DIGITAL CAPABILITIES AND ENVIRONMENTAL PRACTICES: FIRM-LEVEL EVIDENCE FROM ROMANIA

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Abstract:
Digital transformation and environmental sustainability are increasingly shaping firms' strategies and operational practices. This study examines whether firms' digital capabilities are associated with the adoption of environmental practices using firm-level data from the World Bank Enterprise Survey conducted in Romania. The analysis focuses on two dimensions of environmental engagement: monitoring CO_2 emissions and implementing measures aimed at reducing emissions or improving energy efficiency. A digitalization index capturing firms' adoption of basic digital technologies is constructed and included in binary logistic regression models alongside several firm-level characteristics. The results indicate that digitalization does not significantly influence firms' decisions to monitor CO_2 emissions. However, firms with higher levels of digital adoption are significantly more likely to implement measures aimed at improving energy efficiency or reducing emissions. Firm size, export activity, market competition, and sector characteristics also influence the likelihood of adopting environmental measures. These findings suggest that digital capabilities may facilitate the implementation of environmentally responsible practices and highlight the importance of firm characteristics in shaping environmental behavior in emerging economies.

Keywords: *digitalization; environmental practices; environmental sustainability; firm-level analysis; emerging economies; Romania.*

JEL Classification: *Q56; O33; L25; C25.*

1. Introduction

Digital transformation and environmental sustainability have become two of the most important forces shaping the contemporary business environment. The rapid diffusion of digital technologies has fundamentally changed the way firms organize their activities, interact with stakeholders, and manage production processes. At the same time, increasing environmental concerns and growing regulatory pressures have encouraged firms to adopt practices aimed at reducing their environmental impact and improving resource efficiency. In this context, digital technologies may play an important role in supporting environmentally responsible business practices. By improving access to information, enhancing communication, and enabling the monitoring of operational processes, digital tools can facilitate the management of environmental performance within firms. Digital systems can help organizations track emissions, monitor energy use, and optimize resource consumption, thereby supporting the implementation of environmental initiatives. As a result, digital transformation has increasingly been viewed as a potential enabler of the transition toward more sustainable business models. Despite the growing interest in the relationship between digital transformation and environmental sustainability, empirical evidence on how digital capabilities influence firms' environmental practices remains limited.

Existing studies have mainly focused on the effects of digital technologies on productivity, innovation, and firm performance, while their role in shaping environmental behavior has received less attention. Moreover, most empirical analyses have concentrated on developed economies, leaving relatively little evidence for emerging or transition economies.

This study addresses this gap by examining the relationship between digital capabilities and the adoption of environmental practices at the firm level. Using firm-level data from the World Bank Enterprise Survey conducted in Romania, the analysis focuses on two dimensions of environmental engagement: monitoring CO_2 emissions and implementing measures aimed at reducing emissions or improving energy efficiency. Binary logistic regression models are employed to examine whether firms with higher levels of digital adoption are more likely to engage in environmentally responsible practices, while controlling for firm characteristics such as size, human capital, innovation, export activity, market competition, and sectoral affiliation. This article extends a preliminary version of the study previously presented at a scientific conference. Compared to the earlier conference paper, the present study develops a more comprehensive empirical framework, introduces a refined measure of firms' digital capabilities, and provides a more detailed analysis of the relationship between digitalization and environmental practices. So, it provides new firm-level evidence on the relationship between digitalization and environmental practices in the context of an emerging European economy, and distinguishes between different dimensions of environmental engagement, monitoring environmental impact and implementing environmental measures, allowing a more nuanced analysis of how digital capabilities influence firms' environmental behavior. Finally, the study highlights the role of firm characteristics and market conditions in shaping environmental practices, thereby contributing to the growing literature on the interaction between digital transformation and environmental sustainability.

2. Literature Review and Hypotheses

Digital transformation has become a major driver of organizational change and competitiveness in modern economies. The diffusion of digital technologies has reshaped the way firms organize production processes, interact with stakeholders, and generate value (Vial, 2019; Verhoef et al., 2021). Digital transformation enables firms to improve information flows, enhance communication with partners and customers, and optimize internal business processes (Bharadwaj et al., 2013; Nambisan et al., 2017). Through these mechanisms, digitalization can increase operational efficiency, reduce transaction costs, and support more effective managerial decision-making.

At the firm level, digital capabilities are often reflected in the adoption of basic digital tools such as corporate websites, electronic communication systems, online administrative procedures, and digital payment platforms. These technologies facilitate information exchange and strengthen interactions between firms, customers, suppliers, and public institutions.

Empirical research indicates that firms with higher levels of digital adoption tend to exhibit higher productivity, greater organizational flexibility, and stronger innovation performance (OECD, 2021; Verhoef et al., 2021; Li et al., 2018). In addition, digital technologies enhance firms' capacity to collect, process, and analyze large volumes of operational data. Digital systems enable organizations to monitor performance indicators more accurately and respond more rapidly to operational challenges (Brynjolfsson and McAfee, 2014; Vial, 2019).

These enhanced data-processing capabilities may also support the monitoring and management of environmental performance. In recent years, increasing scholarly attention has been devoted to the relationship between digital transformation and environmental sustainability.

Digital technologies can contribute to environmental improvements by enabling more efficient resource management, optimizing production processes, and facilitating the monitoring of environmental impacts (Bai et al., 2023. Macêdo et al., 2024). Digital monitoring systems and automated data collection tools allow firms to track environmental indicators such as emissions, energy consumption, and waste generation more accurately. By improving transparency and access to environmental information, digital technologies may therefore facilitate environmental reporting and support compliance with regulatory requirements (Ahmed et al., 2019).

Beyond monitoring capabilities, digitalization may also facilitate the implementation of concrete environmental measures. Technologies associated with digital transformation, such as data analytics, smart manufacturing systems, and digital communication platforms, can enhance production efficiency and reduce resource consumption (Bai et al., 2023).

As a result, firms with stronger digital capabilities may be better positioned to implement measures aimed at improving energy efficiency or reducing emissions. However, empirical evidence on the environmental consequences of digitalization remains mixed.

While some studies find that digital technologies improve environmental performance, others suggest that these effects depend on firm characteristics, sectoral conditions, or institutional contexts (Song et al., 2024; He and Chen, 2025). These mixed findings highlight the importance of further empirical investigation using firm-level data.

In addition to digital capabilities, several firm-level characteristics may influence the adoption of environmental practices. Firm size is widely recognized as a key determinant of environmental engagement. Larger firms typically possess greater financial and organizational resources, enabling them to invest in environmental technologies and management systems (Cadez et al., 2019). They may also face stronger regulatory pressures and greater scrutiny from stakeholders, which can encourage the adoption of environmentally responsible practices (Darnall et al., 2010). Human capital may also influence environmental performance, as firms with a more skilled workforce may have greater capacity to implement environmental monitoring systems and adopt technologies that improve resource efficiency. Innovation activities may also contribute to environmental engagement. Firms engaged in product or process innovation may be more inclined to adopt cleaner production methods and environmentally efficient technologies (Horbach, 2008). Similarly, export activity can affect firms' environmental behavior, as firms operating in international markets are often exposed to stricter environmental standards and increased competitive pressure. Market competition itself may also act as a driver of environmental engagement, encouraging firms to adopt environmentally responsible practices in order to maintain competitiveness and improve their reputation (Porter and Van der Linde, 1995).

The existing literature highlights the potential role of digital technologies in improving firms' operational efficiency and supporting environmental sustainability. However, empirical evidence on the relationship between digital capabilities and firms' environmental practices remains limited, particularly at the firm level and in the context of emerging economies. Most previous studies rely on aggregate indicators or focus on advanced digital technologies, while less attention has been paid to how the adoption of basic digital tools may influence firms' environmental behavior.

By using firm-level data from the 2023 World Bank Enterprise Survey for Romania, this study contributes to the literature by examining how digital capabilities and firm characteristics jointly influence two distinct dimensions of environmental engagement.

Based on these arguments, the following hypotheses are proposed:

Hypothesis H1: *Firms with higher levels of digitalization are more likely to monitor their CO_2 emissions.*

Hypothesis H2: *Firms with higher levels of digitalization are more likely to implement measures aimed at reducing emissions or improving energy efficiency.*

Hypothesis H3: *Firm characteristics such as size, innovation, export activity, and human capital positively influence the likelihood of adopting environmental practices.*

Figure 1 presents the conceptual framework guiding the empirical analysis and illustrates the hypothesized relationships between firms' digital capabilities and environmental practices. Digital capabilities, measured through the digitalization index, are expected to influence firms' environmental engagement through two distinct dimensions: the monitoring of CO_2 emissions and the implementation of measures aimed at reducing emissions or improving energy efficiency. In addition, several firm-level characteristics are included as control variables, reflecting organizational resources and market conditions that may also shape firms' environmental behavior.

Building on the conceptual framework, the empirical analysis investigates whether firms' digital capabilities are associated with the adoption of environmental practices. In particular, the study examines the extent to which digitalization influences two dimensions of environmental engagement: the monitoring of CO_2 emissions and the implementation of measures aimed at improving energy efficiency or reducing emissions.

By distinguishing between environmental monitoring and the implementation of environmental measures, this study provides a more nuanced perspective on how digital capabilities shape firms' environmental engagement.

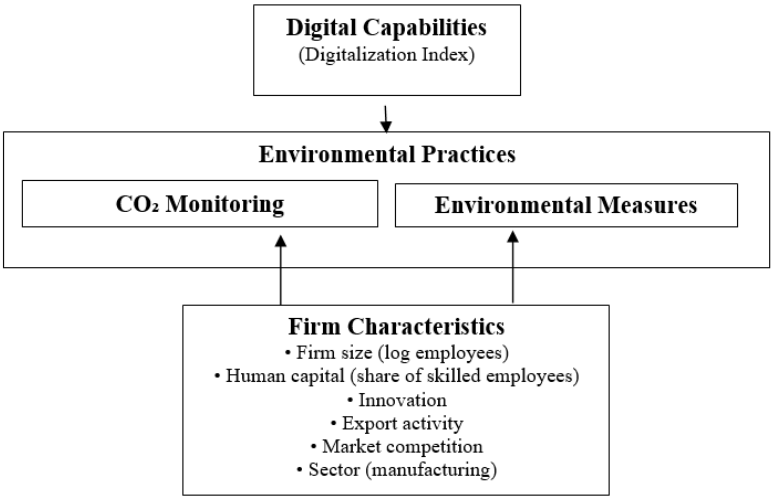

Figure 1. - *Conceptual framework linking digital capabilities to firms' environmental practices*

Source: Author' elaboration

To test these relationships, the analysis relies on firm-level data from the World Bank Enterprise Survey conducted in Romania in 2023 and employs binary logistic regression models that account for relevant firm-level characteristics.

3. Data and Methodology

3.1. Data and variables

The empirical analysis relies on firm-level data from the World Bank Enterprise Survey (WBES) conducted in Romania in 2023 (World Bank, 2023). The WBES provides detailed information on firms' characteristics, business environment conditions, and operational practices across a wide range of economic sectors. The survey is based on a stratified random sampling methodology designed to ensure representativeness across firm size, sector, and geographic location.

The dataset used in this study includes 947 firms operating in both manufacturing and service sectors. The survey collects information on firms' organizational characteristics, digital capabilities, innovation activities, export behavior, workforce composition, and environmental practices. These data allow for the examination of the relationship between digitalization and firms' environmental behavior at the microeconomic level.

Following standard practice in studies using WBES data, observations with missing or non-response categories (such as "don't know") are treated as missing values and excluded from the analysis. The survey weights provided by the WBES are available to account for the sampling design. However, the analysis is conducted on unweighted observations, as commonly applied in firm-level empirical studies using WBES data.

The analysis focuses on two dimensions of firms' environmental engagement. The first dependent variable captures environmental monitoring, measured by a binary indicator that takes the value 1 if the firm monitors its CO_2 emissions or environmental impact and 0 otherwise (WBES variable ge7). The second dependent variable reflects the implementation of environmental measures, measured by a binary variable indicating whether the firm has introduced measures aimed at reducing emissions or improving energy efficiency (WBES variable ge8d). These variables allow the analysis to distinguish between environmental monitoring activities and the implementation of concrete environmental actions, which represent different dimensions of firms' environmental engagement.

The key explanatory variable is a digitalization index designed to capture firms’ adoption of basic digital technologies. The index is constructed as the sum of four binary indicators reflecting the use of digital tools in business operations: the presence of a firm website (c22b), the electronic filing of taxes (j36), the electronic payment of taxes (j37), and the use of electronic payments in business transactions (k33). The resulting index ranges from 0 to 4, with higher values indicating a higher level of digital adoption.

Several firm-level characteristics are included as control variables to account for factors that may influence firms’ environmental behavior. Firm size is measured by the number of employees, reflecting the scale of firm operations. Human capital is captured by the share of skilled employees in total employment, which reflects the firm’s workforce capabilities. Innovation is measured through a binary variable indicating whether the firm introduced a new or significantly improved product or process during the previous three years. Export activity is captured by a dummy variable indicating whether the firm directly exports part of its production. Market competition is measured through a categorical variable indicating whether the firm perceives that competition in its main market has increased during the previous year. Finally, a sector dummy variable is included to distinguish between manufacturing and service firms.

Table 1 summarizes the definition and measurement of all variables used in the empirical analysis.

Table 1. - *Description of Variables*

Variable	Definition	Measurement	Source
Dependent variables			
Environmental monitoring	Indicates whether the firm monitors its CO_2 emissions.	Binary (1 = yes; 0 = no)	WBES (ge7)
Environmental measures	Indicates whether the firm has implemented energy management or emission reduction measures.	Binary (1 = yes; 0 = no)	WBES (ge8d)
Explanatory variable			
Digitalization index	Composite indicator capturing firms’ adoption of basic digital technologies, including website presence, electronic tax filing, electronic tax payment, and the use of electronic payments.	Sum of four binary indicators (range 0–4)	WBES (c22b, j36, j37, k33)
Control variables			
Firm size (log employees)	Firm size is measured as the natural logarithm of the number of permanent employees, reflecting the scale of firm operations.	Natural logarithm of total employees	WBES (l1)
Human capital (share of skilled employees)	Share of skilled employees in total employment.	Ratio (l4a1 / l1)	WBES (l4a1, l1)
Export activity	Indicates whether the firm directly exports part of its production.	Binary (1 = exporter; 0 = non-exporter)	WBES (d3c)
Innovation	Indicates whether the firm introduced a new product or a significantly improved process in the last three years.	Binary (1 = yes; 0 = no)	WBES (h1, h5)
Market competition	Market competition is captured by a dummy variable indicating whether the firm perceives that competition in its main market has increased during the previous year.	Binary (1 = increased competition; 0 = no increase)	WBES (e32)
Sector (manufacturing)	Dummy variable distinguishing manufacturing firms from service firms.	Binary (1 = manufacturing; 0 = services)	WBES (a4a)

Note: Digitalization index ranges from 0 to 4, where higher values indicate a higher level
Source: Author’s elaboration based on World Bank Enterprise Survey (WBES), Romania 2023.

3.2. Empirical Methodology

The relationship between firms' digital capabilities and environmental practices is examined using binary logistic regression models, given the dichotomous nature of the dependent variables. Logistic regression is widely used in empirical research where the dependent variable represents the probability of a binary outcome occurring and allows for the estimation of nonlinear relationships between explanatory variables and a binary response variable (Hosmer et al., 2013; (Menard, 2001; La Rocca et al., 2025).

In contrast to linear probability models, logistic regression ensures that predicted probabilities remain within the [0,1] interval and provides a flexible framework for modeling the influence of multiple explanatory variables on the likelihood of a particular outcome (Wooldridge, 2010). This approach is therefore appropriate for examining whether firms engage in specific environmental practices.

The general specification of the logistic regression model can be expressed as:

$$\ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1 X_i + \varepsilon_i$$

where:

p_i - represents the probability that firm i adopts the environmental practice considered,

X_i - denotes the vector of explanatory variables, and

β - represents the estimated parameters.

In the empirical specification, the model is defined as:

$$\ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1 Digitalization_i + \sum_{k=2}^{K} \beta_k X_{ki} + \varepsilon_i$$

where:

Digitalization - represents the digitalization index capturing firms' digital capabilities, while

X_{ki} - denotes the set of firm-level control variables, including firm size, human capital, innovation activity, export participation, market competition, and sector characteristics.

The dependent variable Y_i takes the value 1 if the firm adopts the environmental practice considered and 0 otherwise. Two separate models are estimated in order to capture different dimensions of environmental engagement. The first model examines the determinants of CO_2 emissions monitoring, while the second model analyzes the factors influencing the implementation of measures aimed at reducing emissions or improving energy efficiency.

Estimating separate models allows the analysis to distinguish between environmental monitoring activities and the adoption of concrete environmental measures, which may be driven by different organizational and technological factors. The estimation results of the empirical models are presented and discussed in the following section.

4. Descriptive Statistics and Correlation Analysis

4.1 Descriptive statistics

Tables 2 and 3 report the descriptive statistics for the variables included in the empirical analysis. These statistics provide an overview of firms' digital capabilities, structural characteristics, and environmental practices.

As shown in Table 2, the digitalization index has an average value of 3.66, indicating a relatively widespread use of basic digital technologies among Romanian firms.

Table 2. - *Descriptive statistics (continuous variables)*

Variable	Observations	Mean	Std. Dev.	Min	Max
Digitalization index	941	3.66	0.51	1	4
Log Firm size	946	3.38	1.30	1.1	7.94
Human capital (share of skilled employees)	938	0.30	0.31	0	1

Source: Authors' calculations using IBM SPSS Statistics based on World Bank Enterprise Survey (Romania, 2023).

The mean value of log firm size is 3.38, reflecting substantial variation in the size distribution of firms within the sample. Regarding human capital, the average share of skilled employees is 0.30, suggesting that skilled workers account for approximately 30% of total employment.

Table 3 presents the distribution of the categorical variables. Around 25.8% of firms report monitoring their CO_2 emissions, while 67.6% indicate that they have implemented measures aimed at reducing emissions or improving energy efficiency. Innovation activity appears relatively limited, with only 8.4% of firms reporting the introduction of new or significantly improved products or processes during the last three years. With respect to market orientation, 22.6% of firms are involved in export activities. A majority of firms (60%) report that market competition has increased in the past year. The sectoral composition of the sample is relatively balanced, with 53.3% of firms operating in manufacturing and 46.7% in services.

Table 3. - *Distribution of categorical variables*

Variable	Category	Frequency	Percentage (%)
CO_2 monitoring	1="Yes"	243	25.8
	0="No"	700	74.2
Environmental measures	1="Yes"	638	67.6
	0="No"	306	32.4
Innovation	1="Yes"	79	8.4
	0="No"	867	91.6
Export activity	1="Yes"	214	22.6
	0="No"	733	77.4
Market competition (increase)	1="Yes"	566	60.0
	0="No"	377	40.0
Sector	1="Manufacturing"	505	53.3
	0="Services"	442	46.7

Source: Authors' calculations using IBM SPSS Statistics based on World Bank Enterprise Survey (Romania, 2023).

Overall, the descriptive statistics reveal moderate levels of digital adoption and considerable heterogeneity in firm characteristics. These patterns provide an appropriate empirical context for examining the relationship between digitalization and firms' environmental practices in the subsequent regression analysis.

4.2 Correlation analysis

To explore the relationships between the variables and to assess potential multicollinearity issues, a pairwise correlation analysis is conducted. Table 4 presents the pairwise correlation coefficients among the explanatory variables included in the regression models.

Table 4. - *Correlation matrix of explanatory variables*

Variables	Digitalization index	Log firm size	Human capital (share of skilled employees)	Innovation	Export activity	Sector (manufacturing)	Market competition (increase)
Digitalization index	1						
Firm size (Log employees)	0.252***	1					
Human capital (share of skilled employees)	-0.025	-0.273***	1				
Innovation	0.108***	0.203***	-0.040	1			
Export activity	0.132***	0.296***	-0.155***	0.074**	1		
Sector (manufacturing)	-0.018	0.139***	-0.199***	0.015	0.273***	1	
Market competition (increase)	0.062*	-0.042	0.098***	-0.113***	-0.038	-0.075**	1

Note: Pearson correlation coefficients are reported.
*** p < 0.01, ** p < 0.05, * p < 0.10.

The digitalization index shows a positive and statistically significant correlation with firm size ($r = 0.252$, $p < 0.01$), export activity ($r = 0.132$, $p < 0.01$), and innovation ($r = 0.108$, $p < 0.01$), indicating that larger, more innovative, and export-oriented firms tend to exhibit higher levels of digital adoption. Firm size is also positively associated with export activity ($r = 0.296$, $p < 0.01$), innovation ($r = 0.203$, $p < 0.01$), and operating in the manufacturing sector ($r = 0.139$, $p < 0.01$), suggesting that larger firms are more likely to be internationally oriented and technologically active. In contrast, the share of skilled employees shows a negative correlation with firm size ($r = -0.273$, $p < 0.01$) and export activity ($r = -0.155$, $p < 0.01$), indicating some structural differences in workforce composition across firms.

Thus, the magnitude of all correlation coefficients remains well below commonly accepted thresholds associated with multicollinearity concerns. Therefore, the explanatory variables can be jointly included in the regression models without posing significant econometric problems.

5. Empirical Results

Table 5 presents the results of the binary logistic regression models examining the relationship between firms' digital capabilities and the adoption of environmental practices. Two models are estimated, corresponding to the two dependent variables: CO_2 monitoring (Model 1) and the implementation of environmental measures aimed at reducing emissions or improving energy efficiency (Model 2).

Table 5. - *Logistic Regression Results: Digitalization and Environmental Practices*

Variables	**CO_2 monitoring (Model 1)**	**Environmental measures (Model 2)**
Digitalization index	1.135	1.626***
Firm size (log employees)	1.534***	1.269***
Human capital (share of skilled employees)	3.695***	0.097
Innovation	0.648	0.644
Export activity	1.045	1.608**
Market competition (increase)	1.243	1.599***
Sector (manufacturing)	1.305	1.367**
Constant	0.25	0.100
Observations	926	927
Pseudo R^2	0.101	0.098

Note: Odds ratios are reported.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

The results presented in Table 5 indicate that digitalization does not have a statistically significant effect on firms' decisions to monitor their CO_2 emissions. Instead, monitoring activities appear to be primarily associated with firm characteristics. In particular, firm size shows a positive and statistically significant effect (odds ratio = 1.534, $p < 0.01$), suggesting that larger firms are more likely to engage in environmental monitoring. Similarly, the share of skilled employees exhibits a strong positive association with CO_2 monitoring (odds ratio = 3.695, $p < 0.01$), indicating that firms with greater human capital are substantially more likely to track their environmental impact.

In contrast, digitalization emerges as a significant determinant of the implementation of environmental measures. The results of Model 2 show that firms with higher levels of digital adoption are significantly more likely to implement actions aimed at reducing emissions or improving energy efficiency (odds ratio = 1.626, $p < 0.01$). This coefficient implies that a one-unit increase in the digitalization index increases the likelihood of adopting environmental measures by approximately 63 percent. This finding suggests that digital technologies may facilitate the adoption of concrete environmental practices by improving access to information, enhancing operational efficiency, and supporting more effective management of resources.

Several firm-level characteristics also influence the likelihood of adopting environmental measures. Firm size remains positively and significantly associated with the implementation of environmental practices (odds ratio = 1.269, $p < 0.01$), indicating that larger firms possess greater resources to invest in environmental improvements. Export activity also has a positive and significant effect (odds ratio = 1.608, $p < 0.05$), suggesting that firms engaged in international markets may face stronger environmental standards or competitive pressures that encourage the adoption of environmentally responsible practices. In addition, firms reporting increased market competition are more likely to implement environmental measures (odds ratio = 1.599, $p < 0.01$), possibly reflecting the role of competitive pressure in stimulating efficiency improvements. Finally, firms operating in the manufacturing sector exhibit a higher probability of adopting environmental measures compared to service firms (odds ratio = 1.367, $p < 0.05$).

Overall, the empirical findings provide mixed evidence regarding the proposed hypotheses. Hypothesis H1, which predicts a positive relationship between digitalization and CO_2 monitoring, is not supported by the empirical results. By contrast, hypothesis H2 is supported, as digitalization is positively associated with the implementation of environmental measures. Hypothesis H3 receives partial support, as several firm-level characteristics, particularly firm size, export activity, and market competition, significantly influence the adoption of environmental practices.

6. Discussions

The empirical results provide several important insights into the relationship between digital capabilities and firms' environmental practices. One of the most notable findings is that digitalization does not appear to significantly influence firms' decisions to monitor their CO_2 emissions. This result suggests that environmental monitoring activities may depend more strongly on internal organizational resources and managerial capabilities than on the adoption of basic digital technologies. In particular, the positive and statistically significant effect of human capital indicates that firms with a more skilled workforce are better able to implement monitoring systems and track environmental indicators. This finding is consistent with previous research emphasizing the role of organizational capabilities and technical expertise in supporting environmental management practices (Cadez et al., 2019).

By contrast, digitalization plays a significant role in explaining the adoption of environmental measures aimed at reducing emissions or improving energy efficiency. Firms with higher levels of digital adoption are more likely to implement such measures, suggesting that digital technologies can facilitate operational improvements and resource optimization. Digital tools may support better coordination of production processes, improve information flows within the firm, and enable more efficient management of energy and material inputs. These mechanisms are consistent with the broader literature on digital transformation, which highlights the potential of digital technologies to enhance operational efficiency and support sustainability-oriented innovation (Macêdo et al., 2024).

The results also confirm the importance of several firm-level characteristics in shaping environmental behavior. Firm size emerges as a consistent determinant across both models, indicating that larger firms are more likely to engage in environmental practices. Larger firms typically possess greater financial and organizational resources, enabling them to invest in environmental technologies and management systems. Moreover, they are often subject to stronger regulatory pressures and greater scrutiny from stakeholders, which may further encourage the adoption of environmentally responsible practices. Export activity also appears to play a role in the adoption of environmental measures. Firms engaged in international markets are often exposed to stricter environmental standards and increased competitive pressure, which may incentivize them to improve their environmental performance. Similarly, increased market competition is associated with a higher likelihood of implementing environmental measures, suggesting that firms may adopt environmentally efficient practices as part of broader strategies aimed at improving productivity and competitiveness. So, while digital technologies alone may not directly lead firms to engage in environmental monitoring, they can play an important enabling role in the implementation of concrete environmental actions. By distinguishing between environmental monitoring and the adoption of environmental measures, this study provides a more nuanced perspective on how digital capabilities influence firms' environmental engagement. Digital capabilities may therefore contribute indirectly to environmental sustainability by supporting operational efficiency and facilitating the adoption of resource-saving practices.

7. Conclusions

This study examined the relationship between firms' digital capabilities and the adoption of environmental practices using firm-level data from the World Bank Enterprise Survey conducted in Romania. By distinguishing between two dimensions of environmental engagement, monitoring CO_2 emissions and implementing measures aimed at reducing emissions or improving energy efficiency, the analysis provides a more nuanced understanding of how digitalization may influence firms' environmental behavior.

The empirical results indicate that digitalization does not significantly influence firms' decisions to monitor their CO_2 emissions. Instead, environmental monitoring appears to be primarily associated with organizational characteristics, particularly firm size and the availability of skilled human capital. These findings suggest that monitoring activities may depend more strongly on internal capabilities and managerial expertise than on the adoption of basic digital technologies. In contrast, digitalization is positively associated with the implementation of environmental measures. Firms with higher levels of digital adoption are significantly more likely to introduce actions aimed at improving energy efficiency or reducing emissions. This result highlights the role of digital technologies as an enabling factor that can facilitate operational improvements and resource-efficient practices. The analysis also confirms the importance of several firm characteristics in shaping environmental behavior. Larger firms are consistently more likely to engage in environmental practices, reflecting their greater availability of financial and organizational resources. Export activity and increased market competition are also positively associated with the adoption of environmental measures, suggesting that exposure to international markets and competitive pressures may encourage firms to improve their environmental performance.

Overall, the digital capabilities may play an important role in supporting the implementation of environmentally responsible practices, even if they do not directly influence environmental monitoring activities. By distinguishing between environmental monitoring and the adoption of environmental measures, this study contributes to the literature by providing a more nuanced perspective on how digital capabilities shape firms' environmental engagement. Despite these contributions, the study has several limitations. First, the analysis relies on cross-sectional survey data, which limits the ability to draw causal conclusions regarding the relationship between digitalization and environmental practices. Second, the digitalization index captures only the adoption of basic digital technologies and does not fully reflect more advanced forms of digital transformation. Future research could extend this analysis by using panel data or more detailed measures of digital technologies in order to further explore the relationship between digital capabilities and firms' environmental performance.

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