the technical partner of companies in the industrial and distribution industries.

From 2010 to 2017, CO2 grew to 12 people to support the technical design, maintain the platform, and refocus the company's proactive commercial behavior. They experienced rapid growth in February 2018, surpassing the professional capacities of its staff, and the firm's managers faced a growth dilemma in deciding the next growth direction.

Gustavo Amann was reluctant to undertake proactive commercial tasks in international markets while the company had growth potential in the local market, except in the case of a previous alliance with a local client that forced them to go abroad. In terms of international market growth, Alberto Mendez and Gustavo Amann agreed. A delegation abroad would first consider the USA.

In 2016, CO2 obtained a positive return on investment and a return on equity ratio, thus, reducing the company's financial risk.

In addition, both managers reacted similarly to the internationalization process for two reasons: first, the organization's design and its business processes. Once the devices were configured in Spain, the client firm was responsible for installing them abroad, as they did in El Salvador. The second reason was the company's economic situation. Because of Gestamp's demands, the firm's financial capacity was significantly reduced. Certainly, CO2's management was not willing to take on the risk of a new internationalization so quickly.

5. Results

After identifying the key drivers of eco-innovation and linking them to the patterns of internationalization, we applied the propositions of study to a real case to obtain evidence to support the research question: Which factors drive the internationalization of eco-innovation business models?

According to CO2's timeline (Fig. 3), we selected those statements of the main actors of the firm that show the firm's actions and managers' perceptions confirming or refuting the propositions of the study (Table 4).

The first proposition of the study stated that "*The entrepreneur's previous networks accelerate the internationalization of business archetypes supported by eco-innovations*."

We supported this proposition in the case of CO2 because the founder benefited from his previous professional link with the manager of an important company involved in international expansion to obtain the contract from the technological partner. The basis of this contract was the client firm manager's personal trust in CO2's founder. This finding supports the findings of Oviatt and McDougall (2005), who stated that networks help entrepreneurs identify opportunities, establish credibility, and form strategic alliances. This result also extends the

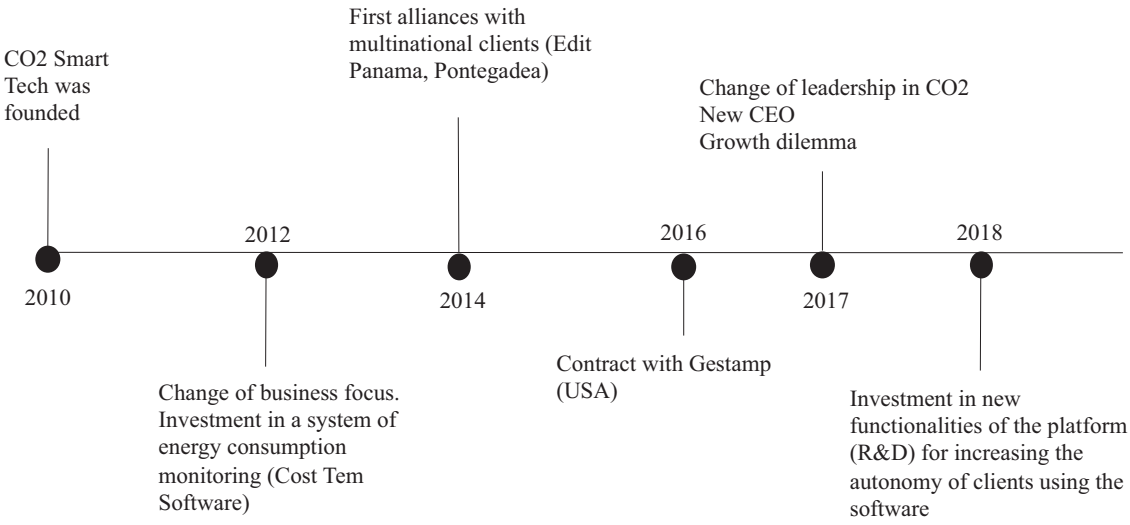

Fig. 3. Timeline of CO2 Smart Tech.

contribution of Stephen et al. (2005) to the field of entrepreneurship, who highlighted the positive effect of role models on entrepreneurial activity, to the field of international expansion.

Regarding the second proposition, "The existing opportunities in the domestic markets reduce the availability of the entrepreneur to internationalize business archetypes supported by eco-innovations," we obtained both favorable and unfavorable evidence. On the one hand, the founder and the current CEO of CO2 agreed to assess the opportunities of the agreement with the multinational Gestamp for the company's international growth. However, the financial risk assumed by the owners in this case is such that the current CEO of the company, Gustavo Amann, is reluctant to undertake new international projects while he sees opportunities in the domestic market. This last evidence is aligned with previous studies (Fan and Phan, 2007; Taylor and Jack, 2013) that concluded that entrepreneurs undervalue the opportunities for growth in international markets when there opportunities still exist in domestic markets.

Finally, we obtained evidence that supports the third proposition of the study "The legal complexity and dynamism of markets accelerate the internationalization of business archetypes supported by eco-innovations." In the case of CO2, the incentives for the green behavior of firms in Spain connect the clients' value chain with the eco-innovation provided by CO2, because this company offers a product that combines technology and the engineering know-how of its staff and allows the client firms to manage a hybrid approach in their strategy. These results are aligned with previous literature (Andersson, 2004; Knight and Cavusgil, 2004; Rialp et al., 2005; Stephen et al., 2009), which reinforces the entrepreneurs' flexibility for adapting their behavior through innovative business patterns and achieving success despite rigid regulations and unexpected changes. Consistent with earlier studies, this study fills some gaps in understanding the role of public incentives in reinforcing the reaction of new ventures and suppliers of eco-innovation in high-tech industries.

6. Discussion

The application of the conceptual framework to the case study has helped identify the connection between sustainable business model archetypes and internationalization patterns of eco-innovations. Fig. 4 shows two main patterns. Pattern 1 (continuous line loop) represents a scheme of the growth dynamic in international markets. The firm identifies a business opportunity in the external market, motivated by the stakeholders' pressure to achieve internal efficiency through eco-innovations. To leverage this opportunity, managers must make new R&D investments that increase the firm's financial risk but allow it to build resources and distinctive competencies and leverage new opportunities in the international market through the network environment.

Pattern 2 (discontinuous line loop) represents a scheme of the growth dynamic in the firm's domestic market. When the firm builds resources and distinctive competencies owing to international compromises, it also increases its competitive advantage in the domestic market. Leveraging the domestic opportunities reduces the financial risk assumed in international agreements and the entrepreneur's international vision, which re-focuses the company's growth in the domestic market, thus reducing the opportunities for international growth in the future. Pattern 2 is a limiting pattern that modulates the previous growth through the internal driver of R&D investments. This increases the financial risk and reduces the entrepreneur's proactive vision in international expansion if there are still opportunities in the domestic market (market failures).

This analysis helps highlight the factors that cloud the international growth of business models supported by eco-innovations from a dynamic perspective. According to this, managers of small and medium-sized enterprises should have a clearer understanding of the internationalization dilemma and better financial scenarios to make decisions that connect the drivers of eco-innovation with the firm's growth vector.

7. Theoretical contribution

Studying the competitive advantages of firms in the market for products offers a novel approach to the literature on strategic management of open innovation. As a first step to building a firm's competitive capacity, we investigate how eco-innovation can be used to compete in the market for resources. First, this analysis contributes to identifying the types of innovation patterns that are better in terms of environmental impact, as demanded by previous studies (Foxon and Pearson, 2008). The factors responsible for the processes of eco-innovation growth not only connect the value chain supplier–client but also serve as drivers of energy efficiency to facilitate a balance between industry growth and control of greenhouse emissions. Our results are consistent with Porter and Kramer's theory of shared value (2011, 2019). Firms that can create social and environmental value through their strategies could also increase their competitive advantage and financial performance.

Second, this study also contributes to the existing literature on the resource-based view of the firm by exploring how previous alliances can accelerate the internationalization of business in the eco-innovation sphere, allowing firms to compete in the market for resources and use

Table 4
Relation of propositions of study with actions and perceptions.

Research proposal	CO2 Actions	Managers' perceptions	Evidence
P1: The entrepreneur's previous networks accelerate the internationalization of business archetypes supported by eco-innovations.	2012. Investment in R&D for developing an application of eco-innovation (Cost Tem) 2014. CO2 became the technical partner of a multinational firm in its international growth.	"Our value-added is that we are an engineering company. It is an important value for clients. Our competitors don't perform complete projects since they don't care about the installation. Therefore, they have to hire engineering companies, which leads to different interlocutors." (Gustavo Amann, CEO of CO2 Smart Tech, December 2017) "We started as an energy consultancy, developing energy studies. We realized that the information we were providing to clients was useful and useless at the same time, since generalizing information from one week to a year makes no sense. So, that is how the idea of creating this system emerges" (Mario Rivera, technician at CO2 Smart Tech, March 2018) "The system Cost Tem is better than others: its functionalities are superior." (Gustavo Amann, CEO of CO2 Smart Tech, December 2017). "CO2 technicians that come to the client's locations are engineers, not computer science professionals. Thus, the client perceives that they have a better understanding of their needs in control of energy consumption (…). CO2 offers a customized system for each company, and even for each facility (…) This innovation pioneers developing real time monitoring software, which is better than the competitors one." (Carlos Pimentel, Sales and Marketing Manager, December 2017) "The clients that we are looking for are those with an invoice equal to or superior to ten million euros, which means an approximate energy consumption of 3 %. That is, CO2 is interested in companies with a turnover higher than €300,000" (Carlos Pimentel, Sales and Marketing Manager of CO2 Smart Tech, February 2017). "Some people I knew before founding the company were very important later on. I knew the CEO of the company Pontegadea when I was working for another company. When we developed the new software, I had a chance to show our service in three buildings in Spain because the CEO knew me." (Alberto Mendez, founder of CO2 Smart Tech, February 2018).	CONFIRMED
P2: The existing opportunities in the domestic markets reduce the availability of the entrepreneur to internationalize business archetypes supported by eco-innovations.	2016. Agreement with Gestamp (USA) with financial risk for CO2. 2017. Growth in the domestic market.	"The future approach is to expand the engineering department. The idea is to continue growing, but I do need to have the security of being able to pay salaries in the future" (Gustavo Amann, CEO of CO2 Smart Tech, December 2017)	NOT CONFIRMED

(*continued on next page*)

Table 4 (*continued*)

Table 4 (*continued*)

Research proposal	CO2 Actions	Managers' perceptions	Evidence
		"The USA is a huge market but difficult to work in. My experience in Pontegadea has given me the chance to know-how the relationship with suppliers is" (Alberto Mendez, founder of CO2 Smart Tech, February 2018). "The Gestamp revenues will account for more than 37 % of the foreign income this year" (Gustavo Amann, CEO of CO2 Smart Tech, December 2017) "Payments (to Gestamp) are made in dollars, so currency fluctuations can be a drawback" (Gustavo Amann, CEO of CO2, December 2017). "These projects are difficult because of the distance. If we were able to send people from Spain to work in the USA, it would be quick and simple for us" (Gustavo Amann, CEO of CO2, December 2017). "If you ask me, do you bet on Gestamp abroad or do you prefer Pescanova and FINSA in Spain? I would choose the ones that are located in Spain because of the proximity" (Gustavo Amann, CEO of CO2, December 2017).	
P3: The legal complexity and dynamism of markets accelerate the internationalization of business archetypes supported by eco-innovations.	2018. New investments in R&D to support the clients in the use of the system without face-to face contact with CO2 staff.	"Reading information is easy; however, when you have to implement changes in your facilities from a remote distance, you need evidence that some security standards are being followed" (Mario Rivera, technical engineer of CO2 Smart Tech, February 2018). "The competitors can offer this type of software, but only a basic version of it; they haven't developed innovative versions. What they offer as added value is the free installation of their equipment" (Gustavo Amann, CEO of CO2, December 2017). "Yes, other companies have developed similar softwares to Cost Tem. The difference between them and us is that they have a different business model: they only offer IT services, while we offer engineering perspectives and installation ones." (Alberto Mendez, founder of CO2 Smart Tech, February 2018). "We keep our position because we fit in terms of flexibility, price, and service quality" (Alberto Mendez, founder of CO2 Smart Tech, February 2018).	CONFIRMED

previous cooperation as an internal driver of their strategy of internationalization. In this sense, firms like CO2 could achieve a competitive advantage by using the know-how of their staff (intangible resources), coupled with previous strategic alliances.

Finally, this study reinforces the role played by the *a priori* considered adverse scenario of increasing in energy price as an enabler of opportunities for new ventures (Davidsson, 2015; Davidsson et al., 2017), which can benefit from offering innovations based on an increase in energy efficiency for their clients.

8. Practical implications

From an application perspective, this study highlights the importance of designing business models that allow a firm to benefit from collaboration for growth in foreign markets and the potential of eco-innovations to address an apparently negative environment into an "external enabler" for a firm's competitive advantage. Energy efficiency could be a useful focus for future regulations of governments to achieve the environmental goals agreed upon in international conventions.

9. Limitations and future research

First, this case study has focused on a single company in one country,

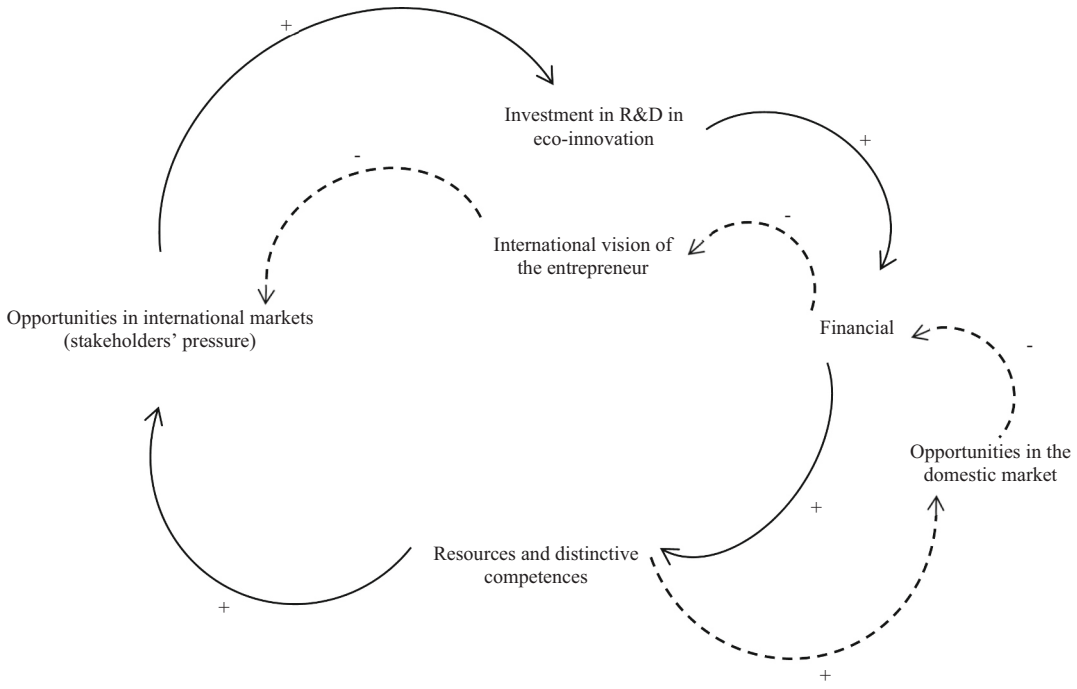

Fig. 4. Dynamic of growth patterns of eco-innovations.

which may limit the generalization of the results to other work settings. Future studies should provide new evidence originating from different industries and innovation perspectives to internationalize and complete the perspective offered in this analysis.

Researcher bias and perceptive measures based on the insights of the interviewees are other limitations of this qualitative study, which is based on in-depth interviews (Gough and Madill, 2012). The case study technique allows the researchers to better understand how the decision maker's perception bias can influence the decision process and strategy development. Frequently, individuals make choices based on subjectivity and incomplete information, both elements influenced by formal and informal institutions arising from different environments (North, 1990). Social research is embedded in the risk of building analysis on perceptive measures; however, it is also true that we cannot forget that behaviors are embedded in the decision makers' perceptions. Future research could make new contributions by studying the drivers identified in other business models and connecting these results with other growth patterns of born-global firms.

10. Conclusion

The future scenario of increasing energy consumption is accompanied by a more than probable price increase. This study contributes to connecting the assumptions of the open innovation and resource-based view of the firm to identify the business drivers that can accelerate or slow down the growth of processes of eco-innovation. The establishment of strategic alliances that increase the value chain supplier–client, the absence of opportunities in the domestic market, and a rapidly changing environment are considered the main factors underlying the internationalization pattern of firms involved in the eco-innovation process.

CRediT authorship contribution statement

Nuria Calvo contributed to study design, data collection, analysis and writing of the manuscript. Ariadna Monje-Amor did a significant contribution in the data collection, analysis and writing. Oskar Villarreal made a significant contribution to analysis, critical review and editing.

Data availability

Data will be made available on request.

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Nuria Calvo is PhD in Business Administration and degree in Economics and Industrial Psychology. After twelve years working in multinational firms (Accenture, Inditex), currently she works as professor of strategic management at University of A Coruña (Spain). Dr. Calvo is senior researcher in the Jean Monnet Research Group on Competitiveness and Development of the EU (C+ D Group) and in the Global Entrepreneurship Research Association (GERA). Her research focuses on the analysis of the individual behavior at organizations, international growth strategies for new companies, simulation of public policies and university-industry cooperation. Her research uses the methodological approaches of system dynamics and case study. Author of 40 research articles indexed in databases of international prestige and a patent for the research transfer, she is an international reviewer of research projects and scientific articles for 20 journals indexed in the Web of Science.

Ariadna Monje-Amor holds a Ph.D. in Economic Analysis and Business Strategy, a master's in Human Resource Management, and a bachelor's degree in Commerce. She is a lecturer at the University of A Coruña (Spain). Her research interests include organizational behavior, human resource management, strategic employee relations and organizational change.

Oskar Villarreal is Associate Professor at the University of the Basque Country (UPV / EHU). He is researcher at Institute of Applied Business Economics of the UPV/EHU. Extraordinary Doctoral Award. Ph.D. in Economics. First prize of methodology in Business Economics (FESIDE Investigator Award 2007) by the European Academy of Management and Business Economics (AEDEM). Author of the methodology and project coordinator "Theme-based Case Studies INNOBASQUE" (Basque Agency for Innovation). Published numerous articles in international journals, several book chapters and presentations and invited lectures in international conferences. Reviewer of scientific journals (specialization in the case study methodology and internationalization).