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Linking firms' green mode and process innovations: Central and Eastern European region case

Viktor Prokop, Jan Stejskal, Wolfgang Gerstlberger, David Zapletal, Do Thi Thanh Nhan

Abstract

This paper focuses on the hitherto less explored issue regarding the nature of the relationship between firms' green mode (including setting environmental targets, monitoring environmental burden, and adopting measures against environmental burden) and the production of process innovations. For these purposes, we focus on the countries of Central and Eastern Europe, which, together with their eastern neighbors, have historically represented the main polluters of the European environment. By using the World Bank Enterprise Survey and data from 3,299 firms in the Czech Republic, Estonia, Latvia, Lithuania, Poland, and Slovakia and the binary logistic regression, we provide evidence that a firm's green mode expressed, for example, by its monitoring of energy consumption or adoption of measures of environmental burden, can significantly trigger its introduction of process innovations. Moreover, we show that a firm's membership in firm groups increases its chances to introduce process innovations. In contrast, we show that firm age does not play a role in our analyses. Our results contribute to the innovation and sustainability literature, especially to the ongoing discussion regarding the innovation and environmental performance of Central and Eastern European countries. In addition, we note several practical implications of our research.

Keywords: *Process innovation, environmental behavior, green mode, Central and Eastern Europe*

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1 INTRODUCTION

As the market changes unexpectedly, resulting in an unstable business environment, firms are constantly pushed to seek new sources of competitive advantage (Chesbrough, 2010). Firms' environmental behavior and CSR practices are seen as one of the fundamental elements of competitive advantage in this regard, even when these firms offer worse products (lower quality, but environmentally friendly) than their competitors (Liu et al., 2012; Horbach et al., 2023). In addition to such competition, various stakeholders, such as policymakers (Hojnik et al., 2022) and customers (Zhu & Geng, 2013), force firms to be environmentally friendly. The so-called "moral legitimacy" forces (Paulraj, 2009), expressed by owner-managers' personal values (Granly & Welo, 2014), are another driving force pushing firms toward environmental behavior and the implication of sustainability in their business models. A list of these forces leading to firms' eco-innovation and environmental behaviors can be found in the studies of Horbach (2008) and Hojnik and Ruzzier (2016).

According to Horbach et al. (2023), firms can accept environmental challenge increases if their managers are able to combine efficient production and quality with the environmental requirements of the market, customers, and society. Moreover, firms must find synergies among their resources to effectively create their environmental outputs, whereas firms' activities

resulting in green innovation and sustainable development do not arise by chance. Sustainable managers, leaders, and entrepreneurs, as well as their knowledge and skills, have been seen as key players influencing sustainable development and substantially shaping markets and society (Prokop et al., 2018; Prokop et al., 2023; Schaltegger & Wagner, 2011). These players decide which values are of strategic importance for a firm and put them at the core of their strategies and (sustainable) business models (Rauter et al., 2017). Jakobsen and Clausen (2016) also confirmed that firms' managers play a crucial position in the process of transformation toward high sustainability, which is helped by their introduction of the so-called green (environmental) mode.

Against this backdrop, there is no doubt that firms must combine several resources and objectives during their environmental activities, which is one of managers' key roles. Starting with a general view of firms' resources, a firm's resources and capabilities represent the main source of competitive advantage, as proposed by the resource-based view (RBV). Considering the environment, there is a growing importance of the natural resource-based view (NRBV), which represents an extension of RBV and includes natural resources (so-called ubiquitous raw materials) and opportunities resulting from the geographical location. Moreover, NRBV emphasizes firms' competitive advantage because of their sustainable management and the elimination of environmental pollution (Aboelmaged, 2018).

However, in addition to these findings, there are still questions that have not been answered that relate to corporate and resource management as well as to the issues of firms' innovation performance, thereby increasing their competitive advantage. Prokop et al. (2022) looked at the so-called reverse relationship between innovation and firms' green behavior and concluded that the following interesting question had not yet been fully answered: Is there an inverse relationship between the environmental mode of firms and their ability to produce innovations? Jakobsen and Clausen (2016) provided evidence from the results of their study that companies accept an ecological regime within their production processes in accordance with the business goals and target orientation of the company (both directly and indirectly). Shu et al. (2016) confirmed that green management influences product innovation in China. Moreover, Zhou et al. (2019) revealed two forms of environmental acceptance—corporate innovations create space for green management, and customer pressure creates demands for changes in corporate strategies and corporate culture in the direction of green innovations—because firms' environmental orientation stimulates them to focus on environmental issues and the demands of various stakeholders, thereby growing information flows and expanding firms' R&D that spur innovation (Vokoun & Dvoulety, 2022).

Following this line of argument, this paper introduces evidence that a relationship exists between firms' "green mode" and their ability to produce process innovations. This study builds on the previous findings of Prokop et al. (2022), who showed that this two-way (reverse) relationship can exist in Central and Eastern European (CEE) countries, to specifically investigate the relationship between environmental management and the production of innovations. Scholars have concluded that green orientation works as a two-way process and is implemented in the practice of different countries at different intensities. Such a conclusion warrants rigorous attention, as these results suggest that these countries are still struggling with their historical legacies of a lower perceived need to be "eco-friendly." The study shows that politicians lack sufficient information and precise recommendations to be able to create high-quality political strategic documents, such as an industrial concept for a given region (Halásková & Halásková, 2020; Mikušová Meričková et al., 2020; Odei & Stejskal, 2018; Prokop et al., 2023). However, such an analysis is needed precisely in this area, because, thus far, attention has focused on the western and northern neighbors rather than the CEE countries. Therefore, following the arguments of Mondéjar-Jiménez et al. (2015), which confirmed the

assumption that firms' eco-innovation activities are positively related to innovation and—if firms are trying to produce innovation—they will presumably emphasize socially responsible behavior, we test whether firms' green mode influences their process innovations (the so-called reverse relationship). For these purposes, we conduct a case study on six CEE countries: the Czech Republic, Estonia, Latvia, Lithuania, Poland, and Slovakia.

The rest of the paper is structured as follows. In Section 2, we present our research sample, data, and method. Section 3 is devoted to the presentation of our findings. Finally, we conclude our paper in Section 4.

2 BACKGROUND THEORIES AND FIRMS' COMPETITIVE ADVANTAGE

In this study, we build our arguments on the foundations of two generally recognized concepts associated with the innovativeness and competitive advantage of firms: resource-based view (RBV) and natural resource-based view (NRBV). We show the link between these concepts and corporate competitiveness, with an emphasis on companies' green behavior.

Wernerfelt (1984) proposed and developed the RBV, which explains a business's competitive advantage when firms effectively use all their resources. More specifically, firms are expected to be successful if they use the most appropriate potential resources and combine resources more effectively than their competitors. RBV focuses on analyzing an enterprise's internal resources and the connection between these internal resources and the external environment (Barney, 1991). According to the RBV, competitive advantage is related to developing and exploiting an enterprise's core resources and capabilities, which develop innovations that enable firms to improve their performance (Wernerfelt, 1995). RBV's core focus is to determine why some businesses can gain a competitive advantage compared to companies in the same industry by analyzing the internal resources of the businesses when they focus more on technologies and innovation (Barney, 1986; Wernerfelt, 1984). The RBV has been applied by Dierickx and Cool (1989), Barney (1991), Lee and Min (2015), and Portillo-Tar et al. (2018), whose studies derived hypotheses across many areas of research in strategic management and other disciplines. As a result, the RBV has become a popular perspective used in the field in recent decades.

Summarizing insights gleaned from the RBV theory thus far, a number of various factors influence firms' innovative processes, including both internal and external. Several authors (e.g., Lee & Min, 2015; Portillo-Tar et al., 2018) have stated that the RBV represents an important framework for studies analyzing the material inputs and production potential crucial for eco-innovation. In addition, synergies in firms' resources yield more benefits for firms (Zhang & Walton, 2017). However, according to Lee and Min (2015), this view has been criticized due to the limited ability to explain how material inputs help create a better product than the competition in a turbulent economic environment and an international base. Moreover, the RBV considers many potential resources and organizations' competitive advantage, but does not mention the relationship between the organization and the natural environment.

In response to the RBV perspective, Hart (1995) proposed the NRBV to explain the link between organizational capabilities and the natural environment. The NRBV theory suggests that firms prefer environmental strategies such as pollution reduction, green products, and sustainable development to create a competitive advantage (Hart & Dowell, 2011). Based on this theory, businesses increase the influence of the natural environment, and their environmental performance can produce an advantage that competitors cannot imitate (Rehman et al., 2021). From the NRBV perspective, business strategy and sources of competitive advantages are based on the ability of company management to behave environmentally and sustainably—all in the context of the economy (Vrabcova et al., 2022; Yusoff et al., 2019).

According to You et al. (2019, pp. 1073–1074), the NRBV includes "three key strategic capabilities: pollution prevention, product stewardship, and sustainable development." As the current study considers firms' green mode, including such activities as setting environmental targets, monitoring environmental burden, and adopting measures of environmental burden, we conclude that the chosen theoretical concepts are suitable.

Summarizing the main basis of these concepts and their relation to increasing firms' competitive advantage, Horbach et al. (2023, p. 2870) concluded that "the effective application and allocation of resources (including all assets, capabilities, organisational processes, knowledge, firm attributes, information and other resources) is the key to the transformation of a short-run competitive advantage into a sustained competitive advantage" and that "there is a need to incorporate the issue of sustainability into firms' activities, even though this activity may not immediately lead to financial earnings." Meanwhile, You et al. (2019, p. 1074) stated that the "NRBV theory encourages firms to take into account the environmental impacts of their production and operation processes and suggests that firms' proactive response to environmental pressure will generate more benefits." Although such practices give companies a competitive advantage, from the opposite point of view, competition is also one of the main triggers of companies' green mode and their eco-innovation, as evidenced by Cai and Li (2018). Yet, even this argument cannot be taken as final because the regional context matters in this case. Horbach et al. (2023), for example, showed that the effect of competition on the green mode of companies varies and can even be negative. As these findings demonstrate, the relationship among firms' greenness, the use of their resources, and increasing their competitive advantage still does not yield clear results, but instead highlights the need for additional research.

3 CEE REGION, DATA SOURCES, AND RESEARCH METHOD

3.1 Research sample and explained variables

In this study, we employ data obtained from the World Bank's Enterprise Survey 2019. The survey is publicly available and covers many topics, such as firms' environment (covering access to finance, corruption, competition, and other measures); it publishes primary data on firms in the manufacturing and service sectors. A standardized research methodology is applied, which works with commonly used tools so that the result is uniform and enables international comparison. It also includes the so-called "green economy mode," offering data on environment-related topics.

For the explained variable, firms' process innovation (if the firm places a new or improved process on the market, including methods of manufacturing products or offering services; logistics, delivery, or distribution methods for inputs, products, or services; and supporting activities for processes) was chosen. This variable is binary (1 = yes, 0 = otherwise). In total, we analyzed 3,299 firms (the percentage of representation of firms in the total sample is given for each country in parentheses) from the Czech Republic (14.79), Estonia (10.88), Latvia (10.85), Lithuania (10.82), Poland (39.75), and Slovakia (12.91), covering the CEE countries. Compared to its richer western neighbors, this specific region (in terms of "green performance and behavior") has often been overlooked by scientists in the past, and currently we see growing calls for analyses of the CEE territory (Jové-Llopis & Segarra-Blasco, 2020; Prokop et al., 2023). Generally speaking, these countries are dependent on external knowledge and information sources, such as competitors and external R&D, and "show very high levels of energy intensity … indicating a great need or even potential for renewable energies in the future" (Horbach, 2016, p. 3). Yet, previous evaluations of the environmental performance of CEE firms and countries, as well as the overall environmental awareness in society,

predominantly compared them with western states and considered indicators compiled in advanced European economies, which resulted in worse performance for CEE territories (Bosna, 2022; Jehlička & Jacobsson, 2021).

From the perspective of innovativeness within the CEE territory, most CEE countries have survived in the average range for a long time, yet still below the average of European assessments. For example, on the European Innovation Scoreboard (see, for example, Onea, 2020, for more details), CEE states fall between emerging and moderate innovators. As for environmental performance (e.g., in the form of eco-innovation) as well as general innovation, CEE states are more dependent on external technologies and knowledge than on their own ability to create knowledge inputs (Stojčić, 2021). Summarizing these arguments, we recognize a research gap and the need for further analysis of the relationship between CEE firms' green behavior and innovation.

3.2 Explanatory variables

In this study, we employed the research process suggested by Prokop et al. (2022), using three groups of explanatory variables: (i) setting environmental targets (Tar); (ii) monitoring environmental burden (Mon); and (iii) adopting measures of environmental burden (Mea). All explanatory variables representing selected groups are listed in Table 1. Moreover, consistent with Jiang et al. (2018), our research also uses control variables to verify the results. The following were selected from the cited studies: firm age, industry sector, and membership in a firm group (these variables are not shown in Table 1). For firm age, Huergo and Jaumandreu (2004) confirmed that firms' innovativeness changes with firm age; they found that older firms are rather less innovative in terms of process innovations. Next, for different industry sectors, Banerjee et al. (2023) confirmed differences between sectors, such as in competition intensity. Finally, Hashi and Stojčić (2013) confirmed the significance of firms' participation in groups, such as by increasing their productivity, including in CEE countries.

Table 1. Explanatory variables. Source: Prokop et al. (2022) and The World Bank Enterprise Survey (2023)

Group	**Variable**	**Description**
Setting environmental targets (Tar)	Energy consumption	Over the last three years, did this establishment have targets for energy consumption?
	CO_2 emissions	Over the last three years, did this establishment have targets for CO_2 emissions?
	Other pollution emissions	Over the last three years, did this establishment have targets for pollution emissions other than CO_2?
Monitoring environmental burden (Mon)	Energy consumption	Over the last three years, did this establishment monitor its energy consumption?
	Water usage	Over the last three years, did this establishment monitor its water usage?
	CO_2 emissions	Over the last three years, did this establishment monitor its CO_2 emissions?
	Other pollution emissions	Over the last three years, did this establishment monitor its emissions of pollutants other than CO2?

Adopting measures of environmental burden (Mea)	Heating and cooling improvements	Over the last three years, did this establishment adopt any of the following measures?
	More climate-friendly energy generation on site	
	Machinery and equipment upgrades	
	Energy management	
	Waste minimization, recycling, and waste management	
	Air pollution control measures	
	Water management	
	Upgrades of vehicles	
	Improvements to lighting systems	
	Other pollution control measures	

This research considered categorical explanatory variables; therefore, each parameter β_j (see Section 2.3) is represented by q-1 estimated parameters, where q represents the number of categories of corresponding explanatory variables. For this reason, it was necessary to define a reference category. For dichotomous variables, the value 0 is used (i.e., the company does not use "green mode"). Similarly, for company group membership, 0 indicates that the company is not a member of the company group while, for firm group membership, the reference category means non-membership. For the rest of the control variables, the reference categories are as follows: manufacturing (sector variable), less than 10 years (firm age variable), and the Czech Republic (country variable).

3.3 Model description

To understand the effects of the analyzed variables on our dependent one, the binary logistic regression model that is commonly used for such types of analyses (see Ferreira et al., 2019; Lefebvre et al., 2015; and Prokop et al., 2021) is used.

The fundamental equation of binary logistic model is (Agresti, 2002):

$$\ln \frac{\pi_i}{1-\pi_i} = \beta_0 + \sum_{j=1}^{p} \beta_j x_{ij}. \quad (1)$$

The expression on the left side of Eq. (1) is often called logit, and $\pi_i = \text{Prob}[Y_i = 1|\mathbf{x}_i]$denotes the probability that for the i-th individual and given values of explanatory variables $X_1, \ldots, X_p$, the explained variable Y is equal to 1. According to Eq. (1), probability π_i is defined as:

$$\pi_i = \frac{\exp\left(\beta_0 + \sum_{j=1}^{p} \beta_j x_{ij}\right)}{1 + \exp\left(\beta_0 + \sum_{j=1}^{p} \beta_j x_{ij}\right)}. \quad (2)$$

An odds ratio OR is used to interpret the influence of the k-th explanatory variable X_k on a dependent variable Y, given by:

$$OR = \frac{\left(\frac{\text{Prob}[Y=1|X_k=1,X_1,\ldots,X_{k-1},X_{k+1},\ldots,X_p]}{\text{Prob}[Y=0|X_k=1,X_1,\ldots,X_{k-1},X_{k+1},\ldots,X_p]}\right)}{\left(\frac{\text{Prob}[Y=1|X_k=0,X_1,\ldots,X_{k-1},X_{k+1},\ldots,X_p]}{\text{Prob}[Y=0|X_k=0,X_1,\ldots,X_{k-1},X_{k+1},\ldots,X_p]}\right)} = \exp(\beta_k).$$

According to Prokop et al. (2022, p. 8), "we assume that the explanatory variable X_k is dichotomous and the other $p-1$ explanatory variables may or may not be dichotomous. Therefore, the value of $\exp(\hat{\beta}_k)$ is the estimated odds ratio OR between Y and X_k when the values of the other $p-1$ explanatory variables are fixed."

4 EXPERIMENTAL RESULTS

The research model works with all variables introduced thus far. All interactions between the explanatory green mode and control variables were also included in the research. A group of input variables was then selected by reducing the full model (with all explanatory variables) in a stepwise fashion based on the Akaike information criterion (AIC). The resulting model consisted of 9 main effects (variables), 6 explanatory and 3 control variables (without firm age, denoting that firm age does not significantly influence our output variable), and 2 interaction variables.

Table 2. Experimental results for process innovations. Source: own research

Variable	Var. level	Coeff.	OR	Lower CI	Upper CI	p-value	Sig.
(Intercept)		-2,399	0,090	0,053	0,148	0.000	***
Mon: Energy consumption	1	0,512	1,669	1,293	2,165	0.000	***
Mea: More climate-friendly energy generation on site	1	-0,517	0,596	0,250	1,306	0,214	
Mea: Machinery and equip. upgrade	1	0,827	2,287	1,410	3,810	0,001	**
Mea: Waste minimization, recycling and waste management	1	0,274	1,316	1,049	1,651	0,017	*
Mea: Water management	1	0,274	1,315	1,017	1,696	0,035	*
Mea: Upgrades of vehicles	1	0,309	1,362	1,088	1,706	0,007	**
Membership	1	0,564	1,758	1,422	2,172	0.000	***
Sector	Retail	-0,515	0,597	0,438	0,806	0,000	***
Sector	Other services	-0,389	0,677	0,530	0,863	0,002	**
Country	Estonia	-0,126	0,881	0,413	1,799	0,733	
Country	Latvia	0,332	1,393	0,702	2,721	0,334	
Country	Lithuania	0,556	1,743	0,988	3,111	0,056	.

Country	Poland	-0,834	0,434	0,246	0,772	0,004	**
Country	Slovakia	-0,688	0,502	0,226	1,051	0,076	.
Mea: More climate-friendly energy generation on site * Country	1: Estonia	1,2	3,320	1,133	10,153	0,031	*
Mea: More climate-friendly energy generation on site * Country	1: Latvia	-0,157	0,854	0,257	2,916	0,798	
Mea: More climate-friendly energy generation on site * Country	1: Lithuania	0,855	2,352	0,765	7,444	0,138	
Mea: More climate-friendly energy generation on site * Country	1: Poland	0,394	1,483	0,551	4,149	0,440	
Mea: More climate-friendly energy generation on site * Country	1: Slovakia	-0,352	0,702	0,219	2,249	0,549	
Mea: Machinery and equipment upgrades * Country	1: Estonia	-0,275	0,759	0,336	1,764	0,512	
Mea: Machinery and equipment upgrades * Country	1: Latvia	0,908	2,481	1,163	5,370	0,019	*
Mea: Machinery and equipment upgrades * Country	1: Lithuania	-0,750	0,472	0,223	0,983	0,046	*
Mea: Machinery and equipment upgrades * Country	1: Poland	-0,322	0,724	0,372	1,392	0,335	
Mea: Machinery and equipment upgrades * Country	1: Slovakia	-0,414	0,660	0,270	1,665	0,368	

The results in Table 2 show that the following green mode variables are important in triggering firms' process innovations: Mon: Energy consumption; Mea: Machinery and equipment upgrades; Mea: Water management; Mea: More climate-friendly energy generation on site; Mea: Waste minimization, recycling and waste management; and Mea: Upgrades of vehicles. The variables related to setting environmental targets were dropped from the model. Due to the small number of firms that set CO_2 emission targets, the statistically significant effect of the logistic regression was not confirmed. However, the back-side effect of the research is the finding that there is a considerable number of CEE-based companies that implement process innovations (Figure 1) in accordance with their environmentally oriented goals. The results document that this happens when setting targets for energy consumption and CO_2 emissions, which positively affects innovation processes.

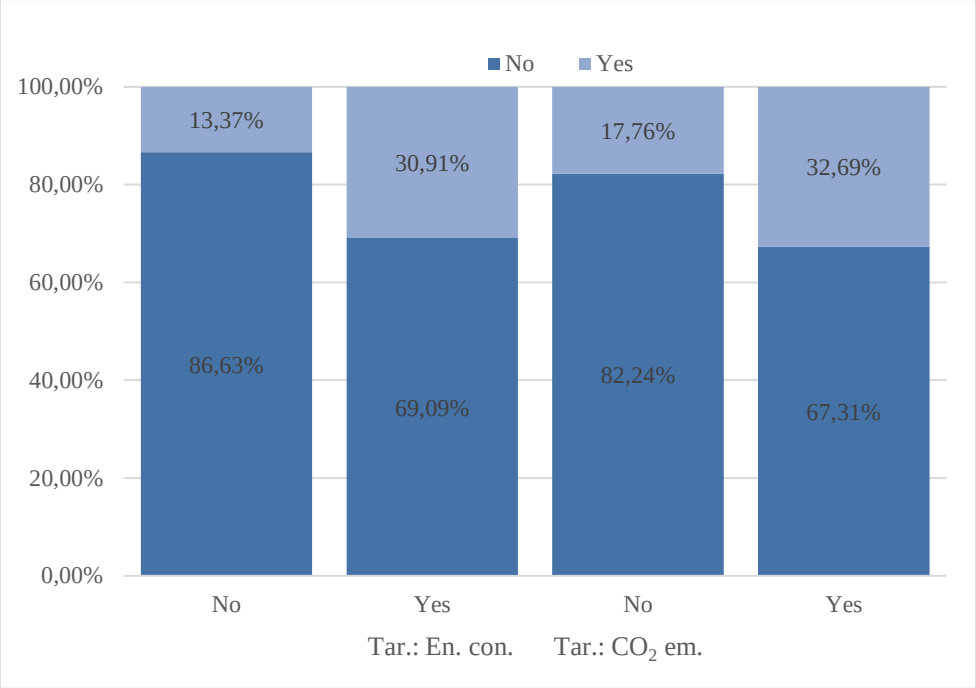

Figure 1. Overview of firms moving toward process innovations that accept the green mode.
Source: own research

Comparing the performance of the selected countries, our results show that Poland tends to have the lowest chances for introducing process innovations (compared to the other examined countries, except Slovakia). Meanwhile, in the Czech Republic, the chance of introducing process innovations is 2.3 times greater than in Poland; in Lithuania, it is 4 times higher. Lithuania and Latvia showed the highest chances of introducing process innovations within the analyzed firms.

Based on the results of the interaction of the country variable with the variables indicating more climate-friendly energy generation on site and machinery and equipment upgrades, we found that firms that adapt more climate-friendly energy generation on site, compared to the least innovative Poland, have the greatest chances of implementing process innovations in Lithuania and Estonia. However, for Slovak companies, this chance is already significantly lower than companies in Poland. For firms that adapt machinery and equipment upgrades, there is a fundamental modification of the chance for process innovation, especially when comparing Poland and Latvia: Latvian firms have a 10 times greater chance of process innovation than Polish ones.

A specific and interesting influence of the selected variables on the ability to create process innovations is presented in Figure 2. Based on the results, firm management implements steps to increase the number of process innovations; consequently, their ratio in the CEE region also increases.

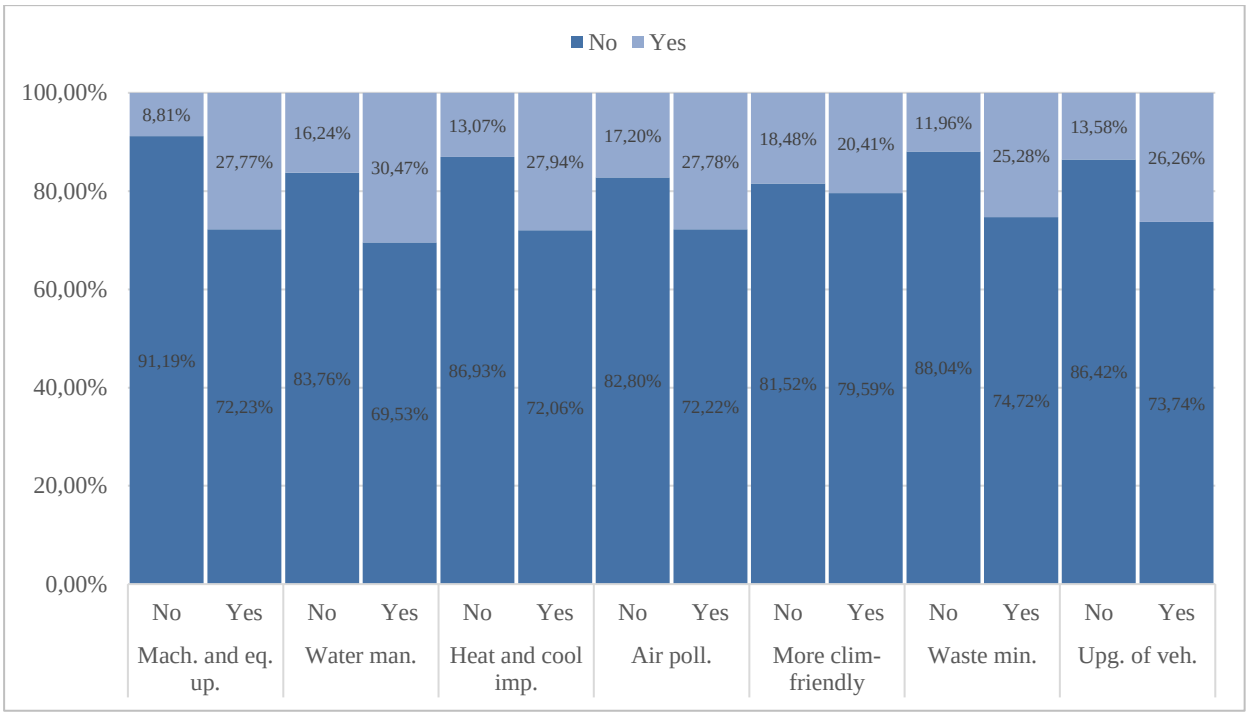

Figure 2. Overview of firms moving toward process innovations and adopted managerial decisions. Source: own research

5 DISCUSSION

This study contributes to the recently emerging literature on green process innovations with new empirical findings from CEE countries—specifically, the Czech Republic, Estonia, Latvia, Lithuania, Poland, and Slovakia. Such states are often characterized as "catching up" countries in terms of sustainable transformation in general and green (process) innovations in particular (e.g., Prokop et al., 2023). The presented empirical results are novel and interesting in terms of both certain independent and control variables. Although our tested and proved-significant independent variables of monitoring energy consumption and adopting measures of environmental burden were identified as triggers for the introduction of process innovations rather than confirming existing literature from other European and global regions, our proven-significant independent variable of firm's membership in firm groups may create space for new discussions concerning both future theory development and empirical study designs in the field of green process innovations (e.g., Horbach, 2016; Horbach et al., 2023). The last, originally empirical, finding of the present study may also have more theoretical implications. First, it points to (actor–) network, cooperation, coalition, and institutional theory, just to name some potential theoretical implications (Jakobsen & Clausen, 2016; Prokop et al., 2022).

Moreover, this paper revealed the potential effects of specific control variables, which we tested in our respective regression analyses. In particular, the regression analyses showed Poland to be the least process innovative country in our CEE sample. This specific result, referring to one the central control variables of this study, could provoke various, rather potential explanations. First, the overall socio-economic and rather conservative/tradition-oriented policy framework of Polish society over the last decade (and even further back; Skjærseth, 2018) may have influenced corporate innovation decisions, strategies, and practices in recent years (e.g., Brauers & Oei, 2020; Halásková & Halásková, 2020). Second, certain technological path dependencies of the Polish industry (for example, a still high share of conventional sources for firms' energy consumption) still seem to have quite a strong impact on businesses' process innovation management in this country (e.g., Jakobsen & Clausen, 2016).

Finally, the overall results of this study also carry additional theoretical and conceptual implications for the wider literature on sustainable green innovation management, especially in (European) "catching up" countries and with a focus on process innovations. In the first place, the present findings support the still quite new conceptual/theoretical NRBV framework, which combines the perspective of technological, production, human, and natural resources. Furthermore, this paper could help initiate further discussions about different ways of corporate strategy-making as well as strategy implementation in the wider area of sustainable innovation management. Such discussions could consider various interconnected aspects, such as internal, external, and combined stakeholder management; internal and external knowledge management (considering both tangible and intangible/tacit knowledge); innovation-oriented human resource management (e.g., Prokop et al., 2023); and corporate social responsibility (CSR) practices.

6 CONCLUSIONS AND IMPLICATIONS

Our study offers some theoretical contributions to the innovation and sustainability literature and current practices. First, we contribute to the NRBV theory by demonstrating that, unlike the RBV, the NRBV does not ignore the interrelationship between the firm and natural environment (Yusoff et al., 2019). As such, a similar type of analysis is recommended (Horbach et al., 2022). Second, we enrich scholarly understanding of how firms' green orientation influences process innovation. We follow the approach of Jakobsen and Clausen (2016), which took a step back compared the conclusions of scholars who have long been devoted to the issue of ecological behavior and ecologically oriented innovations. These authors focused on the influence of firm management decisions regarding green mode and different innovation determinants to better understand the total environmental innovation process and reveal differences in the innovation process within firms with environmental goals. Shu et al. (2016) also studied whether managerial decisions in companies operating in the green mode contribute to an increase or decrease in product innovation. Compared to these studies, we follow the method used by Prokop et al. (2022) and bring to the discussion the influence of other determinants expressing firms' green mode to test its influence on firms' process innovation. In addition, according to Demirel et al. (2019), one of the identified problems associated with business and its green profiling is that researchers do not combine knowledge from several countries, but often apply conclusions from only the immediate surroundings. As a result, cross-country evidence is still largely needed. Similarly, Zhou et al. (2019) concluded that there are not enough high-quality expert studies to confirm clear relationships between innovation and green mode management decisions. Therefore, we focus on cross-country comparisons.

Our results demonstrate that a firm's green mode can increase its chances to introduce process innovations, which can increase its competitiveness in the long run. Moreover, such behavior can improve the overall image of firms in the eyes of other stakeholders and, thus, increase their sales, even when they offer "lower quality" products compared to their "non-green" competitors (Horbach et al., 2023). However, to support the green mode of firms in CEE countries, policymakers and firms must take several steps. From policymakers' perspective, it is mainly the reduction of the bureaucratic burden and the support of the overall environmental perception in society. For firms, it is a subsequently targeted increase in the skills and knowledge of employees (Prokop et al., 2023), such as in the form of seminars, educational events (Janderova, 2019), R&D training, and cooperation with more experienced partners (this can be stimulated by, for example, participation in a group of firms, which we confirmed to be important in our model; Skare et al., 2023). Another important recommendation is the fact that policymakers should explain to companies in CEE the long-term benefits of their green behavior, such as reduced costs, satisfied customers, and even satisfied employees. Moreover, in CEE countries,

it is also necessary to focus on supporting the building of suitable infrastructure, leading to the building of effective innovation ecosystems, which will thus enable support for the more effective creation of innovations (Peterková et al., 2022).

This paper is not without limitations. The main limitation can be seen in the use of predefined variables and secondary data. We offer some recommendations for future research. Scholars should explore primary data more deeply, such as through interviews with company representatives. Furthermore, mixed-method research could increase the empirical significance of the results. We recommend the use of other methods, such as PLS-SEM modelling, possibly in combination with a fuzzy-set qualitative comparative analysis, as recommended by Stejskal and Hajek (2019).

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Contact information

Assoc. Prof. Ing. Viktor Prokop, Ph.D.
University of Pardubice
Faculty of Economics and Administration
Science and Research Centre
Czech Republic
E-mail: viktor.prokop@upce.cz
ORCID: https://orcid.org/0000-0001-6313-395X

Prof. Ing. Jan Stejskal, Ph.D.
University of Pardubice
Faculty of Economics and Administration
Institute of Economics Sciences
Czech Republic
E-mail: jan.stejskal@upce.cz
ORCID: https://orcid.org/0000-0003-3015-8274

Prof. Dr. Wolfgang Gerstlberger
Tallinn University of Technology
School of Business and Governance
Estonia
E-mail: wolfgang.gerstlberger@taltech.ee
ORCID: https://orcid.org/0000-0001-6200-5737

Mgr. David Zapletal, Ph.D.
University of Pardubice
Faculty of Economics and Administration
Science and Research Centre
Czech Republic
E-mail: david.zapletal@upce.cz
ORCID: https://orcid.org/0000-0002-4795-179X

Dr. Do Thi Thanh Nhan
Ton Duc Thang University
Faculty of Finance and Banking
Vietnam
E-mail: dothithanhnhan@tdtu.edu.vn
ORCID: https://orcid.org/0000-0002-2505-1715