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Effects of R&D, networking and leadership roles on environmental innovation adoption in Vietnam's SMEs

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ABSTRACT

Although small and medium-sized enterprises (SMEs) constitute a majority of firms, they still have little knowledge about environmental issues and generally encounter difficulties when integrating environmental aspects into their activities. Similar arguments are also highlighted by Ha et al. in the case of Vietnam. This paper, therefore, builds a guideline for promoting SMEs' organisational environmental innovation adoption based on Environmental Standard Certification (ESC) by investigating the effects of R&D, networking, and leadership roles in Vietnam. By using SME survey data in Vietnam from 2011 to 2015, the empirical results show that R&D spending and organisational capabilities proxied by already owning ESC are positively associated with green innovation implementation. We also find that either collaboration with different partners, including competitors, banks, and public agents or communication networks, affects firms' decisions on green innovations. The demographic characteristics of managers such as gender, educational level, and knowledge about the environmental laws play determining roles in these decisions. Finally, we advanced the literature by indicating the moderating effects of men in leadership roles and leaders with better related knowledge on the impacts of firms' internal resources (R&D) and firms' international orientation (export).

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1. Introduction

The increasing importance of ecological and ethical responsibility for environmental sustainability has increased the pressure on firms to implement environmental or green innovations. In the literature, environmental innovations are defined as any novel product, process, or business model that reduces environmental risks, pollution, and other negative impacts of resource use, thus leading firms to achieve a high level of environmental sustainability (Triguero et al., 2013). However, the implementation of environmental innovation seems to be a very complicated task (Dermody & Hammer-Lloyd, 1996).

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Conventional and environmental innovations are equally vital for small and medium-sized enterprises (SMEs). Although SMEs constitute the majority of firms, they still have little knowledge about environmental issues (De Marchi, 2012; De Marchi & Grandinetti, 2013; Hillary, 2000) and generally encounter difficulties when integrating environmental aspects into their activities (De Marchi, 2012; De Marchi & Grandinetti, 2013; Leistner, 1999). This discussion can be true in the case of Vietnam. In this study, we used a survey of small and medium-sized enterprises (SMEs) in Vietnam conducted by the Central Institute for Economic Management (CIEM) from 2011 to 2015. In our database, most of the surveyed firms are micro-sized (59.52%) or small-sized (39.4%). When the owners of these surveyed firms were asked: "How would you characterise your knowledge about the environmental laws and government regulation?" to check their knowledge about environmental issues, only 20% considered that they had a good level of knowledge about the environment. Similar arguments are also provided by Ha et al. (2021). SMEs are not sure about how to use environmental management systems as an essential tool to improve their profitability (O'Laoire, 1994) or to reduce environmental burdens (Rennings et al., 2003). Hence, Halila (2007) concentrates on organisational environmental innovations based on the Environmental Standard Certificate (ESC) to help SMEs initiate environmental work. Kemp and Arundel (1998) argue that environmental innovations consist of environmental training programs, green product design programs, the introduction of environmental learning techniques, the creation of management teams to address environmental problems, and environmental management and auditing systems such as Environmental Management System (EMS) based on ISO 140001. EMS could be regarded as organisational environmental innovation (OECD, 2015). In this study, we expand on Halila (2007) to build a model that can be used as a guideline for the adoption of the ESC for SMEs in Vietnam. In the literature, there is no empirical evidence on the determinants of environmental innovation in developing areas where the degradation of the environment has become a severe issue. We believe that disentangling the determinants of environmental innovation has great implications for policy makers in this area. At the current stage of development, the Vietnamese government is not ready to issue a mandate for all businesses to meet high environmental requirements. In most cases, environmental innovation is carried out on a voluntary basis on the part of firms. Government policies to promote environmental innovation mostly manipulate firms' incentives so that the results of their cost-benefit analysis will favour innovation activities (Clancy & Moschini, 2018). Analyzing the influences of environmental innovation may help policy makers to understand this decision-making process and to design policies more pertinently and effectively. Formulating a policy without taking into account these factors might lead to inefficient outcomes or even to unwanted side effects. Furthermore, this paper aims to contribute to the theoretical aspect of the literature on environmental innovation. By combining both institutional theory and resource-based theory, we suggest both internal and external influencers of environmental innovation, as in Grant (1991) and Porter (1980). The direct effects and mediating roles of leadership are also investigated to explain the sources of environmental innovation in developing markets.

We select ESC due to the following reasons. As contended by Delmas (2000), the Environmental Management System (EMS) is a voluntary environmental approach that expects participants to commit themselves to reduce any adverse effects on the environment resulting from their actions. The EMS includes a set of rules developed by the managers of an organisation to help firms achieve internally established environmental goals (Coglianese & Nash, 2002). Firms develop their own systems in an effort to comply with the standards of EMS. Since ESC is the international standard for EMS (Szymanski & Tiwari, 2004), firms voluntarily decide to introduce environmental innovations. Based on Decree no. 80/2006/ND-CP (GOV, 2006) that guides the implementation of several articles of the Law of Environmental Protection No.52/2005/QH11 (GOV, 2005) in Vietnam, firms are required to submit an environmental impact assessment (EIA) report to receive the ESC. The EIA requires firms to address various environmental issues, including air quality, water pollution, waste disposal, soil degradation, noise, and heat. If they comply with the requirements in EIA, they will receive the ESC. As argued by OECD (2015) and Kemp and Arundel (1998), this EMS in Vietnam could be regarded as environmental innovation.

There has been a growing body of theoretical and empirical contributions to the literature on environmental innovations. While many studies have concentrated on the relationship between environmental innovations and firm performance (Cainelli et al., 2011), others have investigated the determinants of this type of innovation at the firm level. The focus is on individual firms since they could generate negative externalities on the environment (Galdeano-Gómez, 2008). However, the studies on the determinants of environmental innovation are still limited. Previous research, such as Horbach et al. (2012) and Cuerva et al. (2014), has mainly paid attention to the role of internal factors (technology push), external factors (market pull), or environmental regulation (regulation push or pull). Previous scholars have considered the effects of environmental regulations on environmental innovation decisions. In particular, with regard to privatisation, Pal and Saha (2015) state that an endogenous environmental tax may encourage public firms to improve the environment, while Haruna and Goel (2019) reveal a reduction in environmental R&D caused by this endogenous environmental tax. Also, considering exogenous environmental tax, Xing et al. (2020) indicate that there is an increase in environmental R&D if the authorities set a high tax rate. Although they investigated the same type of environmental tax, Tsai et al. (2016) provided the opposite evidence. In addition to environmental tax, Xing et al. (2019) demonstrate that environmental R&D subsidy policies cause a rise in environmental R&D. The present study analyzes other factors that affect the adoption of green innovations. First, we examine the linkage between exports and green innovation. The literature has paid little attention to a firm's international orientation (Galbreath, 2017). The institutional theory (DiMaggio & Powell, 1983) states that internalisation generates environments that cause firms operating in a foreign country to face external pressures beyond their local borders. A firm that attempts to export is expected to meet the demands of foreign markets to guarantee environmental sustainability. Second, this study analyzes the role of R&D activities and external knowledge networks in facilitating innovation, as argued in, Rogers (2004), and Schmidt (2005). Evidence shows that the innovation of firms can benefit from collaboration

with distinct partners, for example, customers, suppliers, and even competitors (Schøtt & Sedaghat, 2014; Zeng et al., 2010). Foreign networks (ownership and financial relationships) and communication networks (email, internet) are expected to facilitate innovation. To our best knowledge, no paper has yet been published that investigates the linkage between networking and green innovation. Third, we follow Schaltenbrand et al. (2018), Sharma (2000), Sharma et al. (1999), and Walker et al. (2014) to investigate the effects of managers' motivations and their knowledge about environmental issues on a firm's green innovation decisions.

Furthermore, a few studies (Galbreath, 2017; Leonidou et al., 2017) show that there are contingent factors moderating the relationship between green innovation and its determinants. The strategic choices of firms are constrained by both internal resource endowments of firms (Cyert & March, 1963; Pfeffer & Salancik, 1978) and external pressure from international markets (Galbreath, 2017). In our discussion, leaders' personal characteristics might influence strategy, culture formation, product and process expansions, which may strengthen or weaken the association between a firm's internal resources, external pressures from international markets, and green innovation. Therefore, we also advance the literature to examine the possibility that characteristics of managers (such as gender, educational level, knowledge about environmental laws) moderate the relationship between firms' international orientation (proxied by exports), firms' internal resources (proxied by R&D) and green innovation decisions.

To contribute to current debates on the determinants of green innovations, we utilise the logit model for SME survey data in Vietnam conducted by the Central Institute for Economic Management (CIEM) from 2011 to 2015. Few investigations have addressed similar issue, but the majority have focussed on developed countries. There is a lack of empirical evidence for developing areas where negative externalities, such as environmental degradation created by firms, become a serious issue. Therefore, we have filled this gap by providing empirical evidence to explain why firms in developing markets implement environmental innovation. Environmental degradation in these markets has been affirmed as a serious issue, while a lack of data makes it difficult to explore the determinants of firms' motivation to address environmental issues. Furthermore, we base our research on the resource-based and institutional theory to develop a theoretical model examining the effects of international orientation, internal knowledge, and external collaboration networks. These factors have been abstracted in the literature thus far. Our study is also the first to examine the direct effects and moderating roles of managers' characteristics on the associations between a firm's international orientation, its internal resources, and green innovation decisions.

The remainder of the paper is organised as follows. Section 2 covers the details of the model, and Section 3 explains the data and results. Some conclusions are provided in the final section.

2. Theory and hypothesis

This paper investigates the determinants of green or environmental innovation, which can be defined as any novel ideas, products, or processes helping to avoid or lower environmental issues to achieve a high level of environmental sustainability (Beise &

Rennings, 2005; Cuerva et al., 2014; Rennings, 2000). We concentrate on the effects of R&D, organisational capabilities, networks, leadership roles, and the moderating effects of the personal characteristics of managers on green innovation decisions.

2.1. R&D

R&D is an essential driver of green innovation (Cuerva et al., 2014). Firms without R&D encounter the disadvantage of higher costs for achieving and developing innovations. As a result, R&D is positively associated with firms' technical capacities. In the literature, many authors such as Bernauer et al. (2006), Rehfeld et al. (2007), and Horbach (2008) have found that R&D has a positive influence on technological capabilities in environmental technology at the firm level. However, this finding does not imply that R&D leads to better green innovations. The empirical evidence regarding the effects of R&D on the adoption of green innovations is mixed. On one side, a negative relationship between R&D and eco-innovation is found by Belin et al. (2011) in France. In other words, firms implementing eco-innovation carry out less R&D than conventional innovative firms. This argument is supported by Borghesi et al. (2012) when they investigate the implementation of green innovations in Italy. Similarly, eco-innovation in the UK cannot be fostered by an increase in R&D expenditure (Green et al., 1994). On the other side, Cuerva et al. (2014) show that R&D stimulates green innovation to a lower extent than conventional innovation. In this study, we believe that R&D leads to improvements in technological capacities and thus causes firms to invest in environmental innovation. Therefore, we reinvestigate the innovation theory to propose the hypothesis:

Hypothesis 1: R&D is positively related to green innovation implementation.

2.2. Organisational capabilities

Organisational capabilities are defined as policies and procedures that help to exploit firms' resources. They are also an important driver of the innovation process (Corral, 2003). Previous studies mostly concentrate on the influences of organisational capabilities, especially the environmental management systems (EMS), on green innovation. Under the EMS, firms set up environmental targets and programs to obtain them. As a result, the EMS system increases the implementation of green innovation. Wager (2008) confirms this discussion by indicating the positive relationship between green innovation and EMS implementation. Cuerva et al. (2014) focus on the influence of Quality Management System (QMS) certification on green innovation. They show that this management system promotes green innovation. In the case of SMEs, we prefer to use the information about the ESC instead of conventional QMSs and EMSs such as the ISO 9000 series, ISO 9001 series, ISO14000 series, ISO14001 series, or more compatible certificates such as ISO50001[1] (Cuerva et al., 2014). There are plausible reasons to explain our selection. First, firms attempt to develop their own systems to comply with the EMS standards. As contended by Szymanski and Tiwari (2004), the ESC is the international standard for EMS and firms take the voluntary decision to introduce environmental innovations. Second, Decree no. 80/2006/ND-CP

(GOV, 2006) of Vietnam provides guidelines for the implementation of several articles of the Law of Environmental Protection No. 52/2005/QH11 (GOV, 2005). According to the Decree, firms are required to deal with distinct environmental issues such as air quality, water pollution, waste disposal, soil degradation, noise, and heat to receive an environmental impact assessment (EIA) report. Then they must submit the EIA report to obtain the ESC. Firms are motivated to develop and adapt new technologies to address the negative impacts of their production activities on the environment. For firms already owning the ESC, they are still examined the process of taking control of environmental issues in the following years (GOV, 2006). Therefore, we believe that already owning ESC can encourage firms to implement environmental innovation.

In our discussion, organisational capabilities, proxied by already holding ESC, could stimulate green innovation activities: We hypothesise:

Hypothesis 2: Already owning ESC fosters the implementation of green innovations.

2.3. Networks

The literature has so far emphasised networks as an important determinant of innovation (Leyden et al., 2014; Parmigiani & Rivera-Santos, 2011; Pittaway et al., 2004). The first discussion concentrates on inter-firm cooperation, such as rising specialisation and new management logics, which promote this cooperation (Chesbrough, 2003; Zaheer et al., 2000). Huber (2004) argues that knowledge of outside firms can be fostered faster than that of inside firms due to the augmentation of scientific and productive knowledge. In this sense, external relationships enable firms to timely access new knowledge and exploit new opportunities among a limited number of opportunities.

As argued by Burt (2000) and Obstfeld (2005), networks help to connect the ideas and resources of others, and they then enable processes of recombination to produce novelty. In this sense, the mechanisms for information and knowledge transfer have been investigated by several theoretical studies. The difficulties can be diverse. They can consist of high transaction costs and the challenges of achieving tacit knowledge (Dhanaraj & Parkhe, 2006) or the risk of malfeasance (Dyer & Singh, 1998). Furthermore, relational experience, trust, and reciprocity might stimulate inter-firm complementarity and shared understandings, and thereby reduce cognitive barriers to knowledge transfer and enhance the benefits of inter-firm relationships (Jensen & Schøtt, 2015). It can be seen that there is a great deal of theoretical and empirical evidences on the associations between networks and innovations. However, the literature has still abstracted the effects of networks on green innovations.

There is much evidence highlighting the benefits of collaboration with distinct partners, for example, clients, customers, suppliers, and competitors, to firms' innovation. However, very few papers have explored the relationship between networks and the implementation of green innovation (Bansal & Roth, 2000). Furthermore, innovations, in general, may benefit differently from various kinds of partners (Schøtt & Jensen, 2016; Schøtt & Sedaghat, 2014; Zeng et al., 2010), and this innovation partnership may malfunction (Lhuillery & Pfister, 2009; Lokshin et al., 2011). Firms that

access external sources are able to enhance their combinatory potential and meet customers' requirements (Lipparini & Sobrero, 1994). Partanen et al. (2011) argue that the liabilities of newness and smallness in the commercialisation of innovative products are addressed by networks. Various stages of the innovation process can be facilitated when firms interact with diverse types of partners (Love et al., 2011). While collaboration with suppliers, customers, clients, private and public research institutes, and government institutes benefitted innovativeness (Tether, 2002), firms have less incentive to be innovative if collaborating with their competitors (Nieto & Santamaria, 2007). Moreover, research shows that firms can obtain ideas or information through computer connections (communication networks) (Tomiura, 2007).

There are few papers exploring the effects of networks on green innovation. As argued by Biondi et al. (2002), cooperation and networking among SMEs and their stakeholders are considered to be the most effective way to support environmental innovation. The presence of uncertainty and risk can be mediated through membership networks (Meredith & Biondi, 1997). The barriers and constraints to green innovation stemming from SMEs' lack of technical, human, and financial resources can be overcome if they are involved in a network (Biondi et al., 2002). By separating networks into business networks (collaborations with customers, suppliers, consumers, and financial institutions) and regulatory networks (environmental agencies, national environmental authorities, local authorities), Biondi et al. (2002) provided a detailed qualitative discussion on the influences of these types of network on environmental innovation. De Marchi (2012) also highlights the importance of R&D cooperation with different external partners for environmental innovation. In particular, cooperation with suppliers and universities is significantly associated with the probability of environmental innovation, while cooperation with customers does not lead to any important difference. More recently, Chen et al. (2019) examined the effects of networks on green innovation. Their study illustrates that network embeddedness and network diversity are positively associated with green innovation performance. Inigo et al. (2020) also show the positive relationship between alliance proactiveness, alliance portfolio coordination, and firms' sustainability-oriented innovation.

Hence, based on the literature on normal and green innovation, we propose the following hypothesis:

Hypothesis 3: Having collaborations with banks, government institutes, and owning communication networks foster firms' green innovation implementation.

Hypothesis 4: Having collaborations with competitors attenuates firms' green innovation implementation.

2.4. The roles of leadership

The personal characteristics of managers/CEOs, for example, experience, value, and personality, determine their strategic choices such as innovation (Hambrick, 2007). These personal characteristics help managers/CEOs to create their own mental frames with which they formulate and implement their strategic choices. Therefore, it is necessary to incorporate variables capturing these personal characteristics in the model as they are important drivers of green innovation.

Previous studies have emphasized the roles of managerial values and cognition in environmental issues. In particular, Hemingway and Maclagan (2004) emphasise the role of managerial values in the implementation of green policies, while Vazquez-Brust and Liston-Heyes (2010) highlight the intentions of managers as determinants of environmental mindset, values, and beliefs. A few studies have investigated the effects of leaders' values, such as their motivations, experiences, or understanding of environmental concerns, on green investment decisions (Schaltenbrand et al., 2018; Sharma, 2000; Sharma et al., 1999; Walker et al., 2014). However, the empirical evidence regarding the influence of the personal characteristics of managers is still inclusive, especially regarding the effect of leader gender. Furthermore, previous works regarding the effects of leader gender on green innovation mainly concentrate on the case of developed countries (Barbieri et al., 2016), while little attention has been paid to developing countries thus far. Therefore, this paper explores the impacts of managers' characteristics, such as gender, educational level, and knowledge about environmental laws, on green innovation in Vietnam's SMEs.

Employees' educational levels and their knowledge about environmental laws are human capital, which is considered to be a valuable resource for stimulating green innovation. In this paper, we incorporate a new variable that reflects managers' understanding of environmental laws. Chaganti and Sambharya (1987) and Thomas et al. (1991) also emphasise the essential role of educational background on innovation, including green innovation. Midavaine et al. (2016) argue that if leaders have a background in relevant knowledge, they are better able to generate new pieces of knowledge. We discuss here whether, if managers possess greater levels of knowledge, they tend to invest more in green innovation.

Our discussion also pays attention to managers' gender. The effects of organisational leaders' gender on ethical decisions like green innovation implementation have been gaining the attention of researchers. However, gender impacts are still ambiguous in the literature since men and women use distinct frameworks for moral reasoning (Elm et al., 2001). While Elm et al. (2001), Forte (2004), and Wong and Wan (2011) show that men have a high level of moral reasoning, empirical evidence supporting the role of men in leadership is provided by Gilligan (1982) and Callahan (1990). On the other hand, Derry (1987, 1989) find no difference in men's and women's moral reasoning. Women seem to be more empathetic, change catalysts, and inspiration-driven than men. Conversely, Young (2016) argues that men tend to have higher self-control and more accurate self-assessment. As a result, men and women may make decisions differently.

Based on these discussions, researchers have increasingly examined the impact of leader gender on green innovation. In particular, Post et al. (2011), Kassinis et al. (2016), and Galbreath (2017) show that women in leadership roles influence the efforts of firms towards green innovation. These results from developed countries, however, may not be applicable to developing countries. This paper focuses on men in leadership roles since successful leaders need to be self-educated, assertive, and self-confident. The female leaders might cause negative effects on firm performance (Adams & Ferreira, 2009; Ahern & Dittmar, 2012; Matsa & Miller, 2011), thus creating challenges for the implementation of green innovations.

Based on our discussion, we propose the following hypothesis:

Hypothesis 5: The personal characteristics of managers, such as gender, educational level, and knowledge about environmental laws, are associated with the implementation of green innovation.

2.5. The moderating effects of leadership

While the personal characteristics of leaders have become prominent influencers of green innovation, we need to consider other factors. In particular, the strategic choices of firms are constrained by both their internal resource endowments (Cyert & March, 1963; Pfeffer & Salancik, 1978) and external pressure from international markets (Galbreath, 2017). Leaders' personal characteristics might influence strategy, culture formation, product, and process expansions, and this may strengthen or weaken the association between a firm's internal resources, the external pressures from international markets, and green innovation.

In order to examine these effects, we choose R&D investment and exports, which reflect a firm's international orientation. There are plausible reasons to explain these selections. First, R&D investment, which is widely used as a proxy for absorptive capacity in the literature, facilitates firms' adaption to the external environment. Furthermore, absorptive capacity is regarded as a firm's capability for value identification and knowledge application since when new knowledge is absorbed, the organisational memories created by firms are updated and leveraged (Cohen & Levinthal, 1990). As a result, new knowledge is created and added to a firm's knowledge base. Firms then use this new knowledge to stimulate both conventional and green innovations.

With respect to R&D and leaders' characteristics, we argue that top managers monitor R&D spending closely and adjust its level based on their preferences. Barker and Mueller (2002) indicate that leaders' characteristics account for a significant proportion of variance in firms' R&D spending. They also argue that leaders with advanced science-related degrees significantly increase R&D spending. Chaganti and Sambharya (1987) and Thomas et al. (1991) also emphasise the essential roles of educational background in strategic choices and R&D spending. This discussion advocates our prediction that leaders with advanced knowledge about environmental laws tend to invest more in R&D in order to satisfy the technical and environmental standards related to product quality. Moreover, R&D spending is considered to be a form of long-term investment, which is risky and suffers high rates of failure (Mansfield, 1968). Hence, decisions about investment spending vary with executive managers' risk perception, risk preference, and risk-taking. This attitude then depends on their gender. Women tend to be lower risk takers than men, thus, they are likely to spend less on R&D. Moreover, successful R&D investments require leaders to possess agentic qualities such as high emotional self-control, accurate self-assessment, assertiveness, and self-confidence, which are typically associated with men (Young, 2016).

Second, we follow the logic of institutional theory (DiMaggio & Powell, 1983) to assume that export-oriented firms are expected to encounter expectations and

demands from foreign markets with regard to environmental sustainability. Specifically, trade networks connect sellers and buyers in one country with those in another country. As argued by Coe and Yeung (2001) and Smith (2009), this creates a channel transferring coercive supply-chain pressures, which leads to an improvement in product quality, productivity, and competitiveness between domestic suppliers (Porter, 1990). Furthermore, many countries are currently paying more attention to climate change, global warming, deforestation, and other environmental issues. When these environmental concerns are beyond national boundaries, it causes much debate among nations regarding reducing environmental impacts (Pinkse & Gasbarro, 2019). Consequently, exporting firms need to put more effort into meeting global values and moral commitments. However, if the leaders of these firms are more or less attuned to these requirements, or they do have more or less understanding of environmental issues, the magnitude of the effects of exports on green innovation will change. Since men tend to have higher self-control and more accurate self-assessment (Young, 2016), an executive male leader is expected to recognise and comply with global responsibilities to increasingly implement green innovations.

Moreover, Galbreath (2017) indicates that when there are interactions between firms in a home country and those in foreign countries, there is an increase in normative forces influencing the adoption of green innovations. In this study, we follow Gilligan (1982) and Callahan (1990) to assume that men possess higher levels of moral reasoning and ethical behaviour than women. As a consequence, male executive leaders are more likely to take action to implement green innovations. Based on our discussion, we propose the following hypothesis:

Hypothesis 6: The personal characteristics of managers moderate the relationship between exports, R&D, and green innovation implementation.

Figure 1 illustrates the model used in this study. We concentrate on the effects of internationality, organisational capabilities, networks, and the personal characteristics of managers on green innovation. In addition, we emphasise manager profile as an essential driver of green innovation by investigating its moderating effects on the association between R&D investment and exports and green innovation.

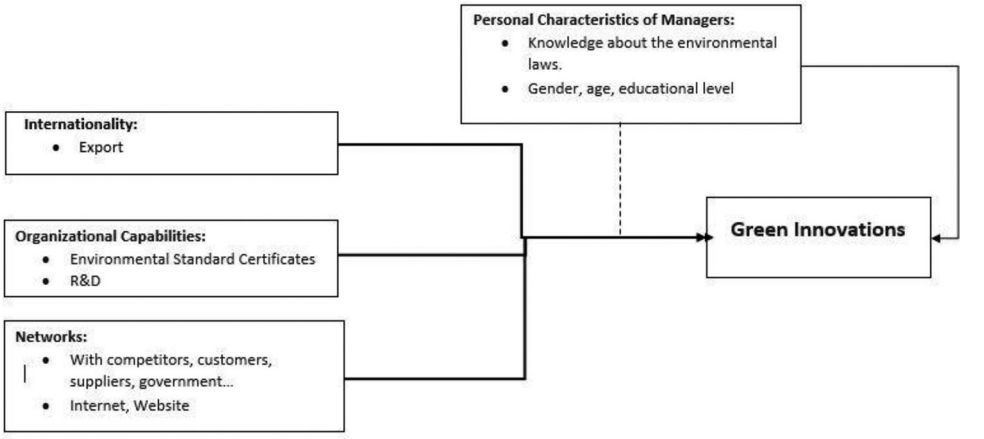

Figure 1. Determinants of green innovation in SMEs.
Source: Authors' calculations from the survey of SMEs in Vietnam (2011-2015).

3. Research methodology

3.1. Data and variables

The present study investigates the determinants of green innovation implementation by employing the survey of SMEs in Vietnam conducted by the Central Institute for Economic Management (CIEM). The survey contains information on SMEs' implementation of innovations related to environmental improvements. Furthermore, information about specific forms of environmental improvements such as air quality improvement, noise pollution treatment, water pollution treatment, and issues concerning water, fire, temperature, and light management are also provided in the survey. This diverse database played a vital role in helping us to examine the preceding hypotheses.

The firms in the sample came from 10 provinces, which jointly account for around 30% of non-state manufacturing enterprises in Vietnam. In each province, the 2-step sampling method was employed to first select a number of districts within each province using proportion-to-size sampling and then select a number of firms within each district from the list of formal/registered non-state and household manufacturing firms. Information on informal manufacturing firms was collected through snowballing techniques. In each district, the surveyors selected firms that were not in the "formal" list but were visually present for interview (on-site identification); additionally, the enumerators were also asked to find as many additional informal firms as possible within each chosen site (block enumeration).

Another objective of the survey was to follow the same enterprise over time to gain insights into their long-term development. Therefore, a tracer survey was created. The team re-interviewed surviving firms in later rounds of the surveys. Exit firms were replaced using two criteria: (1) a constant level of household enterprises had to be maintained from the 2002 Establishment Census, and (2) the updated population of registered firms was used from the annual GSO's Enterprise Census data.

Detailed information regarding the variables included in the model is summarised in Table A1. For the dependent variable, we use a dummy (*Environment*) that takes a value of 1 if SMEs have a certificate for registration of satisfaction of environmental standard in the current year (year t). In addition, we also consider some specific forms of environmental issues (e.g., waste disposal, water pollution, soil degradation) by using a dummy that takes a value of 1 if the firm takes action to mitigate these forms of environmental damage. The explanatory variables consist of proxies for R&D, organisations' capacities, networks, and the role of leadership. In particular, we use a dummy that takes a value of 1 if the firm participates in R&D investment (*RD*) or already has an Environmental Standard Certificate in year *t-1* (*EnvCerti*) as proxies for R&D and organisational capabilities. Networks include dummy variables reflecting the relationship between firms and their competitors (*Net_Com*), banks (*Net_Bank*), a government agent (*Net_Gov*), or government support (*GovAss*). We also consider information about a firm's communication networks, for example, internet (*Internet*) and website (*Website*). To capture international networks, we also include the dummy of export behaviour. Since this paper mainly focuses on the roles of leadership, we

collect information representing the personal characteristics of managers, such as gender (*MaManager*), educational level (*EducManager*), and knowledge about environmental law (*EnvPers*). Finally, we also include variables depicting firms' characteristics such as size (*LnSize*) and sectors ($Sector_i$).

Properties such as the mean and standard deviation of these variables are also provided in Table A1. In our sample, 16% of the surveyed firms implemented environmental innovations. Regarding the characteristics of the firms in the sample, Table A1 illustrates that nearly 10% of surveyed firms export their products to foreign countries. A high proportion of firms have collaborations with competitors (nearly 90%), banks (nearly 83%), and the government (71%). However, the percentage of firms receiving government supports is quite low (nearly 18%). The percentage of firms with Internet, Website, and Email are 32.9%, 17.1%, and 17.9%, respectively. Regarding the characteristics of firms' owners, nearly 20% of managers are male, and just under 18% have good knowledge of environmental laws.

General descriptions of SMEs with ESC are illustrated in Figure A1. In particular, Figure A1a and b respectively depict changes in the number of firms adopting the ESC and reasons why SMEs adopt the ESC over time, respectively. The number of certificate holders rose considerably from 2011 to 2015. It is worth noting that the two main motivations for adopting the ESC are environmental protection and law requirements each year. However, the number of certificate holders is due to the changes in law, whereas there was a remarkable increase in SMEs motivated by environmental responsibility over the 2011–2015 period. Customers' requests to adopt ESC are also important for certificate holders. Cost reductions and other reasons account for a small proportion of this sample.

Figure A2 shows the distribution of certified SMEs across provinces, along with their exporting statuses and sectors. Regarding the geographical distribution of SMEs with ESC, they were concentrated in the two largest cities, Hanoi and Ho Chi Minh City (HCMC), during the 2011–2015 period. The number of SMEs with ESC that export account for a small proportion, and this figure slightly declined from 2011 (14%) to 2015 (11%) in our sample. Nearly 40% of SMEs with ESC were concentrated in the food and beverage industry in 2011. The rubber and fabricated metal product industries occupy the second and third positions, respectively. From 2011 to 2015, the share of firms with ESC in the food and beverage industry significantly decreased, whereas it rose in some sectors such as apparel, leather, wood, and fabricated metal products.

We also employ the taxonomy of Pavitt (1984) to classify the certified firms into three sector groups: supplier-dominated sector, scale-intensive sector, and science-based sector. Our data indicate that certified SMEs were mostly located in the supplier-dominated sector, while the science-based sector accounted for a modest portion.

Some aspects related to the characteristics of managers of certified SMEs are shown in Figure A3. The left figure reports the distribution of managers by gender. The proportion of males in leadership roles in certified SMEs was greater than that of females in almost all of the reported years except for 2011. The middle figure indicates that there was a higher percentage of managers without a high educational level

than those with a high educational level in firms that adopted the ESC. Finally, the share of managers who had a good level of knowledge about environmental laws is small, as reported in the right figure.

3.2. Methodology

The model is specified as follows:

$$\text{Environment}_i = \beta_0 + \beta_i Control_i + \varepsilon_i, \quad (1)$$

where subscript i denotes the firm i. Environmental innovation, $Environment_i$, is the dummy variable that takes a value of 1 if firms have a certificate for meeting environmental standards and 0 otherwise. $Control_i$ is the set of control variables based on our theoretical analysis, which consists of the amount of R&D investment (*RD*) measured in million VND, already owning ESC in previous year (*EnvCerti*), size (*LnSize*), and sectors (Sector_i)., owning the network with their competitors (*Net_Com*), banks (*Net_Bank*), a government agent (*Net_Gov*), or government support (*GovAss*), a firm's communication networks, for example, internet (*Internet*) and website (*Website*) and the personal characteristics of managers, including gender (*MaManager*), educational level (*EducManager*), and knowledge about environmental law (*EnvPers*). The detailed descriptions of the included control variables can be found in Table A1. As the dependent variable is binary, this paper employs the logit model to investigate the determinants of green innovation for Vietnam's SMEs. The probabilities $\text{Prob}\,(\text{Eco} - \text{environment} = 1\text{z}) = \text{F}(Control_i, \text{y})$ are estimated, and marginal effects are computed and reported in the table of estimation results (see Tables A3–A6 in the Appendix).

We perform various analyses in this study. In the first discussion, we investigate the drivers of green innovations in general. To measure the moderating effects of leadership, we add interaction terms that lie between the variable representing personal characteristics of managers and related explanatory variables. We suggest the following model:

$$\text{Environment}_i = \varphi_0 + \varphi_i Control_i + \tau_i X_{1,i} * X_{2,i} + \varepsilon_i, \quad (2)$$

where $X_{1,i}$ is either *RD* or *Export,* and $X_{2,i}$ denotes personal characteristics of managers, including gender (*MaManager*) and knowledge about environmental law (*EnvPers*)[2]. Subsequently, the determinants of specific forms of environmental behaviours are also considered for further analysis.

4. An empirical analysis

4.1. Determinants of green innovation

Table A2 displays the correlation levels between the variables in the model. In general, the correlations are below 0.8, implying that there is no problem of multicollinearity in our theoretical model.

The marginal effects of the explanatory variables of the logit model are provided in Table A3 for better interpretation. The model without the interaction terms (Model 1) and those with the interaction terms (Models 2, 3, 4, and 5) are respectively analyzed. In all models, we incorporate dummy variables representing the firm's sector, including some low-tech SMEs (Food, Apparel, Wood, and Leather) and more high-tech SMEs (Transport, Electronic). First, we investigate the effects of each variable. The results of the models emphasise the roles of R&D, organisational capabilities, networks, and leadership. In particular, both *RD* and *EnvCerti* are positively associated with environmental innovation implementations in Vietnam. In other words, firms with either R&D investment or ESC are more likely to implement green innovations than firms without them. These conclusions support Hypotheses 1 and 2 proposed in this paper. These discussions are also consistent with Cuerva et al. (2014) and other empirical studies. In our study, the magnitude effects of R&D are insignificant. As revealed by Hemmelskamp (1999), the dominance of incremental technologies in green innovation requires a small R&D effort. Furthermore, the strong evidence revealed in this study for the positive influence of organisational capabilities (*EnvCerti*) on environmental innovation is aligned with the study of Cuerva et al. (2014), which considers the effect of standardised Quality Management Systems. As in Cuerva et al. (2014), our study also suggests that organisational capacity is one of the strongest influencers of environmental innovation strategy.

Regarding the effects of networks, there is a great deal of evidence highlighting the benefits of collaboration with different partners, including competitors, banks, and government agents. We advance the literature by exploring the relationships between networks and green innovations. Specifically, firms have fewer incentives to implement green innovations if they are collaborating with their competitors. This conclusion is aligned with the results of Nieto and Santamaria (2007). Collaborations with banks and public agents are expected to stimulate green innovations, but these variables are not statistically significant in our study. Similarly, government support may tempt firms to engage in more environmentally friendly behaviour, but it plays no role in our sample. Our findings are similar to those of Bönte and Dienes (2013) and Cuerva et al. (2014), who found that cooperation with suppliers, customers, and public centers such as universities has no effect on environmental innovation implementation. Bönte and Dienes (2013) also contend that innovative performance may decrease due to cooperation, especially between SMEs in the case of European companies. By contrast, the empirical study of De Marchi (2012) emphasises the importance of R&D cooperation with external partners for environmental innovation, using the data from the Community Innovation Survey on Spanish manufacturing firms.

Furthermore, we show that firms also benefit from communication networks, except for Email, as these provide ideas or information, which then encourages firms to invest more in green innovation. The weak negative relationship between email and green innovation adoption is unexpected. One possible explanation is that highly formal communication may adversely affect technological innovation. In addition, these firms may use email communication networks as their main informal organisational structures. Soucek and Moser (2010) pointed out three aspects of information overload in email communication, including the huge amount of incoming

information, inefficient workflow, and low communication quality. As workplace communication rapidly develops, email is not an effective way of communication. Hence, firms that heavily depend on email for building informal organisational structures are less likely to adopt innovation.

To provide greater insights into the roles of network, we consider different environmental issues, namely air quality, noise, waste disposal, and water pollution. The results shown in Table A4 emphasise the role of collaboration with competitors and public agents. In particular, firms invest more in air quality treatment if they collaborate with their competitors, while relationships with public agents promote firms to deal with waste disposal issues. Collaborations with other partners are not statistically significant.

One of the most important factors in our study is the role of leadership. There is empirical evidence emphasising the importance of the demographic characteristics of leaders/managers. In particular, managers with higher educational levels and knowledge about environmental law tend to increasingly implement green innovations. Educational levels and knowledge about environmental law are a firm's human capital, which is regarded as a valuable resource for promoting green innovation. As in Chaganti and Sambharya (1987) and Thomas et al. (1991), we highlight the essential role of educational background in green innovation implementation. If managers possess good knowledge of environmental laws, they are better able to create new ideas for environmental improvements.

Our concern concentrates mainly on managers' gender. The effects of managers' gender on any ethical decisions like green innovation have attracted the attention of many authors. As in our theoretical model, the empirical results of SMEs in Vietnam show that having men in leadership roles has a positive effect on the probability of green innovation implementation. Following the argument of Young (2016), men tend to have more self-control and more accurate self-assessment than women, and thus they stimulate green innovations.

The moderating effects of leadership roles are discussed by adding interaction terms in Models 2, 3, 4, and 5 of Table A3. Our empirical results indicate that the demographic characteristics of managers, including their gender and knowledge about environmental law, moderate the impacts of firms' internal resources (R&D) and firms' international orientation (exports). First, the results of Model 2 show that managers monitor R&D spending and adjust its level according to their preferences. Managers with better levels of knowledge make improvements to R&D and thus to green innovation. This finding is aligned with those of Barker and Mueller (2002). In the case of Vietnam, leaders of SMEs with advanced knowledge about environmental laws tend to invest more in R&D and promote environmental innovation implementation to satisfy environmental standards related to product quality.

Furthermore, women in leadership roles positively moderate the effects of R&D on green innovation, as reported in Model 3. As argued by Estrin et al. (2013) and Terjesen et al. (2016), the realisation of non-economic goals is preferred by women more than by men. The specific characteristics of executive women make them interested in environmental sensitivity and policy making (Kanter, 1977), and thus they positively impact corporate environmental strategies. Further, we follow Brambor

et al. (2006) to dig a bit deeper into interpreting the effects of interactive terms. In this exercise, we examine how the marginal effects of managers' knowledge about environmental law and gender vary with the level of R&D investment. Figure A4 shows that the marginal effect of EnvPers is positive at all values of R&D amount. This effect increases when the R&D amount rises, but up to some level, this effect shrinks. Meanwhile, Figure A5 indicates that the marginal effect of a manager's gender is positive at all values of R&D amount. This effect is strongest when the R&D amount is at its lowest and falls in magnitude as the R&D amount increases.

For the robustness check on this discussion, we consider a dummy that takes a value of 1 if the firm invests in R&D instead of the amount of R&D investment as previously. The comparison between the two models using different proxies for R&D is reported in Table A5. In general, the results are almost the same except for the moderating effect of leaders' gender on R&D. In the model with the dummy variable representing information about R&D, the men executives positively moderate the effect of R&D on green innovation. However, this effect is statistically insignificant, as in Model 2 shown in Table A5. This finding suggests that the moderating effects of women in leadership roles on R&D investment depend on the way we define R&D. If we only consider whether or not firms invest in R&D, women in leadership roles would stimulate environmental innovation implementation. On the other hand, male managers play an important role in amplifying the effect of R&D investment level on shaping environmental strategy.

Finally, the present study also investigates the moderating effects of leaders' personal characteristics on relationships between exports, proxied for firms' international orientations, and green innovation. Export-oriented firms need to make improvements to products and productivity to satisfy the expectations and demands of customers in foreign markets. Our study shows that the effects of exports on green innovation are significant as leaders are more attuned to these requirements if they have a better understanding of environmental issues, as represented in Model 4 of Table A3. We also examine the role of male executives and their moderating effects. To be more specific, the male executives of export-oriented firms tend to adopt green innovations. This discussion could be supported by the arguments of Gilligan (1982) and Callahan (1990) since men possess higher levels of moral reasoning and ethical behaviour. The empirical results supporting our discussion are provided in Model 5 of Table A3. However, this variable (*MaMana*Export*) is not statistically significant in our sample.

4.2. Sectoral variations

In this section, we investigate the effects of R&D, networking, and leadership roles on green innovation decisions across sectors. In order to classify the sectors, we follow Tomiura (2007), a study that was based on the commonly used taxonomy of Pavitt (1984). In Tomiura's (2007) work, SMEs are classified into three sector groups: supplier-dominated sector, scale-intensive sector, and science-based sector. Appendix A provides a detailed list of industries. There are papers that revisit Pavitt's (1984) taxonomy to cover manufacturing, services, and ICT activities (Bogliacino & Pianta,

2016; Castellacci, 2008). Tomiura (2007) focussed on the manufacturing sector, and his taxonomy revision fits our data set. We then use the same model specification for these groups to show sharp contrasts, as shown in Table A6. In our sample, there are 877 firms, 377 firms, and 278 firms classified as being in the suppler-dominated sector, scale-intensive sector, and science-based sector, respectively.

Table A6 shows striking results across sectors. First, there is a positive association between R&D and green innovation, particularly in the science-based sector. In other sectors, this effect is silent. Second, Table A6 reports the sharp differences in the impacts of networking on green innovation across sectors. Specifically, the remarkably positive relationships between collaborations with banks, public agents, and green innovation implementation are evident in the scale-intensive and science-based sectors, while communication networks via the internet play an important role in stimulating green innovation in the supplier-dominated sector.

Third, the effects of the demographic characteristics of managers such as gender, educational level, and knowledge about environmental laws on green innovation are contingent on the type of sector. In particular, knowledge about environmental laws is found to be statistically significantly correlated with green innovation for all SMEs in the scale-intensive sector. Male executives also play determining roles in these decisions for firms in the scale-intensive and science-based sectors, but not in the supplier-dominated sector. On the other hand, the results highlight a strongly positive relationship between the educational levels of managers and green innovation in all sectors.

Finally, the moderating effects of the leadership role are found in all three types of sectors. Table A6 shows that women managers stimulate the effects of R&D on green innovation decisions in the supplier-dominated sector. Regarding the scale-intensive sector, the effects of exports on green innovations are magnified as leaders have a better understanding of environmental issues. Male executives of export-oriented firms increase the adoption of green innovations in the scale-intensive and science-based sectors. These findings provide more evidence to support our hypothesis on the leadership role.

5. Concluding remarks

This paper investigated the effects of R&D, organisational capabilities proxied by owning ESC, networks including both collaborations with diverse partners and communication networks, and leadership roles on green innovation in Vietnam's SMEs. We performed various exercises in the study. In the first discussion, we investigated the drivers of green innovation in general. Subsequently, the determinants of specific forms of environmental behaviour were investigated. To measure the moderating effects of leadership, we added interaction terms: the variable representing the personal characteristics of managers, including their gender and knowledge, and related explanatory variables.

The empirical results show that investing in R&D and already owning ESC are positively associated with green innovation implementations. We also find that collaborations with different partners, including competitors, banks, and public agents or communication networks, affect firms' decisions over green innovation. While collaboration with competitors lowers firms' incentives to implement green innovation,

collaborations with banks and public agents promote these activities. The demographic characteristics of managers such as gender, educational level, and knowledge about environmental laws play determining roles in these decisions. In particular, managers with higher educational levels and knowledge about environmental law tend to increasingly implement green innovations. We also highlight the roles of male executives. Finally, we advance the literature by indicating the positive moderating effects of leaders, including their gender and knowledge, on firms' internal resources (R&D) and firms' international orientation (exports).

This paper makes a vital contribution to the literature regarding the determinants of SMEs' green innovation in developing countries. However, there are some limitations that should be solved in further studies. First, there may be unobserved heterogeneity in the survey of SMEs in Vietnam. This issue is important since other influencing factors might change our results. The other limitation is related to the selected dependent variables. Due to a lack of information about green innovation implementation in this survey, using binary variables as in our study might not precisely reflect the innovative behaviour contributing to firms' growth and sustainable development. These limitations of the current work suggest that the further empirical studies should be performed to provide a complete understanding of the influences impacting the adoption of green innovations by SMEs.

Notes

1. They are the most used model of reference for QMS and EMS implementations in the case of SMEs. Among them, SMEs with ISO50001 are permitted to integrate energy management systems with quality, environmental management improvement efforts.
2. Since we do not find clear arguments supporting the moderating effects of the educational level of manager and our empirical analysis reports statistical insignificance of these interactions, we do not report this analysis in this paper.
3. To obtain this information, owners of firms were asked: "How would you characterize your knowledge about the environmental laws and government regulation?" They were able to select one of four options: (1) Good, (2) Average, (3) No Knowledge, and (4) Not of my interest. The dummy variable *EnvPers* takes the value of 1 if the respondent selected "Good" in the survey and 0 otherwise.
4. To obtain this information, owners of firm were asked: "What was the highest professional education you completed?" and the owner selected one of five options: (1) Unskilled, (2) Technical certificate/Elementary, (3) Technical worker without certificate, (4) Technical worker with certificate/professional secondary, and (5) College/University/post-graduate. We created a dummy variable (*EducManager*) that takes a value of 1 if the firm's owner selected the fifth option and 0 otherwise.

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Appendix

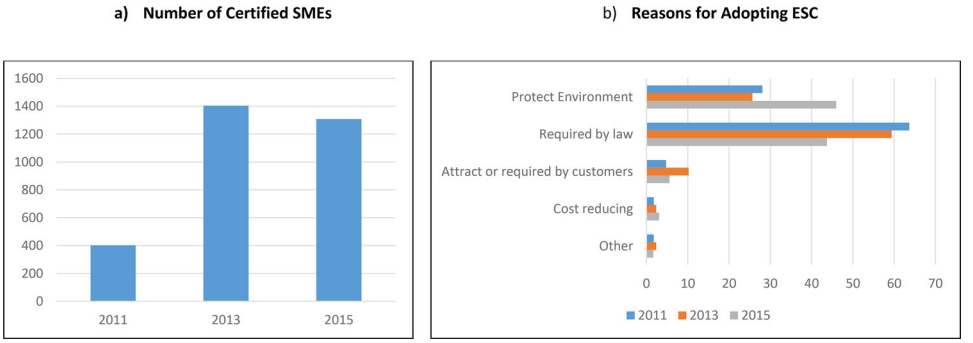

Figure A1. Description of SMEs with ESC.
Source: Authors' calculations from the survey of SMEs in Vietnam (2011-2015).

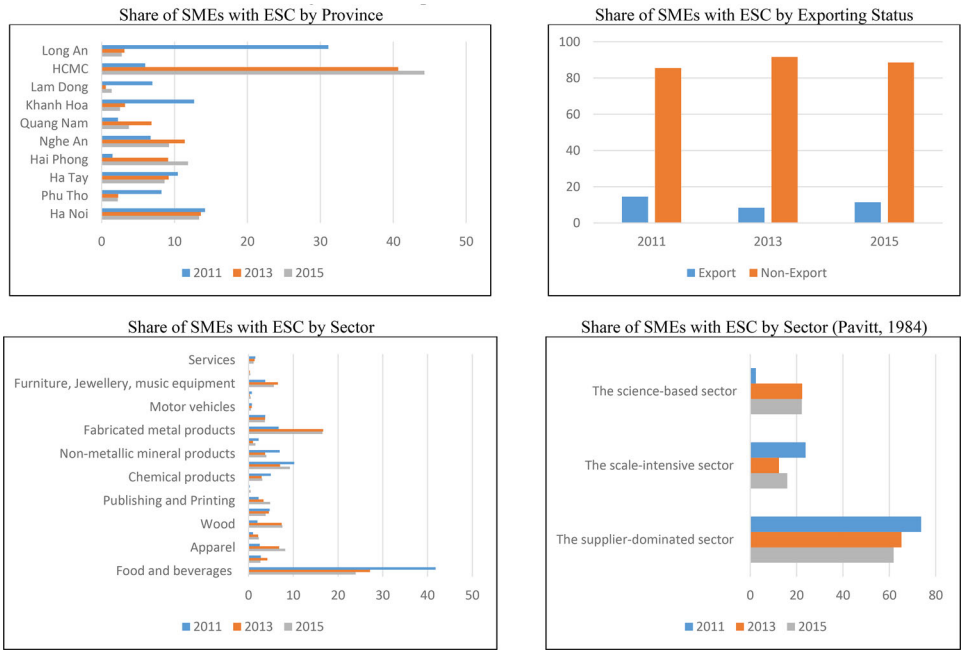

Figure A2. Distribution of SMEs with ESC.
Source: Authors' calculations from the survey of SMEs in Vietnam (2011-2015).

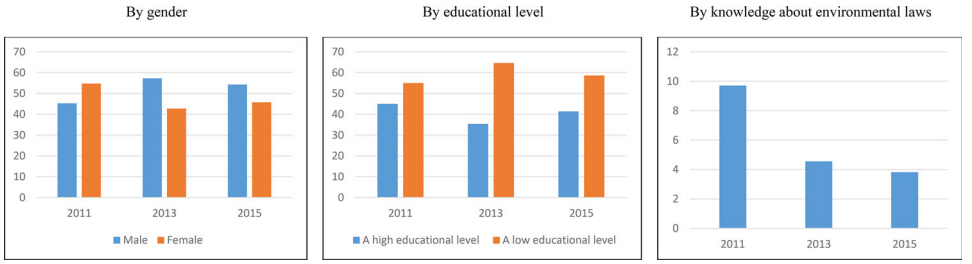

Figure A3. Characteristics of Manager in SMEs with ESC.
Note: This figure displays characteristics of manager/owner of SMEs with ESC only. The mangers/owners of certified SMEs with college/university/post-graduate were labelled as "a high educational level" and those with these certifications were labelled as "a low education level". The right figure displays the trend of proportion of managers/owners in the certified SMEs that have a good knowledge about environmental laws (*EnvPers* = *1* for SMEs with ESC).
Source: Authors' calculations from the survey of SMEs in Vietnam (2011-2015).

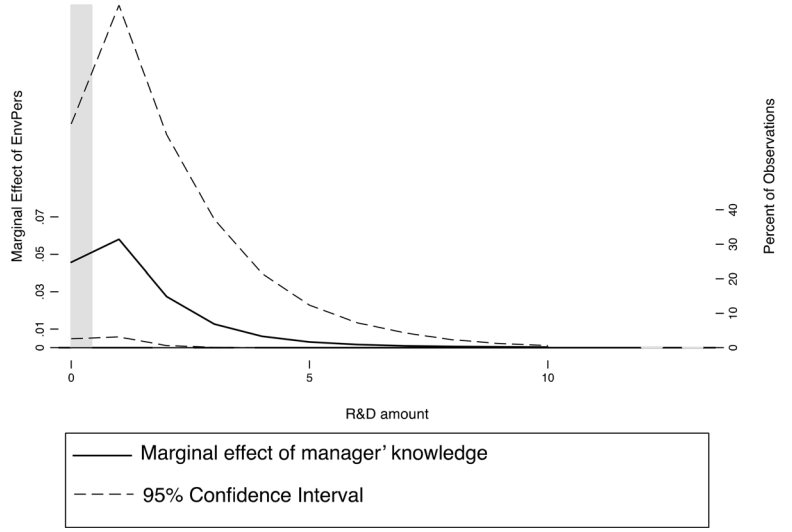

Figure A4. Marginal effect of manager' knowledge about environmental law on green innovation as R&D amount changes.
Source: Authors' calculations from the survey of SMEs in Vietnam (2011-2015).

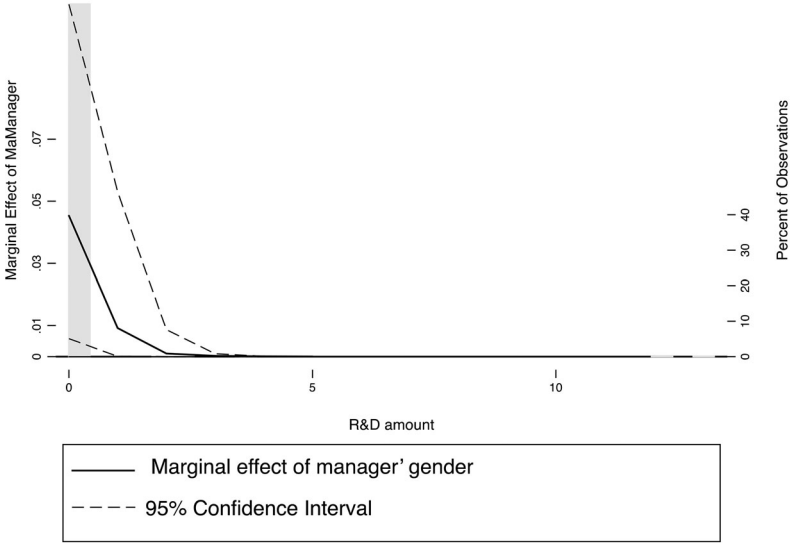

Figure A5. Marginal effect of manager' gender (for male managers, i.e., MaManager = 1) on green innovation as R&D amount changes.
Source: Authors' calculations from the survey of SMEs in Vietnam (2011-2015).

Table A1. Descriptions of used variables in the model.

Symbol	Description	Mean	S.D.
Dependent Variables			
Environment	A dummy variable taking value 1 if firm has a registration of satisfaction of environmental standard and 0 otherwise.	0.16	0.367
Independent Variables			
Export	A dummy variable taking value 1 if firm exports.	0.097	0.296
EnvCerti	A dummy variable taking value 1 if firm already has the Environmental Standard Certificate in year t-1.	0.134	0.341
RD	An amount of investment in R&D.	0.014	0.117
Net_Com	A dummy variable taking value 1 if firm has collaboration/cooperation with competitors.	0.899	0.302
Net_Bank	A dummy variable taking value 1 if firm has collaboration/cooperation with banks.	0.829	0.376
Net_Gov	A dummy variable taking value 1 if firm has collaboration/cooperation with the government.	0.710	0.454
GovAss	A dummy variable taking value 1 if firm receives the government's supports.	0.179	0.383
Internet	A dummy variable taking value 1 if firm uses Internet.	0.329	0.470
Website	A dummy variable taking value 1 if firm has its own website.	0.171	0.376
Email	A dummy variable taking value 1 if firm has email address.	0.179	0.383
EnvPers	A dummy variable taking the value of 1 if the manager has good knowledge[3] about environmental law.	0.204	0.403
MaManager	A dummy variable taking the value of 1 if the manager is male.	0.704	0.457
EducManager[4]	The educational level of a manager.	0.279	0.449
$Sector_i$	Dummy variables representing the sectors: Food and beverage, apparel, wood, leather, transport.		
LnSize	Log of number of full-time regular employees.	2.138	1.103

Source: Authors' calculations from the survey of SMEs in Vietnam (2011-2015).

Table A2. Correlations.

	Export	EnvCerti	RD	Net_Com	Net_Bank	Net_Gov	GovAss	Internet	Website	Email	EnvPers	MaManager	EducManager	LnSize
Environment														
Export	1													
EnvCerti	0.115	1												
RD	0.0502	0.0883	1											
Net_Com	0.00666	0.0279	0.0398	1										
Net_Bank	0.0655	0.0469	0.00121	0.00334	1									
Net_Gov	0.0720	0.0536	−0.0257	0.138	0.124	1								
GovAss	0.0844	0.00989	0.0648	0.0307	0.137	0.0955	1							
Internet	0.329	0.266	0.0712	−0.00330	0.148	0.0982	0.0700	1						
Website	0.273	0.211	0.0513	−0.0101	0.0589	0.101	0.0654	0.465	1					
Email	0.315	0.198	0.0648	0.0174	0.105	0.0602	0.0329	0.667	0.449	1				
EnvPers	0.112	0.198	0.0218	0.0624	0.0466	0.0628	0.0228	0.259	0.187	0.167	1			
MaManager	−0.0264	−0.0400	0.0192	−0.00632	−0.0126	−0.0743	−0.101	−0.101	−0.139	−0.0962	−0.0436	1		
EducManager	0.173	0.207	0.0437	−0.0352	0.0360	0.0467	−0.00429	0.455	0.333	0.362	0.264	−0.0764	1	
LnSize	0.411	0.285	0.0578	−0.0222	0.194	0.0934	0.128	0.606	0.465	0.546	0.268	−0.0467	0.408	1

Source: Authors' calculations from the survey of SMEs in Vietnam (2011-2015).

Table A3. Determinants of Green Innovations.

VARIABLES	(1) Environment	(2) Environment	(3) Environment	(4) Environment	(5) Environment
Export	0.0614	−0.0288	−0.0271	−0.326	−0.301
	(0.180)	(0.185)	(0.184)	(0.233)	(0.359)
EnvCerti	1.890***	1.892***	1.893***	1.893***	1.895***
	(0.136)	(0.137)	(0.136)	(0.137)	(0.136)
RD	0.585*	0.0177	0.587***	0.0273	0.0330
	(0.299)	(0.0476)	(0.200)	(0.0522)	(0.0518)
Net_Com	−0.325*	−0.332*	−0.327*	−0.324*	−0.329*
	(0.190)	(0.190)	(0.189)	(0.190)	(0.188)
Net_Bank	0.241	0.248	0.248	0.241	0.250
	(0.170)	(0.170)	(0.170)	(0.168)	(0.172)
Net_Gov	0.120	0.129	0.111	0.100	0.119
	(0.135)	(0.136)	(0.134)	(0.134)	(0.135)
GovAss	0.0137	−0.00551	0.0154	0.00473	0.0207
	(0.152)	(0.152)	(0.150)	(0.152)	(0.149)
Internet	0.622***	0.616***	0.618***	0.617***	0.610***
	(0.165)	(0.164)	(0.164)	(0.165)	(0.165)
Website	0.282*	0.316*	0.296*	0.322*	0.301*
	(0.169)	(0.169)	(0.169)	(0.167)	(0.168)
Email	−0.293*	−0.303*	−0.294*	−0.295*	−0.302*
	(0.169)	(0.171)	(0.170)	(0.172)	(0.168)
EnvPers	0.314**	0.301**	0.307**	0.184	0.312**
	(0.128)	(0.129)	(0.128)	(0.141)	(0.128)
MaManager	0.335**	0.340**	0.339**	0.343**	0.279**
	(0.137)	(0.137)	(0.137)	(0.137)	(0.141)
EducManager	0.471***	0.514***	0.519***	0.535***	0.513***
	(0.140)	(0.138)	(0.137)	(0.138)	(0.138)
LnSize	0.213***	0.214***	0.212***	0.210***	0.219***
	(0.0700)	(0.0701)	(0.0698)	(0.0711)	(0.0707)
EnvPers*RD		2.033***			
		(0.566)			
MaMana*RD			−0.559***		
			(0.207)		
EnvPers*Export				0.772**	
				(0.361)	
MaManage*Export					0.406
					(0.383)
Observations	1,302	1,302	1,302	1,302	1,302
Pseudo R2	0.483	0.481	0.478	0.482	0.479

Robust standard errors in parentheses.
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.
Source: Authors' calculations from the survey of SMEs in Vietnam (2011-2015).

Table A4. Specific Forms of Environmental Treatments.

VARIABLES	(1) Airquality	(2) Noise	(3) Wastedisposal	(4) Waterpollution
Export	−0.0797	−0.209	−0.0860	0.134
	(0.179)	(0.241)	(0.187)	(0.216)
EnvCerti	0.229	0.187	0.310**	0.437***
	(0.151)	(0.171)	(0.142)	(0.160)
RD	0.177	0.628*	0.292	0.825**
	(0.359)	(0.331)	(0.340)	(0.382)
Net_Com	0.434*	0.322	0.157	0.0589
	(0.248)	(0.314)	(0.210)	(0.210)
Net_Bank	0.242	−0.111	−0.0841	−0.132
	(0.185)	(0.207)	(0.151)	(0.163)
Net_Gov	0.0512	0.217	0.249*	0.134
	(0.133)	(0.167)	(0.137)	(0.144)
GovAss	0.0996	0.0566	0.206	0.220
	(0.139)	(0.168)	(0.136)	(0.153)
Internet	0.125	0.276	0.0381	0.104
	(0.169)	(0.191)	(0.166)	(0.194)
Website	0.0296	−0.0425	0.171	0.189
	(0.151)	(0.201)	(0.146)	(0.188)
Email	−0.0300	−0.0428	0.333*	0.0760
	(0.172)	(0.200)	(0.187)	(0.215)
EnvPers	0.184	−0.0336	0.0964	0.253
	(0.131)	(0.160)	(0.134)	(0.155)
MaManager	0.173	0.0477	0.0133	0.0717
	(0.133)	(0.158)	(0.119)	(0.133)
EducManager	−0.119	−0.121	0.172	−0.134
	(0.139)	(0.171)	(0.133)	(0.151)
LnSize	0.299***	0.280***	−0.0250	−0.0393
	(0.0664)	(0.0825)	(0.0701)	(0.0919)
Observations	1,302	1,302	1,302	1,286
Pseudo R2	0.109	0.128	0.0677	0.121

Robust standard errors in parentheses.
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.
Source: Authors' calculations from the survey of SMEs in Vietnam (2011-2015).

Table A5. The Role of Women Executives: Different Proxy for R&D.

VARIABLES	(1) Environment	(2) Environment
Export	−0.0271	−0.0224
	(0.184)	(0.184)
EnvCerti	1.893***	1.888***
	(0.136)	(0.136)
RD	0.587***	0.283
	(0.200)	(0.378)
Net_Com	−0.327*	−0.337*
	(0.189)	(0.189)
Net_Bank	0.248	0.248
	(0.170)	(0.170)
Net_Gov	0.111	0.120
	(0.134)	(0.135)
GovAss	0.0154	−0.00114
	(0.150)	(0.151)
Internet	0.618***	0.611***
	(0.164)	(0.164)
Website	0.296*	0.291*
	(0.169)	(0.169)
Email	−0.294*	−0.296*
	(0.170)	(0.170)
EnvPers	0.307**	0.311**
	(0.128)	(0.128)
MaManager	0.339**	0.328**
	(0.137)	(0.137)
EducManager	0.519***	0.516***
	(0.137)	(0.138)
LnSize	0.212***	0.215***
	(0.0698)	(0.0701)
MaMana*RD	−0.559***	0.399
	(0.207)	(0.505)
Observations	1,302	1,302
Pseudo R2	0.478	0.479

Robust standard errors in parentheses.
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.
Note: In the model 1, R&D is the amount of asset invested in R&D, while we incorporate the dummy variable taking value 1 if the firm decides to invest in R&D in the model 2.
Source: Authors' calculations from the survey of SMEs in Vietnam (2011-2015).

Table A6. Estimation Results for Specific Sectors.

	Supplier-dominated sector					Scale-intensive sector			Science-based sector	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	Environment	Environment	Environment	Environment	Environment	Environment	Environment	Environment	Environment	Environment
Export	0.0499	−0.0436	−0.0365	−0.138	−0.132	0.553	−0.260	−0.900	0.259	−3.900***
	(0.222)	(0.231)	(0.229)	(0.279)	(0.406)	(0.360)	(0.570)	(0.559)	(0.604)	(0.552)
EnvCerti	1.717***	1.699***	1.706***	1.706***	1.705***	2.459***	2.432***	2.484***	2.816***	2.822***
	(0.169)	(0.170)	(0.169)	(0.170)	(0.169)	(0.298)	(0.285)	(0.299)	(0.400)	(0.396)
RD	0.0362	0.0249	0.602***	0.0354	0.0393	2.581	2.702	3.000	1.218***	1.278***
	(0.0533)	(0.0515)	(0.189)	(0.0538)	(0.0540)	(3.183)	(3.181)	(3.231)	(0.350)	(0.370)
Net_Com	−0.351	−0.359	−0.353	−0.352	−0.353	−0.166	−0.135	−0.219	−0.0767	−0.0984
	(0.238)	(0.240)	(0.237)	(0.237)	(0.236)	(0.375)	(0.391)	(0.372)	(0.450)	(0.451)
Net_Bank	0.207	0.220	0.219	0.216	0.222	0.774**	0.755**	0.792**	−0.479	−0.470
	(0.193)	(0.192)	(0.192)	(0.192)	(0.193)	(0.386)	(0.373)	(0.394)	(0.420)	(0.419)
Net_Gov	−0.0883	−0.0709	−0.0954	−0.0979	−0.0893	0.505	0.478	0.488	1.452***	1.445***
	(0.156)	(0.158)	(0.156)	(0.156)	(0.157)	(0.349)	(0.349)	(0.350)	(0.408)	(0.409)
GovAss	−0.000857	−0.0492	−0.0130	−0.00904	−0.00778	−0.220	−0.337	−0.251	0.0506	0.0710
	(0.182)	(0.186)	(0.183)	(0.183)	(0.181)	(0.311)	(0.319)	(0.311)	(0.460)	(0.464)
Internet	0.789***	0.768***	0.768***	0.764***	0.767***	0.407	0.436	0.360	0.503	0.501
	(0.206)	(0.206)	(0.206)	(0.206)	(0.207)	(0.303)	(0.305)	(0.303)	(0.509)	(0.511)
Website	0.333	0.391*	0.352	0.353	0.343	0.256	0.316	0.297	0.430	0.466
	(0.216)	(0.219)	(0.217)	(0.215)	(0.216)	(0.316)	(0.316)	(0.316)	(0.442)	(0.438)
Email	−0.589***	−0.609***	−0.586***	−0.570**	−0.585***	0.299	0.230	0.317	0.377	0.397
	(0.223)	(0.226)	(0.223)	(0.222)	(0.221)	(0.290)	(0.288)	(0.285)	(0.371)	(0.375)
EnvPers	0.234	0.208	0.220	0.168	0.226	0.513**	0.303	0.538**	0.555	0.527
	(0.157)	(0.160)	(0.159)	(0.176)	(0.158)	(0.244)	(0.265)	(0.246)	(0.365)	(0.363)
MaManager	0.149	0.138	0.140	0.138	0.110	0.671**	0.717**	0.575*	0.706*	0.626
	(0.155)	(0.155)	(0.154)	(0.153)	(0.164)	(0.297)	(0.305)	(0.300)	(0.416)	(0.419)
EducManager	0.467***	0.505***	0.515***	0.519***	0.510***	0.551**	0.555**	0.566**	0.624*	0.636*
	(0.178)	(0.178)	(0.177)	(0.176)	(0.177)	(0.249)	(0.250)	(0.250)	(0.369)	(0.364)
LnSize	0.219**	0.228***	0.224**	0.223**	0.229**	0.164	0.187	0.171	0.113	0.0880
	(0.0881)	(0.0886)	(0.0880)	(0.0883)	(0.0898)	(0.138)	(0.142)	(0.140)	(0.188)	(0.196)
EnvPers*RD		2.110***								
		(0.546)								
MaMana*RD			−0.568***							
			(0.198)							
EnvPers*Export				0.290			1.905**			
				(0.390)			(0.874)			
MaMana*Export					0.166			1.646**		4.391***
					(0.422)			(0.671)		(0.725)
Observations	877	877	877	877	877	377	377	377	278	278
Pseudo R2	0.471	0.473	0.469	0.469	0.469	0.541	0.558	0.547	0.639	0.642

Robust standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$; *$p < 0.1$.
Source: Authors' calculations from the survey of SMEs in Vietnam (2011-2015).