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Can green producers achieve strong profitability without engaging in high-risk activities?

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Abstract

Purpose – As environmental awareness becomes more widespread, the issue of making manufacturing more sustainable has gained increasing attention. The natural-resource-based view (NRBV) sets out to explain how firms can reduce their environmental footprint while simultaneously improving their financial performance. Drawing on the NRBV and entrepreneurial orientation (EO) literature, this study examines the relationship between pollution prevention, risk-taking and financial performance.

Design/methodology/approach – Data from 303 Swedish manufacturing firms were collected through a survey.

Findings – The findings reveals a positive relationship between pollution prevention and financial performance, and this relationship is found to be negatively moderated by risk-taking; that is, pollution prevention reduces the requisite for risk-taking in the achievement of financial performance.

Originality/value – This is the first study to explore how risk-taking moderates the relationship between a pollution prevention strategy and financial performance.

Keywords Pollution prevention, Natural resource-based view, Risk-taking, Financial performance

Paper type Research paper

Introduction

The question of whether investments in cleaner production can lead to improved financial performance has been intensively debated over the last decades (Aragón-Correa and Sharma, 2003; Song *et al.*, 2017; Zeng *et al.*, 2010). Drawing on the natural-resource-based view (NRBV) of the firm pollution prevention provides a theoretical framework for systematically analyzing this central issue (Hart, 1995; Russo and Fouts, 1997). Pollution prevention as an environmental strategy is predicted to improve a firm's financial performance by preventing waste and emissions from the production process (Hart and Dowell, 2011), thereby increasing operational efficiency and lowering costs (Nishitani *et al.*, 2011; Christmann, 2000; Hart, 1995). Even though pollution prevention has received a great deal of attention (Hart and Dowell, 2011; Graham and McAdam, 2016), the number of empirical studies that have explored the direct link between pollution prevention and financial performance is limited, and the results have been inconclusive. Hart and Ahuja (1996) and King and Lenox (2002) were among the first to explore this relationship, and both studies found strong support for the financial benefits of pollution prevention. However, more contemporary studies have shown contradictory results. Miroshnychenko *et al.* (2017) studied the impact of green practices on financial performance and concluded that pollution prevention (as a green practice) has a positive impact on financial performance. On the other hand, Mao *et al.* (2017) found that even though pollution-preventing activities improved a firm's environmental performance, they

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had a negative impact on the firm's financial performance. Other studies, including that of Graham and Potter (2015), have come to mixed conclusions. In the study by Graham and Potter, pollution prevention was divided into waste prevention and energy reduction, and the results showed that waste prevention had a positive effect on financial performance while energy reduction did not. The inconclusive results from previous studies highlight the importance of further investigating the potential financial benefits of implementing a pollution-prevention strategy.

A key managerial issue for green producers is how to manage risk (Silajdžić *et al.*, 2015; Ebrahimi and Mirbargkar, 2017; Ndubisi and Nair, 2009). Entrepreneurial orientation (EO) research has demonstrated that firms must be willing to take risks in order to realize their financial performance potential (Rauch *et al.*, 2009; Wiklund, 1999; Wiklund and Shepherd, 2005). However, according to Naldi *et al.* (2007), there may be circumstances in which the risk-performance relationship is offset. One such circumstance is when a firm experiences high demand for its products, for example due to a reputation for cleaner production processes. However, no study has yet explored whether and how risk-taking moderates the relationship between pollution prevention and the financial performance of a firm within the context of NRBV. Based on this discussion, the aim of this study is to examine the relationship between pollution prevention and financial performance, and to examine the effect of risk-taking on this relationship.

The rest of the article is structured as follows: Section 2 lays out the foundation for the NRBV and then develops the hypotheses. Section 3 describes the study's methodology, and Section 4 presents the results. Section 5 discusses the contribution of this paper in relation to previous research and how the findings from this study can be further explored. It also discusses managerial implications and limitations. Finally, Section 6 summarizes the conclusions from this study.

Theory and hypotheses development

NRBV was introduced by Hart (1995) in the mid-1990s as an extension of the resource-based view. The main contribution of NRBV is the formulation of environmental strategies that are predicted to enable firms to financially outperform their competitors while simultaneously lowering their environmental impact. Pollution prevention is the environmental strategy that has attracted the most scholarly interest (Hart and Dowell, 2011), and its aim is to improve firms' operational efficiency by reducing emissions and waste from their production processes (Hart, 1995; Menguc and Ozanne, 2005). Pollution prevention can have either a proactive or reactive nature depending on managements' approach (Christmann, 2000; Klassen and Whybark, 1999). If management chooses a reactive approach, the focus will be on compliance to environmental regulations and on controlling emissions by filtering effluents (Russo and Fouts, 1997; Graham and Potter, 2015). In this way, the original production process stays intact and management's focus is on end-of-the-pipe investments (Klassen and Whybark, 1999). If management chooses a proactive approach instead, the aim is to improve the efficiency of the production process by investing in new production assets with the ability to reduce inputs and prevent waste (Aragón-Correa and Sharma, 2003; Christmann, 2000). To succeed with a proactive pollution-prevention strategy, the firm needs to develop expertise in managing the operations of the new assets; it also needs to develop knowledge of new environmentally friendly production technologies (Russo and Fouts, 1997).

Over the last decades, NRBV has become an established research field, and cross-disciplinary studies have been conducted that stretch over a wide range of research fields. Studies that integrate NRBV with supply-chain management (Miemczyk *et al.*, 2016; Nishant *et al.*, 2016; Huo *et al.*, 2019), dynamic capabilities (Aragón-Correa and Sharma, 2003; Graham, 2018; Kabongo and Boiral, 2017), institutional theory (Li *et al.*, 2019; Prajogo *et al.*, 2012),

stakeholder theory (Schmidt *et al.*, 2017; Li *et al.*, 2016), strategic alliances (Norheim-Hansen, 2018) and absorptive capacity (Aboelmaged and Hashem, 2019) are examples of this. Even though the EO research field ought to be closely related to NRBV, since its central theme is the identification of drivers for financial performance (Wiklund, 1999; Miller, 1983), there is a scarcity of studies that explores the interaction between EO and NRBV. Menguc and Ozanne (2005) pioneered this endeavor by showing that entrepreneurship, in combination with CSR and commitment to the natural environment (as a higher order construct within NRBV), have a positive impact on firms' financial performance. However, Menguc and Ozanne (2005) did not include the risk-taking aspect of EO in their study. Based on this literature review, the present study is the first to integrate the risk-taking concept of EO with NRBV.

Pollution prevention and financial performance

To be able to implement a pollution-prevention strategy, a firm must be proactive and forward-looking, in that it takes the lead within the industry in the transition toward more sustainable manufacturing (Aragón-Correa and Sharma, 2003; Graham, 2018). According to Russo and Fouts (1997), a central feature of the implementation of a pollution-prevention strategy is the redesign of the production process. To redesign the production process, investments in new environmentally friendly production assets are often required. However, since most production assets can be bought on the open market, these assets cannot by themselves improve the firm's financial performance relative to that of the firm's competitors. Instead, it is through the firm's technical know-how that environmentally friendly production assets can be used to enhance the operational efficiency.

The implementation of a pollution-prevention strategy is an ongoing process in which continuous improvements are made in the production process through the firm's technical know-how (Menguc and Ozanne, 2005; Buysse and Verbeke, 2003). To be able to continuously improve the production process, innovativeness—such as openness to new ideas and the promotion of creativity (Brettel *et al.*, 2015)—must be an inherent characteristic of the organization (Hart, 1995; Klassen and Whybark, 1999). This is especially important within the R&D department, which constitutes the heart of an organization's innovative capacity. In fact, it is the creativity within the R&D department that establishes the boundaries for the efficiency improvements a pollution-prevention strategy can deliver. But the R&D department cannot work in isolation; it must collaborate with other departments. For example, to reduce the amount of raw material per produced unit or to minimize spillage in the production process, the R&D department must work in close collaboration with the production department (Agan *et al.*, 2013; Aragón-Correa *et al.*, 2008). In other cases, collaboration with the marketing department is central. Employees in the marketing department who possess technical expertise must be in close contact with customers to ensure that technical improvements have no unintended consequences that will hinder implementation.

Another important aspect of an environmentally efficient production processes is the reduction of energy usage (Agan *et al.*, 2013; Graham, 2018). Although energy consumption is mainly dependent on investments in new production assets with high energy efficiency, firms with strong technical know-how can achieve further reductions through technical advancements in the production process. Overall, the main purpose of the pollution-prevention strategy is to improve the efficiency of the firm's production process, which will result in lower costs (by reducing the usage of raw material, energy, and spillage) and thereby increase the firm's financial performance.

H1. The implementation of a pollution-prevention strategy will enhance the firm's financial performance.

The moderating role of risk-taking on the relationship between pollution prevention and financial performance

In this section, I will argue that firms that have successfully implemented a pollution-prevention strategy do not have to take the same amount of risk to achieve strong financial performance as firms that lack a focus on environmentally friendly production processes. It is well supported from empirical studies that risk-taking is necessary in order for a firm to realize its financial performance potential (Rauch *et al.*, 2009). However, taking on too much risk is associated with potential financial losses (Begley and Boyd, 1987; Kreiser and Davis, 2010), which makes it preferable to avoid risk-taking if possible (Miller and Friesen, 1978). According to some researchers, there are circumstances in which the risk-performance relationship can be offset (Naldi *et al.*, 2007). One such circumstance is likely to occur when a firm enjoys high demand for its products due to, for example, a reputation for environmentally friendly production (Nishitani *et al.*, 2011). In an era of high consumer awareness (Li *et al.*, 2019) and increased pressure on companies to make their business more sustainable (Lee, 2009; Yen and Yen, 2012), firms that can help to lower the environmental footprint of customers will experience high demand for their products. For firms in such an attractive market position, the risk-performance relationship can be offset, since they will not have to enter into more risky activities to generate high demand for their products. Instead, these firms can focus on low-risk activities such as further refining their production process and strengthening their current market position, while still enjoying a strong financial performance. However, most firms must engage in highly risky activities, such as entering new markets and/or developing new products (especially if these are based on a new technology) (Wiklund and Shepherd, 2005), in order to increase the demand for their products and realize the firm's financial performance potential (Lumpkin and Dess, 1996; Dess and Lumpkin, 2005). Thus, the second hypothesis states:

H2. Risk-taking will weaken the positive relationship between pollution prevention and the firm's financial performance.

Method

Sample and data collection

The data presented in this study was collected as part of a larger research project concerning the environmental impact of small manufacturing firms. The variables used in the present paper have not been used in any other studies within the frame of the research project. The data comes from Swedish manufacturing firms with 10–49 employees and a turnover below 10 million Euros (i.e., the European Union's definition of small firms). Since previous studies that have explored the link between pollution prevention and financial performance have used data from large firms (Mao *et al.*, 2017; Hart and Ahuja, 1996; Miroshnychenko *et al.*, 2017) or medium-sized and large firms (Graham and Potter, 2015), the data used in this study is unique within the context of the purpose of the study.

Firms in this study were identified through the database *Bisnode Infotorg Företag*, which includes all limited Swedish companies. Every study that explores constructs at the firm level faces the challenge of reaching a critical number of respondents. This is especially true for studies taking place in smaller countries that have a limited number of large and medium-sized companies. Based on this notion, it was decided to collect data from small firms, since these comprise more than 80% of the total number of firms with more than 10 employees in the Swedish context (Statistics Sweden). It was considered to be important to only collect data from the Swedish context (i.e., from a single country), since doing so would produce more uniform data and exclude potential contextual biases. Furthermore, the data was collected from six different manufacturing industries that are all characterized by having defined

production processes (e.g., rubber and plastic products and fabricated metal products), which is important for the purpose of this study.

Companies that were not relevant for this study, such as subsidiaries that are incorporated in large corporate groups and firms that have gone out of business, were removed. For the remaining companies, e-mail addresses were collected. A total of 2,188 companies were contacted by e-mail and asked to participate in an online survey. Two reminders were sent out in addition to the original e-mail. A total of 314 answers were received, but 11 were removed due to a lack of answers covering all variables examined in the present study. This resulted in 303 useable answers and a response rate of 13.8%. To analyze the potential non-response bias, the answers resulting from the first e-mail were compared with those resulting from the two reminders, and no significant differences concerning key variables were discovered.

Measures

An online survey with a seven-point Likert scale was used to collect all subjective measures, and the *Bisnode Infotorg Företag* database was used to collect the objective measures. The *Bisnode Infotorg Företag* includes information from several official Swedish sources, including the Swedish Companies Registration Office and the Swedish Tax Agency. The database also provides access to the annual reports of all limited Swedish companies.

Dependent variable. Profitability was used as the dependent variable, as it is a well-established measurement of financial performance (Hart and Ahuja, 1996; Russo and Fouts, 1997; Amores-Salvadó *et al.*, 2014). The scale used to measure profitability was a modified version of the scale developed by Ingram *et al.* (2019), which asks respondents to rate their performance over the last two years in relation to those of their competitors. The original scale by Ingram *et al.* includes both profitability (five items) and growth measures (two items). In the present study, only the profitability items were used, including overall profitability, profit margin, ROE, ROA, and cash flow. However, one of the original items was adjusted from "return on investment" to "return on equity." In addition, the time period over which the respondents were asked to estimate their profitability was extended from two to three years. The Cronbach's α for the dependent variable was 0.97.

An average score of the five items was calculated. Subjective measures of profitability were chosen before objective measures for two reasons: First, objective measures are affected by industry-related factors, and comparing firms from different industries without compensating for those factors will result in numbers that are not comparable (Covin and Slevin, 1989). Second, even if the financial data is correctly reported, it can be difficult to interpret. For example, operating losses are not always negative and can be a result of heavy investments and strong growth, especially in small firms (Covin and Slevin, 1989).

Independent variables. Pollution prevention was measured using the scale developed by Chen *et al.* (2006). The scale was slightly modified through the reformulation of language in order to clarify the essence of the questions, and one question was divided into two to make the content more explicit. In the original article by Chen *et al.* (2006), the first question includes the firm's work to reduce both hazardous substances and spillage from the production process. Since these are two different but equally important areas in a firm's green production processes, it was decided to divide them into separate questions. The remaining questions from Chen *et al.* (2006) were used in their original form. The Cronbach's α for pollution prevention was 0.90.

Risk-taking was measured using the scale developed by Miller (1983) and Covin and Slevin (1989). The scale was originally developed to measure EO at an aggregated level through the sub-concepts of risk-taking, innovativeness, and proactivity. This study only focuses on risk-taking, and since the scale by Miller and by Covin and Slevin is the most

established measurement of risk-taking (Rauch *et al.*, 2009), it was considered to be the most appropriate measurement of the construct. The Cronbach's α for this variable was 0.76.

Control variables. Three variables were controlled for in the present study: size, age, and industry. These variables have been found to affect SME performance (Rauch *et al.*, 2009) and have been used as control variables in many previous studies (Andersén, 2021; Wiklund and Shepherd, 2003, 2005). Firm size and age were transformed by square root in order to achieve normality. The point of registration was used as a measurement of a firm's age. To control for industry, dummy variables were used.

Analysis and results

Data analysis

Descriptive data is presented in Table 1 and includes mean, standard deviation and correlation between the variables. As is evident from the correlation matrix, the independent variables of theoretical interest (pollution prevention and risk-taking) were not correlated. However, two of the control variables, age and size, were significantly correlated. In order to ensure that the correlation between these variables had no effect on the regression models a separate analysis was conducted by excluding the age variable. The second analysis corresponded to the results from the original analysis showing that the correlation between the age and size control variables had no effect on the regression results and that multicollinearity was not an issue.

Confirmatory factor analysis (CFA) was used to evaluate construct validity. The results from the CFA are summarized in Table 2. The model fit values showed strong levels of incremental fit (CFI = 0.996, TLI = 0.995), parsimonious fit (AGFI = 0.943, x^2/df ratio = 1.228), and absolute fit (RMSEA = 0.027, SRMR = 0.036) (Hair *et al.*, 2006). Most importantly, the *p value* was not significant (0.112). The discriminant validity was satisfactory for all variables. The lowest average variance extracted (AVE) was higher than the correlation between any pair of the constructs (Fornell and Larcker, 1981) and the maximum shared variance (MSV) was lower than the AVE for all constructs (Hair *et al.*, 2010). The convergent validity was evaluated by examining the AVE and the composite reliability. The values for all constructs surpassed the thresholds of 0.5 and 0.7 (Hair *et al.*, 2010; Bagozzi and Yi, 2012), indicating high convergent validity.

Hypothesis testing. The regression analysis was conducted by means of a step-wise regression procedure. The first model only included control variables. None of the control variables were significantly correlated to the dependent variable. In the next step, Model 2, the independent variables were added. The first hypothesis (i.e., pollution prevention has a positive effect on financial performance) was tested by adding pollution prevention to the model. Table 3 shows that pollution prevention had a significant effect ($p < 0.001$) on financial performance, while the other independent variable, risk-taking, had no significant effect on the dependent variable. Adding the independent variables to Model 2 caused the adjusted R^2 value to increase by 6% ($p < 0.001$). Thus, the first hypothesis is supported. This result is in line with previous studies on pollution prevention and financial performance that have

	Mean	S.D.	1	2	3	4	5
1. Financial performance	4.62	1.38					
2. Age	5.16	1.59	0.04				
3. Size	1.38	0.29	0.04	0.98**			
4. Pollution prevention	5.29	1.31	0.25**	0.10	−0.1		
5. Risk-taking	4.05	1.06	0.80	−0.06	−0.04	0.07	

Table 1.
Descriptive statistics and correlation matrix

Item/factor	Factor loading	Cronbach's alpha	CR	AVE	MSV
Pollution prevention (a modified version of Chen *et al.* (2006) scale)		0.897	0.904	0.654	0.060
In our production process we emphasis the . . .					
. . . reduction of hazardous substances per produced unit	0.776				
. . . reduction of spillage per produced unit	0.884				
. . .					
. . . consumption of less energy per produced unit	0.829				
. . . reduction of raw material per produced unit	0.833				
. . . reusage of spillage, emissions/energy	0.711				
Risk-taking (Covin and Slevin, 1989)		0.764	0.767	0.524	0.006
Our firm usually prioritizes low-risk projects with normal and safe return . . . Our firm usually prioritizes high-risk projects with the possibility of high return	0.656				
Due to the nature of the market, step-wise and careful introduction of new projects is preferable . . . Due to the nature of the market, bold and offensive actions are needed to reach our goals	0.730				
When facing a choice with uncertain outcome, we usually use a wait-and-see approach to minimize the risk of wrong and costly decisions . . . When facing a choice with uncertain outcome, we usually act boldly to maximize the possibility of capturing opportunities	0.780				
Financial performance (a modified version of Ingram *et al.* (2019) scale)		0.970	0.969	0.861	0.060
In relation to your closest competitors . . .					
. . . how has the firm performed regarding profitability over the last three years	0.879				
. . . how has the firm performed regarding profit margin over the last three years?	0.943				
. . . how has the firm performed regarding ROE over the last three years?	0.986				
. . . how has the firm performed regarding ROA over the last three years?	0.943				
. . . how has the firm performed regarding cash flow over the last three years?	0.879				

Note(s): CR = Composite reliability
AVE = Average variance extracted
MSV = Maximum shared variance
All factor loadings, $p < 0.001$

Table 2.
Confirmatory factor analysis results

focused on large and medium-sized firms (see for example Miroshnychenko *et al.*, 2017; Hart and Ahuja, 1996). The final step was to include the interaction effect of pollution prevention and risk-taking on financial performance. The second hypothesis states that risk-taking negatively moderates the relationship between pollution prevention and financial performance; this hypothesis was confirmed by Model 3. The interaction term had a significant effect ($p < 0.05$) on the dependent variable. Model selection analysis using the Akaike criterion (Akaike, 1974) was used, and Model 3 was confirmed to be the best model.

The nature of the interaction effect is illustrated in Figure 1. As shown in this figure, firms that have not implemented a pollution-prevention strategy must take on a substantial amount of risk to reach their financial performance potential. The model also illustrates that

	Model 1 (Controls)	Model 2 (Independent)	Model 3 (Moderation)
Constant	4.60***	4.61***	4.63***
Age	0.01	−0.5	−0.18
Size	0.05	0.45	0.24
Industry 20 (n = 13)	−0.10	−0.12	−0.11
Industry 22 (n = 39)	0.30	0.14	0.11
Industry 23 (n = 24)	0.01	−0.05	−0.06
Industry 24 (n = 13)	−0.23	−0.14	−0.11
Industry 28 (n = 65)	−0.01	0.06	0.01
Pollution prevention		0.33***	0.34***
Risk-taking		0.08	0.9
Pollution prevention x Risk-taking			−0.17*
F	0.35	2.39*	2.64**
R^2	0.01	0.07	0.08
Adjusted R^2	−0.02	0.04	0.05
Δ R^2	0.01***	0.06***	0.01*
Akaike Information Criterion	206.98	192.04	189.33

Note(s): Unstandardized coefficients are reported
Industry 25 (n = 149) not included as a dummy
*p < 0.05; **p < 0.01; ***p < 0.001

Table 3.
Regression models

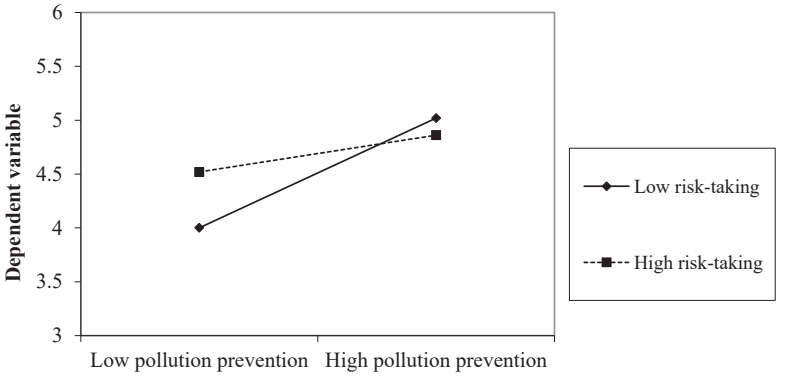

Figure 1.
The interaction effect of pollution prevention and risk-taking on financial performance

the risk-performance relationship is offset for firms that have successfully implemented a pollution-prevention strategy. For firms that have implemented a pollution-prevention strategy, risk-taking is not a necessity to achieve strong financial performance. In fact, it might be more beneficial for these firms to be risk-averse and not to enter into risky activities.

Discussion and conclusions

The question of whether it pays to be green is still under strong debate, and this study adds to the sustainability puzzle by providing evidence that cleaner production can lead to improved financial performance. According to NRBV, pollution prevention is one of the main strategies that can be used to enhance a firm's financial performance while simultaneously allowing the firm to take environmental concerns into consideration (Hart, 1995). The results from this study are in line with those from several other pollution-prevention studies (Miroshnychenko *et al.*, 2017; Hart and Ahuja, 1996; King and Lenox, 2002) but add nuance to the conclusion of

those studies, since this work focuses on small manufacturing firms. An important contribution from this study is that the results indicate that size may not have a role to play in the pollution-prevention strategy; that is, efficiency improvements that can be achieved through pollution prevention are independent of firm size.

Most of the studies, including this one, that have found support for the pollution-prevention/financial performance link have been conducted in Western countries (the US, the EU, Canada, and Australia). In contrast Mao *et al.* (2017) used data from Chinese manufacturing firms and did not find support for this link. Since the competitive context differs between Western countries and China, there might be contextual differences that influence the relationship between pollution prevention and financial performance. Whether contextual differences influence the pollution-prevention/financial performance relationship and how this influence might occur are questions that remain to be answered, and more studies based on data from various countries are needed to explore this incidence angle.

Perhaps the most important contribution from this study is that it is the first NRBV study to address the question of risk-taking. The results show that firms with cleaner production that invest in preventing pollution can achieve high profitability without taking on the same amount of risk as firms with less environmentally friendly production processes. This is an important contribution to the theoretical development of NRBV in the sense that it broadens our understanding of the potential benefits of investments in cleaner production. However, this is only the first piece of the sustainability puzzle regarding the relationship between pollution prevention, risk-taking, and financial performance. Previously, risk-taking has been viewed as a necessity to reach a firm's financial performance potential, albeit with the disadvantage of potential financial losses. The insights from this study change this notion and provide empirical evidence for circumstances in which the risk-performance relationship is offset. In an era of increased sustainability awareness, the demand for more sustainable manufacturing is growing. This provides an opportunity for manufacturing firms to be part of the transition into a more sustainable society while simultaneously improving their financial position. Manufacturing firms can engage in less risky activities while improving their financial performance. Although this situation creates a great opportunity, the potential upside will vary depending on industry growth. For manufacturing firms operating in stable industries, growth opportunities can be difficult to find and are often associated with risk-taking (Wiklund and Shepherd, 2005; Naldi *et al.*, 2007). Therefore, in low-growth manufacturing industries, most firms will not be able to take on high levels of risk even if they want to, since opportunities to introduce new products or enter new markets, for example, are limited. However, investments in cleaner production will still be beneficial for such firms since the implementation of a pollution-prevention strategy will lead to improved financial performance even in low-risk environments (Model 2). For manufacturing firms operating in medium-growth industries, the results from this study provide the most interesting insights. These firms will be able to use a low-risk strategy—meaning that they only enter new markets and introduce new products in the segments with the highest profitability potential, and can stay out of the riskiest market segments. To selectively be able to choose which market segments to enter (and not be forced to enter all growth segments) will lower a firm's risk approach while simultaneously ensuring high profitability. Lastly, for firms operating in high-growth industries, investment in cleaner production will have the same effect as for firms operating in low-growth industries. In industries with high growth, firms must take on risk in order to be successful and grow with the market. The argument for these firms to invest in cleaner production is the same as that for firms operating in low-growth industries: Investments in cleaner production provide, in and of themselves, an opportunity for enhanced financial performance.

Managerial implications

Societal awareness is growing about the importance of shifting all economic sectors in a more sustainable direction. The external pressure on manufacturing firm managers to take on more environmental responsibility is increasing. Research on cleaner production has an important role to play in guiding managers in this green transition. However, some of the concepts being proposed, such as natural environmental orientation (Menguc and Ozanne, 2005) and environmental management (Armas-Cruz, 2011), are abstract and do not always succeed in guiding managerial actions. The specific measurement of investments in cleaner production (through the implementation of a pollution-prevention strategy) used in this study can provide more concrete guidance to managers and will probably be easier for them to apply. Thus, the results from this study provides guidance on how managers can take steps to make their firms' manufacturing processes more sustainable.

Managers are constantly weighting the pros and cons of different alternatives, and every alternative comes with a certain degree of risk. Risk-taking is constantly on managers' minds; thus, by clarifying the role of risk-taking in certain investment decisions, scholars can provide much-needed directions for managers. This is especially true for managers that are striving to make their firms' production processes more sustainable.

Limitations and avenues for future research

This study also has some limitations. First, the data only covers small manufacturing firms. Since this study is the first to explore the interaction effect of risk-taking on the pollution-prevention/financial performance relationship, the results from this study may not apply to larger firms. It is therefore important for future studies to test this relationship on medium-sized and large firms in order to determine whether the results from this study are generalizable to manufacturing firms of all sizes. Second, the data in this study was gathered from a single country in Northern Europe. Many of the studies that have explored the financial effects of pollution prevention are conducted in Western countries, and the study by Mao *et al.* (2017) indicates that these results may not be attributable to other parts of the world. Therefore, more studies are needed on both the relationship between pollution prevention and financial performance and the interaction effect of risk-taking on this relationship, in order to explore the role of the context in which firms operate.

To conclude, this study has shown that pollution prevention leads to improved financial performance for small manufacturing firms. It has also explored the role of risk-taking on this relationship, which is a significant contribution to the NRBV literature. Investments in cleaner production can allow firms to take on less risk while simultaneously realizing their financial performance potential. These results may have important consequences for the transition into more sustainable manufacturing, in that they provide additional arguments for the financial benefits of "going green".

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