Business Strategy and the Environment

WILEY | Business Strategy and the Environment

RESEARCH ARTICLE OPEN ACCESS

Understanding the MSME Environmental Transition: Nonlinear and Moderation Effects of Digitalization and Institutional Context

José Antonio Clemente-Almendros[1] | Marcelo Vallejo García[2] | María Blanco-Hernández[1]

[1]Universidad Internacional de La Rioja, Logroño, Spain | [2]Universidad Pontificia de Salamanca, Salamanca, Spain

Correspondence: José Antonio Clemente-Almendros (joseantonio.clemente@unir.net)

Received: 31 March 2025 | **Revised:** 31 October 2025 | **Accepted:** 30 November 2025

Keywords: digitalization | environmental practices | institutional quality | MSME | U-shaped effect

ABSTRACT

The necessary environmental transition involves a substantial challenge for micro, small, and medium-sized enterprises (MSMEs). Moreover, in the Ibero-American context, it is even more challenging. Our study aims to shed light on the scarce and inconclusive evidence in this regard, analyzing the influence of digitalization, given its inclusion in the so-called MSMEs' double transition, as well as the effect of the institutional setting. The so-called double transition is more sensitive in emerging areas. By means of analyzing direct and moderation effects on a representative database of 17.498 Ibero-American MSMEs, we aim to show the existence of linear and nonlinear relationships that determine the level of environmental involvement of those organizations. Our results show that the expected positive effect of digitalization exists, but it is not linear, but U-shaped. The extension of the Kuznets curve is confirmed for digitalization in MSMEs. Additionally, the institutional context's positive influence also moderates this nonlinear influence. These findings involve the need for not only digital technologies but also a transformational internal process, which is influenced by institutional quality. Managers need to understand the importance of substantial organizational commitment and their own transformational capacity in the dual transition to avoid negative effects. In this vein, institutions must focus on reducing the duration of the downward part of the U-shaped influence of digitalization. Ultimately, digital transformation and institutional quality must move forward to sustainable change in MSMEs aligned.

1 | Introduction

Micro, small, and medium-sized enterprises (MSMEs) represent 99.5% of all businesses in Latin America and the Caribbean and around 60% of formal employment (Organización para la Cooperación y el Desarrollo Económico [OECD] 2023). A comparable trend is observed in other geographical areas, with figures reaching 99.8% and 64.2% in the European Union (EU) (European Commission: Joint Research Centre et al. 2024) and 99.9% and 46% in the United States (US Small Business Administration 2023).

Sustainability and digitalization represent significant challenges that are reshaping the economy and society, with pronounced implications for MSMEs (Del Río et al. 2021; European Commission 2012).

Sustainability has become a dominant concern for a wide range of stakeholders, from businesses and governments to civil and social organizations, academics, and individuals around the world (Chege and Wang 2020). Businesses are under increasing pressure to improve their sustainability performance (Hanaysha et al. 2022). This concern is no stranger to smaller companies,

as they account for 40% of the business sector's aggregate greenhouse gas emissions (OECD 2023).

Various initiatives have emerged in response to this situation to promote the development of sustainable environmental practices by SMEs, such as the SME Strategy for a Sustainable and Digital Europe (European Commission 2020) and the OECD Platform on Financing SMEs for Sustainability in 2021.

However, nowadays, SMEs face difficulties in adopting sustainable transformation strategies, including complex regulatory processes, difficulties in implementing legislation, the cost of sustainable actions, and limited availability of required inputs (Singh et al. 2023; Rubio-Andrés et al. 2023).

Moreover, achieving sustainability is still one of the main challenges facing companies today (Bansal 2019). This concern is not limited to large companies, as sustainable practices can also confer a competitive advantage for smaller companies (Jansson et al. 2017). SMEs are under increasing pressure to implement sustainability practices and collaborate in sustainable development (Suchek and Franco 2024).

In this context, the emergence of new digital technologies has created both opportunities and challenges for SMEs (Kallmuenzer et al. 2024). However, SMEs have not taken full advantage of these advanced technologies, creating a notable digitalization gap between them and large companies (Trueba-Castañeda et al. 2024). The same handicap is suffered by Ibero-American MSMEs (Economic Commission for Latin America and CAF Development Bank of Latin America 2020).

So, the transitions toward sustainability and digital transformation are closely interconnected. SMEs are required to adapt to both developments (Wenzel 2017).

A new area, digital sustainability, has emerged in recent literature. It means "an organization's ability to advance the UN SDGs through the effective deployment of digitally enabled resources and solutions" (George et al. 2021). Scholars see digital sustainability as an urgent research area, aiming to understand how rapid adoption of advanced digital technologies impacts sustainability in firms (Bansal 2019).

As a result, the relationship between digitalization and sustainability has become a dynamic, multidisciplinary research area of prime importance. However, the precise contributions of digital paradigms to sustainability are still unclear, often because these challenges have been examined in isolation (Isensee et al. 2020; Trueba-Castañeda et al. 2024).

Additionally, the relationship between digitalization and environmental quality is complex, encompassing technological, economic, policy-related, and temporal dimensions, which further complicate this association (Ben Youssef and Dahmani 2024).

The effect of digitalization on sustainability is also contingent upon formal (those concerning government arrangements) and informal (e.g., implicit rules, norms, or culture) institutional forces (Sheng et al. 2011; Zhou et al. 2017; Guo et al. 2023). For example, high-quality institutions have a positive impact on reducing carbon emissions (Gleditsch and Sverdrup 2002; Harbaugh et al. 2002; Chen et al. 2022; Yu and Qayyum 2022).

Considering these complexities, this research aims to elucidate the impact of digitalization on sustainability in SMEs, with particular emphasis on the moderating role of the institutional context.

In this way, we aim to fill the gap in the scarce and puzzling analysis of the relationship between digitalization and sustainability, applied to sensitive organizations, such as smaller companies, and to a specific environment, such as Ibero-American countries. For this purpose, an empirical analysis was conducted on a unique, representative sample of 17,948 MSMEs from 18 Ibero-American countries. Despite a considerable number of studies demonstrating the relationship between digitalization and sustainability, most have used macro data. Few studies had analyzed this relationship in the context of MSMEs (Tick et al. 2022; Issah et al. 2024; Haq and Huo 2023; Miranda et al. 2024).

The relationship between digitalization and sustainability is still poorly understood in developing areas. In developed countries, advanced ICT infrastructure, robust policies, and high public awareness appear to help achieve positive environmental outcomes (Ben Youssef and Dahmani 2024). However, studies that focus on developing economies often reach different conclusions (Baggia et al. 2019; Guo et al. 2023; Haq and Huo 2023; Issah et al. 2024).

In addition, there is a lack of evidence in MSMEs regarding the nonlinear relationship tested in economic studies on the double transition. Very few authors have analyzed it in SMEs (Ahmadova et al. 2022; Yang et al. 2023). Furthermore, one of these is limited to a particular geographic environment (China). To the best of the authors' knowledge, this relationship has not been analyzed in the Latin American SME environment.

A further contribution of this study is the inclusion of institutional quality (IQ) in the relationship between digitalization and sustainability. Beyond the expected positive effect of institutional context, as shown in limited research on small companies (Boura et al. 2020; Rahi et al. 2023), no research to date has demonstrated its potential moderating effect on MSMEs' double transition. The research by Guo et al. (2023) showed that government intervention, via factor market intervention, weakens the effect of green digitalization on boosting sustainable innovation in Chinese MSMs. The present study tests the hypothesis that this moderation effect extends to IQ and influences digitalization's effect on sustainable practices in Latin American MSMEs. Consequently, in our study, we formulate the following research questions: What is the type of relationship between the use of digitalization and the use of environmental practices? Does the institutional context influence this relationship?

The research is anchored in two theories. An important approach for explaining the sustainable performance of SMEs is the dynamic capability theory (DCV). This theory (Pisano and Teece 1994) emerged to address the limitations of the resource-based view (RBV) theory in explaining how companies can create competitive advantage in a changing market environment

(Priem and Butler 2001). In this context, it is necessary for the company to integrate, build, and shape internal and external competencies (Pisano and Teece 1994). These dynamic capabilities differ from the "ordinary" (also called first-order) capabilities contemplated in the RBV and are related to the capacities for adaptation, absorption, and innovation (Pisano 1994; Grant 1996; Wang and Ahmed 2007). The relationship between dynamic capabilities and organizational performance has been examined by various studies (Luo 2000; Danneels 2002; Zott 2003; Hung et al. 2010).

The fundamental concept underpinning the enhancement of dynamic capabilities in SMEs is that of strategic flexibility. It is evident that small firms are unable to compete with large firms on the basis of economies of scale due to their limited financial resources. It is therefore evident that strategic flexibility is a necessity for these entities, in order that resources can be deployed for the purpose of competition within a market niche, with the development of customized products small firms, with their relatively simple and flexible structure, may develop strategic flexibility by adopting a strong market orientation, which would allow them to implement sustainability measures more quickly than larger firms (Nabais and Franco 2024).

Institutional theory (IT) is another paradigm. This theory has been widely and repeatedly applied as a framework to describe firms' behaviors across different institutional settings (Rahi et al. 2023). IT emphasizes the imposition of environmental factors on social entities and explains how such institutional forces shape organizational behavior (Scott 1995). According to it, organizational actions are primarily influenced and constrained by their institutional environment rather than solely driven by economics. Following this logic, some research has shown that companies demonstrate high sustainable performance to gain legitimacy when faced with institutional influence (Bansal 2003; Bansal and Clelland 2004; Berrone et al. 2010; Hoffman 2001). Consequently, improvements in sustainability are likely to occur in environments with higher IQ.

The subsequent section reviews the pertinent literature and outlines the hypotheses under investigation. The "Data" section describes the databases and variables incorporated into the model. The "Methodology and Results" section detail the empirical approach and key findings, including robustness assessments. The "Discussion" and "Conclusion" sections synthesize the principal results, implications, and limitations.

2 | Literature and Hypotheses

2.1 | Digitalization

The first studies focused on digitization's impact on energy efficiency, which generally reduced the environmental impact of goods production (Berkhout and Hertin 2004; Pudjianto et al. 2007; Hilty 2008; Weinert et al. 2011; Gebler et al. 2014; Kreiger et al. 2014; Ahmadi Achachlouei and Hilty 2015; Ding et al. 2017; Beier et al. 2018).

Additionally, many of the studies have demonstrated the positive role of digitalization in improving environmental management practices. (Bendig et al. 2023; Chen et al. 2020; Gouvea et al. 2018; Shen et al. 2023; Yang et al. 2023).

What is more, some authors suggest that digitalization is positively associated with environmental innovation (Guo et al. 2023). Others focus on its effect in reducing the costs associated with seeking external knowledge on environmental sustainability, such as specialized training, valuable case studies, or sector-specific sustainability reports (Yang et al. 2023), a particularly important advantage for SMEs (Ardito et al. 2021).

In the case of advanced technologies, such as open data, artificial intelligence, big data, the Internet of Things, or cloud computing, they can also address the problems of resource scarcity, traffic congestion, and air pollution (Lu et al. 2016; Jetzek et al. 2019; Brenner and Hartl 2021; Wu et al. 2021; Agrawal et al. 2022). In addition, such technologies can also solve environmental problems related to solid waste, e-waste, food waste, and agricultural waste.

However, other studies have come to the opposite conclusion. Several authors argue that there is a negative relationship between digitalization and sustainability, mainly due to increased resource and energy consumption, as well as increased waste and emissions associated with the production, use, and disposal of technology (Park et al. 2018; Gupta et al. 2020; Ardito et al. 2021; Acciarini et al. 2022).

A number of empirical studies have analyzed the impact of digitalization on sustainability within the context of MSMEs (Issah et al. 2024; Haq and Huo 2023; Miranda et al. 2024; Trueba-Castañeda et al. 2024). The conclusions of these studies are consistent, with the majority indicating a significant positive impact of digitalization on sustainability, which aligns with the DCV theory's postulations. This positive impact can be attributed to the well-established link between dynamic capabilities and digital transformation (Al-Moaid and Almarhdi 2024).

In light of the above, given the explicit benefit of digitalization on MSMEs, the following hypothesis is proposed:

H1a. *Sustainability is positively affected by digitalization in MSMEs.*

However, there is also empirical evidence showing a nonlinear relationship (Li and Wang 2017; Ahmadova et al. 2022; Peiró-Palomino et al. 2022; Li and Yang 2024), and a nonlinear relationship has been identified by a limited number of studies (Li and Wang 2017; Delgosha et al. 2020; Adeshola et al. 2024; Yang et al. 2023).

This nonlinear relationship aligns with the concept of the environmental Kuznets curve (EKC). This approach postulates that income inequality first rises and then decreases during economic development (Kuznets 1955). Consequently, environmental impacts rise and then decrease during growth (Stern 2004).

Next, the digitalization of the economy has a positive impact on economic development (European Commission 2012; OECD 2015; Manyika et al. 2016; Kwilinski et al. 2020). Therefore, extending the postulates of EKC to digitalization, an

increase in digitalization will cause negative environmental effects up to a certain point, after which the positive effects mentioned above would emerge, so that the relationship between the two constructs would follow an inverted U-shaped relationship: Low levels of digitalization would have negative environmental effects, but these effects would decrease as the level of digitalization increases, reaching a point where digital advances would improve sustainability. Several studies have empirically supported this thesis (Higón et al. 2017; Li and Wang 2017; Kamah et al. 2021; Peiró-Palomino et al. 2022).

In consequence, applying the above reasoning to MSMEs leads us to propose a similar nonlinear relationship. So, the following hypothesis is tested in this paper:

H1b. *The relationship between digitalization in MSMEs and sustainability is nonlinear.*

2.2 | Institutional Context

Another aspect that promotes sustainability is IQ. Good institutions are fundamental in managing the relevant resources needed to improve the quality of the environment (Salman et al. 2019; Guo et al. 2023), and the predominant theoretical framework employed to argue the influence of institutional factors on corporate sustainability performance (Wright et al. 2005; Aguilera et al. 2007). According to the theory's postulates, organizations seek to enhance or maintain their legitimacy through sustainable activities (Scott 1995). In line with this logic, environmental quality depends on policies and measures formulated and implemented by the government to influence macroeconomic outcomes, such as environmental pollution (Traoré et al. 2024).

A considerable body of research has investigated the relationship between IQ and sustainability using macroeconomic country data. Some have examined the effect of IQ on carbon emissions in different countries and regions. Focusing only on the most recent empirical research, many of them have demonstrated the existence of a positive effect of IQ on CO_2 emissions (Azam et al. 2021; Nwani and Adams 2021; Shan et al. 2021; Teng et al. 2021; Karim et al. 2022; Khan et al. 2022; Obobisa et al. 2022; Ofoeda et al. 2024).

A limited number of empirical studies have analyzed the relationship between IQ and sustainability using firm-level data. Boura et al. (2020) analyze the relationship between a set of IQ variables (environmental performance, openness to international trade, regulatory quality, and corruption) and sustainability disclosure, drawing on previous studies (Cahan et al. 2016; Pucheta-Martínez and Gallego-Álvarez 2019). Based on data from 2687 companies from 21 countries, the results show the positive impact of various institutional variables on sustainability disclosure. Rahi et al. (2023) analyzed the nexus between IQ and sustainable corporate performance, based on the relationship between the company's environmental, social and governance (ESG) performance and the Worldwide Governance Indicators by the World Bank, using data from 796 companies from different sectors and sizes collected in 30 European countries. So, there is a positive and significant relationship between the quality of institutions and the ESG score, except for the combination of political stability and the absence of violence and regulatory quality. This effect is more pronounced for companies with lower levels of ESG compliance, meaning that as these companies improve their IQ, their ESG compliance increases more than for companies with better environmental compliance.

Therefore, the above findings lead to the test of the following hypothesis:

H2. *IQ enhances sustainability in MSMEs*

2.3 | Moderation Effect of Institutional Context on Digitalization

It argues that institutional factors influence firm behavior. One of the main effects of this influence is to moderate the impact of certain variables on the outcome of their decisions, as is the case with digitalization.

As argued before, many studies have demonstrated the positive impact of digitalization on sustainability. However, this effect may be conditioned by institutional factors that affect its

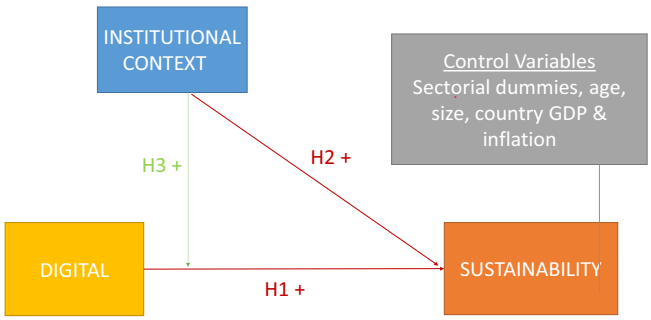

FIGURE 1 | Research model.

TABLE 1 | Sample distribution by sector and size.

Variable	Categories	*Number of MSMEs*	%
Sector	*Primary*	953	5.4
	Extractive	153	0.9
	Manufacture	4.270	24.4
	Energy, water, recycling	177	1.0
	Construction	668	3.8
	Commerce	2.432	13.9
	Services	6.402	36.6
	Other	2.443	14.0
Size	*Micro (6–9 employees)*	9.186	52.5
	Small (10–49 employees)	5.364	30.7
	Medium (50–249 employees)	2.948	16.8
	Total sample	17.498	100.0

intensity (Guo et al. 2023). The efficacy of green digitalization as a catalyst for environmental innovation may be contingent upon two formal institutional forces: government intervention (financial investment in building digital infrastructures) and government support (intervening in the factor market).

Some studies have shown that certain institutional factors influence this relationship across contexts. For example, a study conducted across different Chinese provinces between 2012 and 2018 found that the greater the degree of government intervention, the smaller the effect of digitalization on environmental innovation (Guo et al. 2023).

A study of 486 companies across different regions shows that companies can improve their sustainability (not only environmental but also economic and social) through digitalization capabilities amid institutional pressures (legal restrictions or regulations, especially those banning environmental pollution) (Lee et al. 2024).

In the European context, this moderating effect has also been observed. A study of the impact of the introduction of digital public services on the value of trade in green goods in 25 European economies shows that this effect is more significant in economies with a well-developed institutional system, as measured by the six indicators of the level of IQ from the International Country Risk Guide (ICRG): voice and accountability, political stability and absence of violence/terrorism, government

TABLE 2 | Sample distribution by country.

Country	*Number of MSMEs*	*%*
Argentina	1.142	6.7
Bolivia	137	0.8
Brasil	987	5.6
Chile	271	1.5
Colombia	4.600	26.3
Costa Rica	532	3.0
Dominican Republic	135	0.8
Ecuador	2.059	11.8
El Salvador	161	0.9
Guatemala	112	0.6
Honduras	130	0.7
Mexico	4.121	23.6
Nicaragua	450	2.6
Panama	514	2.9
Paraguay	441	2.5
Peru	347	2.0
Spain	1.044	6.0
Uruguay	315	1.8
Total sample	17.498	100.0

TABLE 3 | Descriptive statistics, correlations, and VIF.

Variables	Obs.	Mean	S.D.	*SUSTAINABILITY*	DIGITAL	IQ	SIZE	AGE	GDP	INFLATION
SUSTAINABILITY	14.315	−0.004	1	1.000						
DIGITAL	14.316	0.003	1	0.411 (0.000)	1.000					
IQ	14.315	−0.220	0.397	−0.031 (0.000)	−0.045 (0.000)	1.000				
SIZE	14.315	1.651	0.755	0.159 (0.000)	0.362 (0.000)	0.001(0.966)	1.000			
AGE	14.315	14.740	16.731	0.037 (0.000)	0.127 (0.000)	0.144 (0.000)	0.288 (0.000)	1.000		
GDP	14.315	10.76361	6.27921	−0.077(0.000)	−0.044(0.000)	0.718 (0.000)	0.022 (0.002)	0.193 (0.000)	1.000	
INFLATION	14.315	0.142	0.223	−0.126(0.000)	−0.009(0.245)	0.015 (0.037)	0.125 (0.000)	0.171 (0.000)	0.133 (0.000)	1.000
VIF					1.17	2.20	1.30	1.23	2.29	1.09

effectiveness, regulatory quality rule of law, and control of corruption (Ha and Thanh 2022).

So, in light of the abovementioned evidence, we expect a positive effect of the nonlinear relationship between digitalization and environmental practices in MSMEs:

H3. *IQ moderates the nonlinear relation between digitalization and sustainability in MSMEs.*

In line with the abovementioned hypotheses, we check the following research model shown in Figure 1:

3 | Data

3.1 | Sample

To test our hypotheses, we used the data from the "MSME 2022 report: Digitalization and Sustainable Development of MSME in Ibero-America," carried out by the Ibero-American Observatory of the MSME. These data were collected by telephone and online surveys, as in previous observational studies. General managers are the key decision-makers (O'Regan and Sims 2008), and they were questioned. Random sampling was used to select each stratum. To obtain aggregate results, the corresponding elevation factors had to be used, since the results are not exactly proportional to the reference population or universe. This guarantees a comparable, objective process for assessing whether the sample is sufficient to meet the research goals. However, it is crucial to stress that the various statistical tests and analyses that have been conducted during the study will have their significance or level of accuracy assessed based on the data that was collected in the survey, as well as in compliance with the statistical methods applied and the degree of aggregation determined in each instance. The final sample has answers from 17.498 Ibero-American MSMEs. Table 1 shows the distribution of the sample by sector of activity and size, and Table 2 shows the distribution by country. The overall sampling error for the sample used is 1.1% at a confidence level of 95%. The population sizes (total number of companies in each stratum) were obtained from the official statistical sources of the countries in the sample.

Additionally, we conducted tests to assess potential bias in our data. Using Harman's one-factor test, we first performed a principal component analysis on the variables in our model (Podsakoff et al. 2003). The absence of common method bias is indicated by the result, which showed that no dominant factor emerged (10.763% of variance explained). To rule out nonresponse bias, we also compared the early and late responders in our sample (Armstrong and Overton 1977). According to our findings, there are no appreciable variations between the two groups in terms of the dependent and independent variables: size and industry.

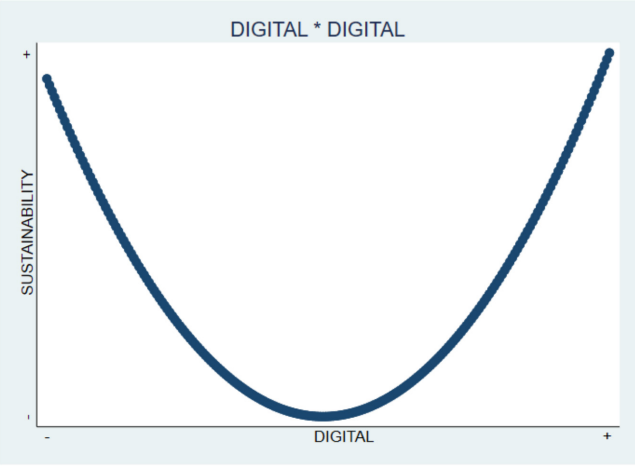

FIGURE 2 | Nonlinear effect of DIGITAL*DIGITAL. Nonlinear effect of DIGITAL on SUSTAINABILITY.

TABLE 4 | Regression coefficients.

	H1a, H2	H1b	H3
DIGITAL	0.399*** (0.007)	0.378*** (0.010)	0.336*** (0.011)
IQ	0.117*** (0.028)	0.120*** (0.028)	0.052 (0.037)
*DIGITAL*DIGITAL*		0.030*** (0.008)	0.039*** (0.011)
*DIGITAL*IQ*			−0.174*** (0.024)
*DIGITAL*DIGITAL*IQ*			0.051** (0.025)
SIZE	0.026** (0.011)	0.027** (0.011)	0.026** (0.011)
AGE	0.001 (0.001)	0.001 (0.001)	0.001* (0.001)
GDP	0.001 (0.001)	0.001(0.001)	0.001* (0.001)
INFLATION	−0.541*** (0.033)	−0.540*** (0.033)	−0.540*** (0.033)
Constant	0.216*** (0.062)	0.181*** (0.062)	0.162** (0.062)
Observations	14.315	14.315	14.315
R-squared	0.201	0.202	0.204

Note: Heteroskedasticity-robust regression coefficients. Heteroskedasticity *y*-robust standard error in parentheses. Sectoral dummy variables are included in the three models (industry, construction, distribution, and service).

3.2 | Variables

3.2.1 | Dependent Variables

3.2.1.1 | Environmental Practices (SUSTAINABILITY). The following specific MSME features are included in this variable: supplier selection, process design, energy management, water management, management of plastic containers and derivatives, and environmental certifications. The Sustainable Development Goals (SDG) and the 2030 Agenda for Sustainable Development (United Nations 2015), as well as the literature on SMEs, sustainable management, and sustainability, are all in accordance with these environmental procedures (Jansson et al. 2017; Cantele and Zardini 2020; Ndubisi et al. 2021). Our variable includes organizational change intended to accomplish the 2030 SDG as well as environmentally responsible action. MSMEs are essential to achieving the SDGs because they are the dominant business model and because their contributions and unique challenges must be taken into account, as they do not operate like large corporations (Cantele and Zardini 2020).

This construct has an alpha of Cronbach of 0.922, a Kaiser–Meyer–Olkin (KMO) of 0.920, and a Bartlett *p*-value of 0.00. Most of the items show a factor loading higher than 0.70. Principal component analysis shows a strong first factor with an eigenvalue of 4.79, explaining 68.54% of the variance. Average variance extracted (AVE) is 0.681, and comparative fix index (CFI) is 0.949.

3.2.2 | Independent Variables

3.2.2.1 | Digitalization (DIGITALIZATION). The construct represented by this independent variable is derived from a set of 5-point Likert-scale questions regarding the use and significance of various advanced technologies in small and medium-sized enterprises (SMEs) within our sample. These technologies include corporate intranets, big data and data analysis software, robotization and sensitization, cybersecurity services, ERPs (integrated management systems), and the Internet of Things. One component of digital transformation strategies is the application of advanced technologies (Matt et al. 2015). Possessing advanced technology can give a company a competitive advantage. Consequently, there could be a significant improvement in corporate performance that would affect every facet of the business (Heavin and Power 2018).

We obtained the construct from the first factor derived from the factor analysis of the aforementioned questions. The alpha of Cronbach is 0.890, the KMO is 0.9004, and the Bartlett test provides a significance *p*-value of 0.00. All the questions have a factor loading higher than 0.70. Principal component analysis shows a strong first factor with an eigenvalue of 3.88, explaining 64.71% of the variance. AVE is 0.60, and CFI is 0.955.

3.2.2.2 | IQ. To measure the quality of the institutional context, we use a variable, the average value of the six indicators of governance established by the World Bank, the Worldwide Governance Indicators. The related data were obtained from the World Bank repository. This variable has been widely used to measure the impact of the institutional context in similar studies (Cahan et al. 2016; Boura et al. 2020; Rahi et al. 2023).

3.2.3 | Control Variables

As control variables, we use the log of firm age (*AGE*), *SIZE* (number of employees), country's gross domestic product (*GDP*),

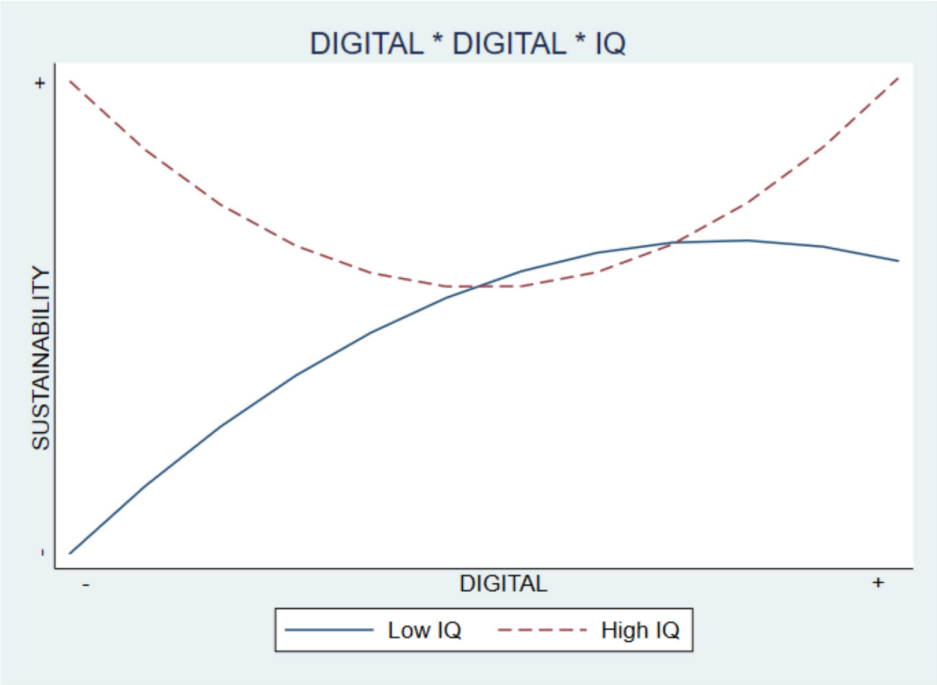

FIGURE 3 | Moderation DIGITAL*DIGITAL*IQ. Moderating influence of contexts with high and low IQ, on the nonlinear effect of DIGITAL on SUSTAINABILITY.

inflation (*INFLATION*), and sectoral dummies (*INDUSTRY, CONSTRUCTION, COMMERCE, AND SERVICE*).

3.2.4 | Summary Statistics

Table 3 presents the descriptive statistics, correlations, and variance inflation factors (VIFs) for the estimation sample. Most of the MSMEs in our sample are micro (6–9 employees) or small (10–49 employees). Moreover, the average age is 13 years (the value of the variable AGE without taking the logarithm). Correlation and collinearity are not a problem in our sample.

Note: Significance levels are in parentheses.

4 | Methodology and Results

As in similar studies related to MSMEs and moderating hypotheses (Clemente-Almendros et al. 2025; García-Pérez-de-Lema et al. 2021), we use ordinary least squares (OLS) linear regression to test our hypotheses. We checked the regression analysis's statistical assumptions to assess the robustness of our results. First, we use heteroskedasticity-robust standard errors, which ensure homoscedasticity validity (White 1980). Second, the Durbin–Watson statistic is 1.945, which falls within the range of 1.5 to 2.5, and the residuals have a mean of zero. Third, the normality assumption was tested (Jarque and Bera 1987; Lumley et al. 2002). Fourth, in addition to the unstandardized variables, we use standardized variables with robust standard errors. To examine the moderating hypotheses, we plot the two-way interactions in our model to better understand them (Aracil-Jordá et al. 2023; Pérez-Luño et al. 2018).

Table 4 shows that all of our hypotheses are confirmed. DIGITAL exhibits a positive and significant coefficient of 0.399, confirming the positive influence of digitalization on environmental practices (H1a). The positive and significant coefficient of 0.030 shows the nonlinear relationship between DIGITAL and our dependent variable (H1b). The influence of the institutional context is probed by the coefficient of 0.117 (H2). Finally, the moderation role of IQ is satisfied by the coefficient of 0.051 (H3).

*$p < 0.10$.

**$p < 0.05$.

***$p < 0.01$.

5 | Discussion

Achieving the desired double transition represents a significant challenge for MSMEs. While these entities possess greater flexibility to adapt to the changes required by this transition, the lower availability of resources (economic and human) presents a significant obstacle to its implementation (Tick et al. 2022; Issah et al. 2024). Additionally, managers often express concern about the potential trade-offs between adopting advanced digital technologies and maintaining environmental performance (Miranda et al. 2024).

TABLE 5 | Quantile regression nonlinear relationship of DIGITAL*DIGITAL.

	q10	*q30*	*q50*	*q70*	*q90*
DIGITAL	0.242*** (0.015)	0.588*** (0.020)	0.523*** (0.013)	0.341*** (0.013)	0.151*** (0.015)
IQ	0.001 (0.006)	0.058 (0.052)	0.175*** (0.055)	0.150*** (0.033)	0.078*** (0.019)
*DIGITAL * DIGITAL*	0.143*** (0.012)	0.045*** (0.017)	0.034*** (0.012)	0.042*** (0.008)	−0.002 (0.010)
SIZE	0.006 (0.004)	0.047*** (0.012)	0.005 (0.012)	0.000 (0.010)	0.004 (0.007)
AGE	0.000 (0.000)	0.001* (0.000)	0.000 (0.0001)	−0.000 (0.000)	−0.000 (0.000)
GDP	2.68e−07 (5.29e−07)	−7.26e−06** (2.82e−06)	−1.76e−05*** (2.85e−06)	−1.47e−05*** (2.26e−06)	−8.42e−06*** (1.41e−06)
INFLATION	−0.108*** (0.031)	−0.512*** (0.042)	−0.693*** (0.051)	−0.564*** (0.073)	−0.347*** (0.077)
Constant	−1.402*** (0.015)	−0.498*** (0.126)	0.314*** (0.106)	0.887*** (0.059)	1.413*** (0.037)
Observations	14.315	14.315	14.315	14.315	14.315

Note: Quantile regression coefficients. Standard errors in parentheses. 10th, 30th, 50th, 70th, and 90th quantiles. Sectoral dummy variables are included in the three models (industry, construction, distribution, and service).
*$p < 0.10$.
**$p < 0.05$.
***$p < 0.01$.

Nevertheless, there is a paucity of empirical research in this area, with none having been carried out in the Ibero-American context (Hernandez 2018; Chege and Wang 2020; Issah et al. 2024; Miranda et al. 2024). Even though empirical evidence from several geographical areas has demonstrated a positive influence of digitalization on sustainability, the results are inconclusive. However, it remains to be investigated in the context of Ibero-American MSMEs, which exhibit deficiencies in digitalization and environmental sustainability, where the effect of IQ is more critical.

Our results confirm that the level of importance attached to advanced digitalization technologies drives the use of environmental criteria in smaller companies, thus supporting hypothesis H1a. Furthermore, several empirical studies have demonstrated that the relationship between digitalization and environmental sustainability is nonlinear (Higón et al. 2017; Li and Wang 2017; Peiró-Palomino et al. 2022; Li and Yang 2024). Some research has shown that this relationship exhibits a U-shaped pattern, suggesting that the impact of digitalization on environmental sustainability may initially be adverse before reversing. This pattern aligns with the well-known Kuznets curve, though applied to digitalization rather than economic development.

Notwithstanding the above, previous studies have proven the existence of this nonlinear relationship mainly at the macroeconomic level. Our research extends this to the micro level by showing a nonlinear quadratic effect between the digitalization of MSMEs and the adoption of environmental practices, thereby confirming hypothesis H1b. Figure 2 illustrates this relationship, showing that the implementation of advanced digitalization technologies in MSMEs will only have an impact on sustainability if their utilization and significance are high; otherwise, the effects will be contrary to those desired.

Furthermore, the proven positive impact of digitalization and other institutional factors, such as digital infrastructure, government measures, cyberculture, quality of digital public services, and government efforts to improve sustainability (Guo et al. 2023; Ha and Thanh 2022; Lee et al. 2024) can be extended to the use of environmental management criteria in Ibero-American MSMEs. This confirms hypothesis H2. Environmental management in Ibero-American MSMEs is affected by improving the IQ of their countries. This idea is aligned with the influence of institutional factors.

This research also shows that IQ moderates the relationship between digitalization and the development of environmental practices in Ibero-American MSMEs, thereby supporting hypothesis H3. Figure 3 provides a visual representation of this moderation effect. Using the Johnson–Neyman technique (Mitchell 2021), we statistically validated region-wise slopes and found that the conditional effect of digitalization on sustainability, as a function of IQ, is significant, with positive confidence intervals across all values of the moderator.

When analyzing this moderating effect more deeply in Figure 3, the relationship between digitalization and the use

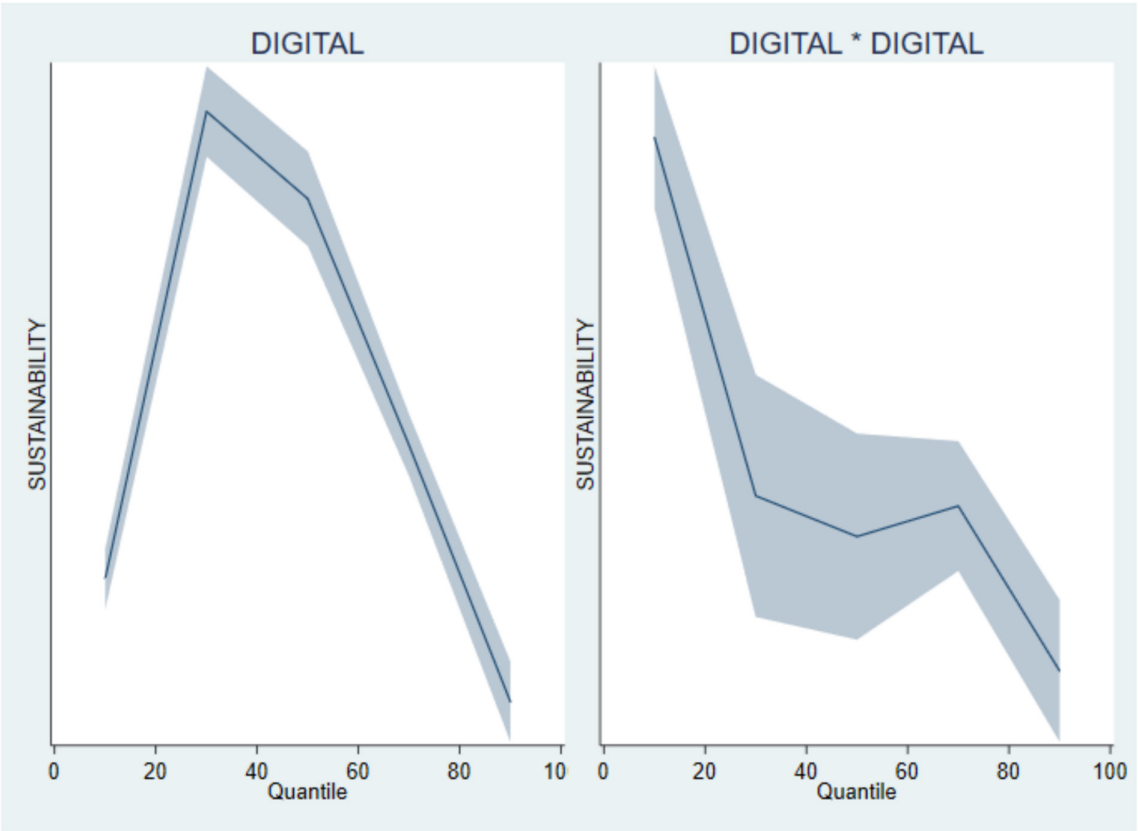

FIGURE 4 | Quantile regression nonlinear relationship of DIGITAL*DIGITAL. Quantile regressions of the Nonlinear effect of DIGITAL on SUSTAINABILITY.

of environmental criteria, although still quadratic, may also be inverted. In countries with low IQ, improvements in the use of advanced technologies initially increase the development of environmental policies. However, this positive effect disappears beyond a certain level of digitalization. It shows a nonlinear relationship, which is aligned with H1b and Figure 2. However, the shape of this nonlinear relationship can change by the effect of IQ. Conversely, in countries with high IQ, digitalization and environmental sustainability may initially be perceived as trade-offs; however, beyond a certain point, companies begin to view environmental improvements as investments, leading to greater implementation of environmental measures. Therefore, although the moderating effect of IQ is evident, it varies depending on the level of IQ in the firm's country.

5.1 | Theoretical Implications

According to the results of hypothesis H1a, digitalization drives the development of environmental management practices in Ibero-American MSMEs. However, this relationship is conditioned by environmental factors that determine the quality of institutions: voice and accountability, political stability/absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption, as the H2 hypothesis demonstrates.

If the institutional context is at an appropriate level, in the early stages of MSME digitalization, promoting environmental sustainability will be seen as a cost, and managers will be reluctant to adopt environmental practices. However, once the digital transition is complete, companies will be able to implement environmental practices due to institutional encouragement, regulation, and market demand. In short, in these contexts, the extension of the Kuznets curve to the adoption of advanced digital technologies is confirmed.

However, in case that institutional context does not help, MSME managers may also choose to make the double transition. However, there will come a point where the lack of institutional and market pressure and support will discourage the pursuit of these practices.

In short, the mere availability of digital technologies may not, in itself, provide value in MMSEs. These resources must interact with the organization through a transformational process (Díaz-Pelaez et al. 2024) via environmental awareness, and their effect is influenced by contingency factors, one of which is IQ. In line with DCV and IT theories, it is the manager's transformational capacity and IQ that determine the intensity of use and the importance attached to environmental practices in MSMEs.

5.2 | Managerial Implications

From a managerial perspective, the acceptance of hypothesis H1 implies that the use of advanced digital technologies (ERP software, cybersecurity services, big data and data analytics, robotization, localization, and the Internet of Things) can facilitate the development of environmental strategies in small and medium-sized businesses.

TABLE 6 | Quantile regression: the moderation effect of IQ.

	q10	*q30*	*q50*	*q70*	*q90*
DIGITAL	0.217*** (0.013)	0.518*** (0.019)	0.464*** (0.022)	0.302*** (0.016)	0.139*** (0.011)
IQ	0.008 (0.051)	0.019 (0.062)	0.112** (0.054)	0.138** (0.055)	0.0354 (0.045)
DIGITAL * *DIGITAL*	0.111*** (0.018)	0.050** (0.020)	0.053*** (0.017)	0.051*** (0.017)	0.004 (0.009)
DIGITAL * *IQ*	−0.100** (0.039)	−0.258*** (0.035)	−0.264*** (0.028)	−0.149*** (0.034)	−0.081*** (0.024)
DIGITAL * *DIGITAL* * *IQ*	−0.113** (0.052)	0.029 (0.036)	0.105*** (0.034)	0.047 (0.030)	0.049** (0.020)
SIZE	0.008 (0.006)	0.038*** (0.013)	0.004 (0.012)	0.002 (0.008)	0.006 (0.006)
AGE	0.000 (0.000)	0.001*** (0.000)	0.000** (0.000)	−0.000 (0.000)	−0.000 (0.000)
GDP	6.17e−07 (7.32e−07)	−9.04e−06*** (2.64e−06)	−1.85e−05*** (3.38e−06)	−1.58e−05*** (2.84e−06)	−8.52e−06*** (1.71e−06)
INFLATION	−0.115*** (0.038)	−0.511*** (0.038)	−0.689*** (0.037)	−0.557*** (0.051)	−0.328*** (0.076)
Constant	−1.401*** (0.022)	−0.501*** (0.113)	0.334*** (0.117)	0.900*** (0.063)	1.395*** (0.045)
Observations	14.315	14.315	14.315	14.315	14.315

Note: Quantile regression coefficients. Standard error in parentheses. 10th, 30th, 50th, 70th, and 90th quantiles. Sectorial dummy variables are included in the three models (industry, construction, distribution, and service).
*$p < 0.10$.
**$p < 0.05$.
***$p < 0.01$.

However, this requires a real commitment to digitalization. When company managers assign high importance to the use and significance of novel digital technologies, they are more inclined to emphasize environmental practices in MSMEs. The application of digitalization in SMEs should not be seen as a business fad but as a tool that brings benefits on many levels, one of which is sustainability. Dynamic management capabilities to anticipate environmental changes and understand the implications of digitalization alternatives on environmental practices are essential to achieving the double transition.

5.3 | Institutional Implications

The findings emphasize the pivotal role of public institutions in enabling MSMEs to achieve the double transition. Understanding how institutional factors influence the relationship between digitalization and sustainability is essential for designing effective policy measures.

Results supporting hypothesis H3 highlight that IQ moderates the impact of digitalization on sustainability. In favorable contexts, governments should focus on accelerating the digital–green transition by providing incentives, training, and access to technology, ensuring that firms perceive environmental investments as opportunities rather than costs.

In contrast, in less favorable environments, public action must first aim to strengthen governance, transparency, and legal stability. Improving participation, freedom of expression, political stability, and control of corruption is critical to creating credible frameworks that sustain MSME innovation. Without such institutional support, progress in digitalization and environmental practices will likely remain temporary and fragile.

Ultimately, achieving the double transition in MSMEs requires a coordinated strategy: Digital transformation, environmental commitment, and institutional strengthening must advance simultaneously. Only under such conditions can the twin transition become a long-term, self-sustaining process.

5.4 | Robustness

To check the robustness of our nonlinear and interaction models, we use quantile regressions. Table 5 shows the quantile regression coefficients for H2. All the coefficients for DIGITAL and DIGITAL*DIGITAL are significant for all the quantiles,

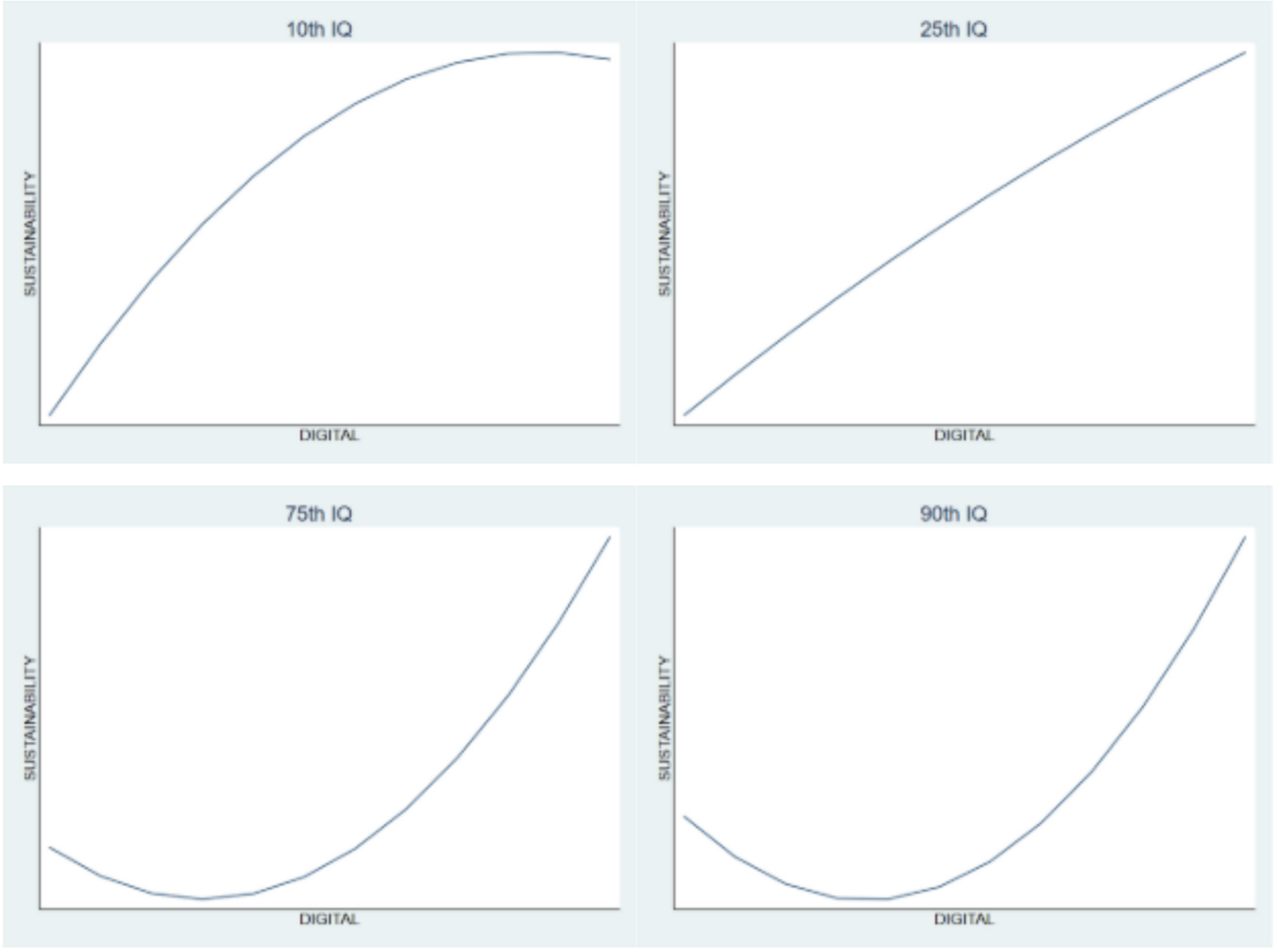

FIGURE 5 | Quantile regression: the moderation effect of IQ.

aligned with Table 4, with the only exception of the 90th quantile.

Figure 4 helps to visualize the nonlinear relationship shown in Table 5. The opposite shape of the linear and nonlinear coefficients confirms H1b (Shakib et al. 2023; Damra et al. 2023).

Next, Table 6 shows the results from quantile regression for our moderation hypothesis. Most interaction effects are significant, which aligns with Table 3.

Figure 5 shows the marginal effects of DIGITAL on SUSTAINABILITY at its 50th quantile conditional on the 10th, 25th, 50th, 75th, and 90th quantiles of IQ (Hoang et al. 2024).

Finally, given the nested nature of the data, we use OLS with country-clustered standard errors and a mixed-effects model, yielding results similar to those in Table 4.[1] Moreover, in the mixed-effects model, the variance of the random intercept for countries (0.0142) and the intraclass correlation coefficient (0.0176) suggest that grouping by country is not useful, making a single-level model appropriate.

Statistical and graphically, our findings help to answer our research questions, extending the current state-of-the-art, and going beyond plain effects. We analyze in a greater depth more complex relationships, showing a non-so-obvious interplay. There is a nonlinear relationship, as well as a transition or reversal influence in the analyzed relationships. By means of H1b and H3, the final effects of DIGITAL and INSTITUTIONAL CONTEXT are really understood by the nonlinear and moderation relationships.

6 | Conclusion

The main objective of this study is to explore the relationship between digitalization and sustainability in Latin American MSMs and to investigate the moderating role of IQ in this relationship.

The results show that the impact of digitalization on employment and sustainable activities in MSMEs is not direct. It depends on both managers' ability and motivation to implement such measures, as well as on the country's IQ. Although in the short term, implementing technological improvements in SMEs can improve environmental performance, only an appropriate institutional climate will sustain these improvements over time.

The results are consistent with DCV and IT theories. Dynamic capabilities have a significantly positive impact on digital transformation. The manager's ability to anticipate and implement constant changes in the technological environment is the key to achieving sustainable improvements. Similarly, and in line with the postulates of IT, institutional pressures play a fundamental role in the relationship between digitalization and sustainability, as they determine the level of IQ.

The study offers very important implications for both theory and practice. Firstly, it addresses a crucial gap in the literature on the relationship between digitalization and sustainability in smaller companies by exploring their link to IQ. The research offers new perspectives on the double transition in these companies. It highlights the pivotal role of managers in advancing sustainability and emphasizes their commitment to digitalization within their organizations. In addition, the study highlights the significance of IQ in this relationship. The formulation of sustainability policies must not be conceived in isolation; rather, institutional considerations must be incorporated to enhance their efficacy. Sustainability is compromised when digitalization policies are implemented without robust institutions. Consequently, future research may address how different institutional programs can favor sustainability in MSMEs in order to prioritize public actions according to their efficiency. In this line, different types of actions in these organizations aimed to improve organizational commitment toward both digitalization and sustainability may improve the efficiency of the sustainable transition.

The present study is subject to several limitations inherent to its nature. Although the present work provides novel insights into the importance of DCV and IT between digitalization and sustainability in MSMEs, future studies could assess the applicability of stakeholder theory in this relationship as a driving force to promote institutional strength. Furthermore, the study focuses exclusively on Latin American MSMEs, so the findings may not extend to other areas. Finally, qualitative case studies and longitudinal analysis would enhance and confirm our findings.

Funding

This study was supported by the Universidad Internacional de La Rioja, with the reference PP-2021-04.

Endnotes

[1] The results are available under request.

References

Acciarini, C., F. Borelli, F. Capo, F. Cappa, and C. Sarrocco. 2022. "Can Digitalization Favour the Emergence of Innovative and Sustainable Business Models? A Qualitative Exploration in the Automotive Sector." *Journal of Strategy and Management* 15, no. 3: 335–352. https://doi.org/10.1108/JSMA-02-2021-0033.

Adeshola, I., O. Usman, M. Agoyi, A. A. Awosusi, and T. S. Adebayo. 2024. "Digitalization and the Environment: the Role of Information and Communication Technology and Environmental Taxes in European Countries." *Natural Resources Forum* 48, no. 4: 1088–1108. https://doi.org/10.1111/1477-8947.12342.

Agrawal, R., V. A. Wankhede, A. Kumar, A. Upadhyay, and J. A. Garza-Reyes. 2022. "Nexus of Circular Economy and Sustainable Business Performance in the Era of Digitalization." *International Journal of Productivity and Performance Management* 71, no. 3: 748–774. https://doi.org/10.1108/IJPPM-12-2020-0676.

Aguilera, R. V., D. E. Rupp, C. A. Williams, and J. Ganapathi. 2007. "Putting the S Back in Corporate Social Responsibility: a Multilevel Theory of Social Change in Organizations." *Academy of Management Review* 32, no. 3: 836–863. https://doi.org/10.5465/amr.2007.25275678.

Ahmadi Achachlouei, M., and L. M. Hilty. 2015. "Modeling the effects of ICT on environmental sustainability: Revisiting a system dynamics model developed for the European Commission." In *ICT Innovations for Sustainability*, edited by H. Springer, 449–474. Springer International Publishing. https://doi.org/10.1007/978-3-319-09228-7_27.

Ahmadova, G., B. L. Delgado-Márquez, L. E. Pedauga, and D. I. de la Leyva- Hiz. 2022. "Too Good to Be True: the Inverted U-Shaped Relationship Between Home-Country Digitalization and Environmental Performance." *Ecological Economics* 196: 107393. https://doi.org/10.1016/j.ecolecon.2022.107393.

Al-Moaid, N. A. A., and S. G. Almarhdi. 2024. "Developing Dynamic Capabilities for Successful Digital Transformation Projects: the Mediating Role of Change Management." *Journal of Innovation and Entrepreneurship* 13, no. 1: 85. https://doi.org/10.1186/s13731-024-00446-9.

Aracil-Jordá, J., J. A. Clemente-Almendros, A. I. Jiménez-Zarco, and I. González-González. 2023. "Improving the Social Performance of Women-Led Microenterprises: the Role of Social Media Marketing Actions." *Technological Forecasting and Social Change* 191: 122484. https://doi.org/10.1016/j.techfore.2023.122484.

Ardito, L., S. Raby, V. Albino, and B. Bertoldi. 2021. "The Duality of Digital and Environmental Orientations in the Context of SMEs: Implications for Innovation Performance." *Journal of Business Research* 123: 44–56. https://doi.org/10.1016/j.jbusres.2020.09.022.

Armstrong, J. S., and T. S. Overton. 1977. "Estimating Nonresponse Bias in Mail Surveys." *Journal of Marketing Research* 14, no. 3: 396–402. https://doi.org/10.2307/3150783.

Azam, M., A. I. Hunjra, E. Bouri, Y. Tan, and M. A. S. Al-Faryan. 2021. "Impact of Institutional Quality on Sustainable Development: Evidence From Developing Countries." *Journal of Environmental Management* 298: 113465. https://doi.org/10.1016/j.jenvman.2021.113465.

Baggia, A., M. Maletič, A. Žnidaršič, and A. Brezavšček. 2019. "Drivers and Outcomes of Green IS Adoption in Small and Medium-Sized Enterprises." *Sustainability* 11, no. 6: 1575. https://doi.org/10.3390/su11061575.

Bansal, P. 2003. "From Issues to Actions: the Importance of Individual Concerns and Organizational Values in Responding to Natural Environmental Issues." *Organization Science* 14, no. 5: 510–527. https://doi.org/10.1287/orsc.14.5.510.16765.

Bansal, P. 2019. "Sustainable Development in an Age of Disruption." *Academy of Management Discoveries* 5, no. 1: 8–12. https://doi.org/10.5465/amd.2019.0001.

Bansal, P., and I. Clelland. 2004. "Talking Trash: Legitimacy, Impression Management, and Unsystematic Risk in the Context of the Natural Environment." *Academy of Management Journal* 47, no. 1: 93–103. https://doi.org/10.5465/20159562.

Beier, G., S. Niehoff, and B. Xue. 2018. "More Sustainability in Industry Through Industrial Internet of Things?" *Applied Sciences* 8, no. 2: 219. https://doi.org/10.3390/app8020219.

Ben Youssef, A., and M. Dahmani. 2024. "Assessing the Impact of Digitalization, Tax Revenues, and Energy Resource Capacity on Environmental Quality: Fresh Evidence from CS-ARDL in the EKC Framework." *Sustainability* 16, no. 2: 474. https://doi.org/10.3390/su16020474.

Bendig, D., C. Schulz, L. Theis, and S. Raff. 2023. "Digital Orientation and Environmental Performance in Times of Technological Change." *Technological Forecasting and Social Change* 188: 122272. https://doi.org/10.1016/j.techfore.2022.122272.

Berkhout, F., and J. Hertin. 2004. "De-Materialising and Re-Materialising: Digital Technologies and the Environment." *Futures* 36, no. 8: 903–920. https://doi.org/10.1016/j.futures.2004.01.003.

Berrone, P., C. Cruz, L. R. Gomez-Mejia, and M. Larraza-Kintana. 2010. "Socioemotional Wealth and Corporate Responses to Institutional Pressures: Do Family-Controlled Firms Pollute Less?" *Administrative Science Quarterly* 55, no. 1: 82–113. https://doi.org/10.2189/asqu.2010.55.1.82.

Boura, M., D. A. Tsouknidis, and S. Lioukas. 2020. "The Role of Pro-Social Orientation and National Context in Corporate Environmental Disclosure." *European Management Review* 17, no. 4: 1027–1040. https://doi.org/10.1111/emre.12416.

Brenner, B., and B. Hartl. 2021. "The Perceived Relationship Between Digitalization and Ecological, Economic, and Social Sustainability." *Journal of Cleaner Production* 315: 128128. https://doi.org/10.1016/j.jclepro.2021.128128.

Cahan, S. F., C. De Villiers, D. C. Jeter, V. Naiker, and C. J. Van Staden. 2016. "Are CSR Disclosures Value Relevant? Cross-Country Evidence." *European Accounting Review* 25, no. 3: 579–611. https://doi.org/10.1080/09638180.2015.1064009.

Cantele, S., and A. Zardini. 2020. "What Drives Small and Medium Enterprises Towards Sustainability? Role of Interactions Between Pressures, Barriers, and Benefits." *Corporate Social Responsibility and Environmental Management* 27, no. 1: 126–136. https://doi.org/10.1002/csr.1778.

Chege, S. M., and D. Wang. 2020. "The Influence of Technology Innovation on SME Performance Through Environmental Sustainability Practices in Kenya." *Technology in Society* 60: 101210. https://doi.org/10.1016/j.techsoc.2019.101210.

Chen, X., M. Despeisse, and B. Johansson. 2020. "Environmental Sustainability of Digitalization in Manufacturing: a Review." *Sustainability* 12, no. 24: 10298. https://doi.org/10.3390/su122410298.

Chen, Z., X. Hao, and M. Zhou. 2022. "Does Institutional Quality Affect Air Pollution?" *Environmental Science and Pollution Research* 29, no. 19: 28317–28338. https://doi.org/10.1007/s11356-021-17934-0.

Clemente-Almendros, J. A., T. González-Cruz, and S. Camisón-Haba. 2025. "Does Innovation Practices Enhance the Impact of Environmental Criteria Adoption Over Entrepreneurial SMEs' Performance?" *International Entrepreneurship and Management Journal* 21: 18. https://doi.org/10.1007/s11365-024-01030-z.

Damra, Y., S. Yasin, and M. Albaity. 2023. "Trust But Verify Financial Inclusion in the MENA Region." *Borsa Istanbul Review* 23, no. 6: 1430–1447.

Danneels, E. 2002. "The Dynamics of Product Innovation and Firm Competences." *Strategic Management Journal* 23, no. 12: 1095–1121. https://doi.org/10.1002/smj.275.

Del Río, G., M. C. González, and A. Uruburu. 2021. "Unleashing the Convergence amid Digitalization and Sustainability towards Pursuing the Sustainable Development Goals (SDGs): a Holistic Review." *Journal of Cleaner Production* 280: 122204. https://doi.org/10.1016/j.jclepro.2020.122204.

Delgosha, M. S., N. Hajiheydari, and T. Saheb. 2020. "The Configurational Impact of Digital Transformation on Sustainability: a Country-Level Perspective." In *In Proceedings of the 28th European Conference on Information Systems (ECIS 2020)*. AIS Electronic Library (AISeL).

Díaz-Pelaez, A., G. Chura-Quispe, J. A. Clemente-Almendros, and J. F. Velarde-Molina. 2024. "Analysing the Influence of Digital Strategy and Innovation on MSMEs' Performance in Emerging Countries." *Creativity and Innovation Management* 34: 1–363. https://doi.org/10.1111/caim.12642.

Ding, K., P. Jiang, and M. Zheng. 2017. "Environmental and Economic Sustainability-Aware Resource Service Scheduling for Industrial Product Service Systems." *Journal of Intelligent Manufacturing* 28: 1303–1316. https://doi.org/10.1007/s10845-015-1051-7.

Duréndez, A., D. Ruíz-Palomo, D. García-Pérez-de-Lema, and J. Diéguez-Soto. 2016. "Management Control Systems and Performance in Small and Medium Family Firms." *European Journal of Family Business* 6, no. 1: 10–20. https://doi.org/10.1016/j.ejfb.2016.05.001.

Economic Commission for Latin America, and CAF Development Bank of Latin America. 2020. *Latin American Economic Outlook 2020 Digital Transformation for Building Back Better*. OECD Publishing. https://doi.org/10.1787/e6e864fb-en.

European Commission. 2012. The Digital Agenda for Europe—Driving European Growth Digitally. https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A52012DC0784.

European Commission. 2020. SME Strategy for a Sustainable and Digital Europe. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0103.

European Commission: Joint Research Centre, Katsinis, A.A., Lagüera González, J., Di Bella, L., Odenthal, L., Hell, M., and Lozar, B., Annual Report on European SMEs 2023/2024, SME Performance Review, Publications Office of the European Union, 2024, https://data.europa.eu/doi/10.2826/355464, JRC138678.

García-Pérez-de-Lema, D., D. Ruiz-Palomo, and J. Diéguez-Soto. 2021. "Analysing the Roles of CEO's Financial Literacy and Financial Constraints on Spanish SMEs Technological Innovation." *Technology in Society* 64: 101519. https://doi.org/10.1016/j.techsoc.2020.101519.

García-Pérez-de-Lema, D., E. J. Gálvez-Albarracín, and G. Maldonado-Guzmán. 2016. "Efecto de la innovación en el crecimiento y el desempeño de las Mipymes de la Alianza del Pacífico. Un estudio empírico." *Estudios Gerenciales* 32, no. 141: 326–335. https://doi.org/10.1016/j.estger.2016.07.003.

Gebler, M., A. J. S. Uiterkamp, and C. Visser. 2014. "A Global Sustainability Perspective on 3D Printing Technologies." *Energy Policy* 74: 158–167. https://doi.org/10.1016/j.enpol.2014.08.033.

George, G., R. K. Merrill, and S. J. Schillebeeckx. 2021. "Digital Sustainability and Entrepreneurship: How Digital Innovations Are Helping Tackle Climate Change and Sustainable Development." *Entrepreneurship Theory and Practice* 45, no. 5: 999–1027. https://doi.org/10.1177/1042258719899425.

Gleditsch, N. P., and B. O. Sverdrup. 2002. "Democracy and the Environment." In *Human Security and the Environment: International comparisons*, edited by E. A. Page and M. Redclift. Publisher.

González-Cruz, T., J. Clemente-Almendros, and A. Puig-Denia. 2021. "Family Governance Systems: the Complementary Role of Constitutions and Councils." *Economic Research-Ekonomska Istraživanja* 34, no. 1: 3139–3165. https://doi.org/10.1080/1331677X.2020.1867603.

Gouvea, R., D. Kapelianis, and S. Kassicieh. 2018. "Assessing the Nexus of Sustainability and Information & Communications Technology." *Technological Forecasting and Social Change* 130: 39–44. https://doi.org/10.1016/j.techfore.2017.07.023.

Grant, R. M. 1996. "Prospering in Dynamically Competitive Environments: Organizational Capability as Knowledge Integration." *Organization Science* 7, no. 4: 375–387. https://doi.org/10.1287/orsc.7.4.375.

Guo, Q., C. Geng, and N. Yao. 2023. "How Does Green Digitalization Affect Environmental Innovation? The Moderating Role of Institutional Forces." *Business Strategy and the Environment* 32, no. 6: 3088–3105. https://doi.org/10.1002/bse.3288.

Gupta, S., M. Motlagh, and J. Rhyner. 2020. "The Digitalization Sustainability Matrix: a Participatory Research Tool for Investigating Digitainability." *Sustainability* 12, no. 21: 9283. https://doi.org/10.3390/su12219283.

Ha, L. T., and T. T. Thanh. 2022. "Effects of Digital Public Services on Trades in Green Goods: Does Institutional Quality Matter?" *Journal of Innovation & Knowledge* 7, no. 1: 100168. https://doi.org/10.1016/j.jik.2022.100168.

Hanaysha, J. R., M. E. Al-Shaikh, S. Joghee, and H. M. Alzoubi. 2022. "Impact of Innovation Capabilities on Business Sustainability in Small and Medium Enterprises." *FIIB Business Review* 11, no. 1: 67–78. https://doi.org/10.1177/2319714521104223.

Haq, I. U., and C. Huo. 2023. "Digital Strategy and Environmental Performance: The Mediating Role of Digitalization in SMEs." *Digital Economy and Sustainable Development* 1, no. 1: 9. https://doi.org/10.1007/s44265-023-00010-5.

Harbaugh, W. T., A. Levinson, and D. M. Wilson. 2002. "Reexamining the Empirical Evidence for An Environmental Kuznets Curve." *Review of Economics and Statistics* 84, no. 3: 541–551. https://doi.org/10.1162/003465302320259538.

Heavin, C., and D. J. Power. 2018. "Challenges for Digital Transformation—Towards a Conceptual Decision Support Guide for Managers." *Journal of Decision Systems* 27, no. sup1: 38–45. https://doi.org/10.1080/12460125.2018.1468697.

Hernandez, A. 2018. "Exploring the Factors to Green IT Adoption of SMEs in the Philippines." *Journal of Cases on Information Technology* 20, no. 2: 49–66.

Higón, D. A., R. Gholami, and F. Shirazi. 2017. "ICT and Environmental Sustainability: a Global Perspective." *Telematics and Informatics* 34, no. 4: 85–95. https://doi.org/10.1016/j.tele.2017.01.001.

Hilty, L. M. 2008. *Information Technology and Sustainability: Essays on the Relationship Between ICT and Sustainable Development*. Books on Demand.

Hoang, D. P., L. K. Chu, T. T. To, and N. X. Pham. 2024. "Exploring the Nexus Between Fiscal Decentralization and Ecological Sustainability: a Fresh Perspective from the Moderating Role of Geopolitical Risk and Updated International Evidence." *Environmental Science and Pollution Research* 31: 15689–15715. https://doi.org/10.1007/s11356-024-31989-9.

Hoffman, A. J. 2001. "Linking Organizational and Field-Level Analyses: The Diffusion of Corporate Environmental Practice." *Organization & Environment* 14, no. 2: 133–156. https://doi.org/10.1177/1086026601142001.

Hung, R. Y. Y., B. Yang, B. Y. H. Lien, G. N. McLean, and Y. M. Kuo. 2010. "Dynamic Capability: Impact of Process Alignment and Organizational Learning Culture on Performance." *Journal of World Business* 45, no. 3: 285–294. https://doi.org/10.1016/j.jwb.2009.09.003.

Isensee, C., F. Teuteberg, K. M. Griese, and C. Topi. 2020. "The Relationship Between Organizational Culture, Sustainability, and Digitalization in SMEs: a Systematic Review." *Journal of Cleaner Production* 275: 122944. https://doi.org/10.1016/j.jclepro.2020.122944.

Issah, W. B., L. T. Ferdous, F. Bhuiyan, and T. Sharif. 2024. "Digitalisation and Environmental Management Activities: the Effects of Family Ownership." *Business Strategy and the Environment* 33, no. 5: 4351–4374. https://doi.org/10.1002/bse.3706.

Jansson, J., J. Nilsson, F. Modig, and G. Hed Vall. 2017. "Commitment to Sustainability in Small and Medium-Sized Enterprises: the Influence of Strategic Orientations and Management Values." *Business Strategy and the Environment* 26, no. 1: 69–83. https://doi.org/10.1002/bse.1901.

Jarque, C. M., and A. K. Bera. 1987. "A Test for Normality of Observations and Regression Residuals." *International Statistical Review* 55, no. 2: 163–172. https://doi.org/10.2307/1403192.

Jetzek, T., M. Avital, and N. Bjorn-Andersen. 2019. "The Sustainable Value of Open Government Data." *Journal of the Association for Information Systems* 20, no. 6: 702–734. https://doi.org/10.17705/1jais.00549.

Kallmuenzer, A., A. Mikhaylov, M. Chelaru, and W. Czakon. 2024. "Adoption and Performance Outcome of Digitalization in Small and Medium-Sized Enterprises." *Review of Managerial Science* 19: 2011–2038. https://doi.org/10.1007/s11846-024-00744-2.

Kamah, M., J. S. Riti, and P. Bin. 2021. "Inclusive Growth and Environmental Sustainability: The Role of Institutional Quality in Sub-Saharan Africa." *Environmental Science and Pollution Research* 28: 34885–34901. https://doi.org/10.1007/s11356-021-13125-z.

Karim, S., M. Appiah, M. A. Naeem, B. M. Lucey, and M. Li. 2022. "Modelling the Role of Institutional Quality on Carbon Emissions in Sub-Saharan African Countries." *Renewable Energy* 198: 213–221. https://doi.org/10.1016/j.renene.2022.08.074.

Khan, H., L. Weili, and I. Khan. 2022. "The Role of Institutional Quality in FDI Inflows and Carbon Emission Reduction: Evidence From the Global Developing and Belt Road Initiative Countries." *Environmental Science and Pollution Research* 29, no. 20: 30594–30621. https://doi.org/10.1007/s11356-021-17958-6.

Kreiger, M. A., M. L. Mulder, A. G. Glover, and J. M. Pearce. 2014. "Life Cycle Analysis of Distributed Recycling of Post-Consumer High Density Polyethylene for 3-D Printing Filament." *Journal of Cleaner Production* 70: 90–96. https://doi.org/10.1016/j.jclepro.2014.02.009.

Kuznets, S. 1955. "Economic Growth and Income Inequality." In *The gap between rich and poor*, 25–37. Routledge. http://www.jstor.org/stable/1811581.

Kwilinski, A., O. Vyshnevskyi, and H. Dzwigol. 2020. "Digitalization of the EU Economies and People at Risk of Poverty or Social Exclusion." *Journal of Risk and Financial Management* 13, no. 7: 142. https://doi.org/10.3390/jrfm13070142.

Lee, M. J., A. Pak, and T. Roh. 2024. "The Interplay of Institutional Pressures, Digitalization Capability, Environmental, Social, and Governance Strategy, and Triple Bottom Line Performance: a Moderated Mediation Model." *Business Strategy and the Environment* 33, no. 6: 5247–5268. https://doi.org/10.1002/bse.3755.

Li, H., and Z. Yang. 2024. "Does Digital Economy Development Affect Urban Environment Quality: Evidence From 285 Cities in China." *Plos one* 19, no. 2: e0297503. https://doi.org/10.1371/journal.pone.0297503.

Li, M., and Q. Wang. 2017. "Will Technology Advances Alleviate Climate Change? Dual Effects of Technology Change on Aggregate Carbon Dioxide Emissions." *Energy for Sustainable Development* 41: 61–68. https://doi.org/10.1016/j.esd.2017.08.004.

Lu, W., X. Chen, D. C. Ho, and H. Wang. 2016. "Analysis of the Construction Waste Management Performance in Hong Kong: the Public and Private Sectors Compared Using Big Data." *Journal of Cleaner Production* 112: 521–531. https://doi.org/10.1016/j.jclepro.2015.06.106.

Lumley, T., P. Diehr, S. Emerson, and L. Chen. 2002. "The Importance of the Normality Assumption in Large Public Health Data Sets." *Annual Review of Public Health* 23, no. 1: 151–169. https://doi.org/10.1146/annurev.publhealth.23.100901.140546.

Luo, Y. 2000. "Dynamic Capabilities in International Expansion." *Journal of World Business* 35, no. 4: 355–378. https://doi.org/10.1016/S1090-9516(00)00043-2.

Manyika, J., S. Lund, J. Bughin, J. Woetzel, K. Stamenov, and D. Dhingra. 2016. *Digital Globalization: the New Era of Global Flows*. McKinsey Global Institute. https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/digital-globalization-the-new-era-of-global-flows.

Matt, C., T. Hess, and A. Benlian. 2015. "Digital Transformation Strategies." *Business & Information Systems Engineering* 57: 339–343. https://doi.org/10.1007/s12599-015-0401-5.

Miranda, L. F., M. Saunila, C. Cruz-Cázares, and J. Ukko. 2024. "Business Digitalisation as a Driver of Environmental and Economic Sustainability in Micro, Small, and Medium-Sized Enterprises." *Sustainable Development* 32, no. 6: 7036–7050. https://doi.org/10.1002/sd.3084.

Mitchell, M. N. 2021. *Interpreting and Visualizing Regression Models Using Stata*. 2nd ed. Stata Press.

Nabais, E., and M. Franco. 2024. "Sustainable Development Practices in Small and Medium-Sized Enterprises: Multiple Case Studies." *International Journal of Organizational Analysis* 32, no. 10: 2494–2516. https://doi.org/10.1108/IJOA-08-2023-3900.

Ndubisi, N. O., X. A. Zhai, and K. H. Lai. 2021. "Small and Medium Manufacturing Enterprises and Asia's Sustainable Economic Development." *International Journal of Production Economics* 233: 107971. https://doi.org/10.1016/j.ijpe.2020.107971.

Nwani, C., and S. Adams. 2021. "Environmental Cost of Natural Resource Rents Based on Production and Consumption Inventories of Carbon Emissions: Assessing the Role of Institutional Quality." *Resources Policy* 74: 102282. https://doi.org/10.1016/j.resourpol.2021.102282.

Obobisa, E. S., H. Chen, and I. A. Mensah. 2022. "The Impact of Green Technological Innovation and Institutional Quality on CO_2 Emissions in African Countries." *Technological Forecasting and Social Change* 180: 121670. https://doi.org/10.1016/j.techfore.2022.121670.

OECD. 2015. *OECD Digital Economy Outlook 2015*. OECD Publishing. https://doi.org/10.1787/9789264232440-en.

Ofoeda, I., J. K. M. Mawutor, B. D. Mensah, and S. A. Asongu. 2024. "Role of Institutional Quality in Green Technology-Carbon Emissions Nexus." *Journal of the Knowledge Economy* 15: 18019–18025. https://doi.org/10.1007/s13132-024-01777-4.

O'Regan, N., and M. A. Sims. 2008. "Identifying High Technology Small Firms: a Sectoral Analysis." *Technovation* 28, no. 7: 408–423. https://doi.org/10.1016/j.technovation.2008.02.010.

Organización para la Cooperación y el Desarrollo Económico [OECD]. 2023. *Financing SMEs for Sustainability—Financial Institution Strategies and Approaches: Results of an OECD Survey of Public and Private Financial Institutions*. OECD Publishing. https://doi.org/10.1787/b3fe3647-en.

Park, Y., F. Meng, and M. A. Baloch. 2018. "The Effect of ICT, Financial Development, Growth, and Trade Openness on CO_2 Emissions: an Empirical Analysis." *Environmental Science and Pollution Research* 25: 30708–30719. https://doi.org/10.1007/s11356-018-3108-6.

Peiró-Palomino, J., E. Rodríguez-Crespo, and M. Suárez-Varela. 2022. "Do Countries With Higher Institutional Quality Transition to Cleaner Trade?" *Ecological Economics* 201: 107554. https://doi.org/10.1016/j.ecolecon.2022.107554.

Pérez-Luño, A., A. Bojica, and S. Golapakrishnan. 2018. "The Role of Crossfunctional Integration, Knowledge Complexity and Product Innovation in Firm Performance." *International Journal of Operations & Production Management* 39: 94–115. https://doi.org/10.1108/ijopm04-2017-0251.

Pisano, G., and D. Teece. 1994. "The Dynamic Capabilities of Firms: an Introduction." *Industrial and Corporate Change* 3, no. 3: 537–556. https://doi.org/10.1093/icc/3.3.537-a.

Pisano, G. P. 1994. "Knowledge, Integration, and the Locus of Learning: an Empirical Analysis of Process Development." *Strategic Management Journal* 15, no. S1: 85–100. https://doi.org/10.1002/smj.4250150907.

Podsakoff, P. M., S. B. MacKenzie, N. P. Podsakoff, and J. Y. Lee. 2003. "The Mismeasure of Man (agement) and Its Implications for Leadership Research." *Leadership Quarterly* 14, no. 6: 615–656. https://doi.org/10.1016/j.leaqua.2003.08.002.

Priem, R. L., and J. E. Butler. 2001. "Is the Resource-Based "View" a Useful Perspective for Strategic Management Research?" *Academy of Management Review* 26, no. 1: 22–40. https://doi.org/10.5465/amr.2001.4011928.

Pucheta-Martínez, M. C., and I. Gallego-Álvarez. 2019. "An International Approach of the Relationship Between Board Attributes and the Disclosure of Corporate Social Responsibility Issues." *Corporate Social Responsibility and Environmental Management* 26, no. 3: 612–627. https://doi.org/10.1002/csr.1707.

Pudjianto, D., C. Ramsay, and G. Strbac. 2007. "Virtual Power Plant and System Integration of Distributed Energy Resources." *IET Renewable Power Generation* 1, no. 1: 10–16. https://doi.org/10.1049/iet-rpg:20060023.

Rahi, A. F., M. A. F. Chowdhury, J. Johansson, and M. Blomkvist. 2023. "Nexus Between Institutional Quality and Corporate Sustainable Performance: European Evidence." *Journal of Cleaner Production* 382: 135188. https://doi.org/10.1016/j.jclepro.2022.135188.

Rubio-Andrés, M., M. del Mar Ramos-González, M. Á. Sastre-Castillo, and S. Gutiérrez-Broncano. 2023. "Stakeholder Pressure and Innovation Capacity of SMEs in the COVID-19 Pandemic: Mediating and Multigroup Analysis." *Technological Forecasting and Social Change* 190: 122432. https://doi.org/10.1016/j.techfore.2023.122432.

Salman, M., X. Long, L. Dauda, and C. N. Mensah. 2019. "The Impact of Institutional Quality on Economic Growth and Carbon Emissions: Evidence from Indonesia, South Korea and Thailand." *Journal of Cleaner Production* 241: 118331. https://doi.org/10.1016/j.jclepro.2019.118331.

Scott, W. R. 1995. *Institutions and Organizations*. Vol. 2. Sage Publications.

Shakib, M., K. Sohag, O. Mariev, N. Samargandi, and A. Ferraris. 2023. "Innovation and Credit Market Deepening: Evidence From Russian Region." *Journal of Innovation & Knowledge* 8: 100391.

Shan, S., S. Y. Genç, H. W. Kamran, and G. Dinca. 2021. "Role of Green Technology Innovation and Renewable Energy in Carbon Neutrality: a Sustainable Investigation From Turkey." *Journal of Environmental Management* 294: 113004. https://doi.org/10.1016/j.jenvman.2021.113004.

Shen, Z., J. Chen, K. Bai, Y. Li, Y. Cui, and M. Song. 2023. "The Digital Impact on Environmental Performance: Evidence From Chinese Publishing." *Emerging Markets Finance and Trade* 59: 3982–3998. https://doi.org/10.1080/1540496X.2022.2164188.

Sheng, S., K. Z. Zhou, and J. J. Li. 2011. "The Effects of Business and Political Ties on Firm Performance: Evidence From China." *Journal of Marketing* 75, no. 1: 1–15. https://doi.org/10.1509/jm.75.1.1.

Singh, A. B., P. Tandon, and D. Jasuja. 2023. "Does Financial Inclusion Spur Carbon Emissions in India: an ARDL Approach." *Management of Environmental Quality: An International Journal* 34, no. 2: 511–534. https://doi.org/10.1108/MEQ-04-2022-0102.

Stern, D. I. 2004. "The Rise and Fall of the Environmental Kuznets Curve." *World Development* 32, no. 8: 1419–1439. https://doi.org/10.1016/j.worlddev.2004.03.004.

Suchek, N., and M. Franco. 2024. "Inter-Organisational Cooperation Oriented Towards Sustainability Involving SMEs: a Systematic Literature Review." *Journal of the Knowledge Economy* 15, no. 1: 1952–1972. https://doi.org/10.1007/s13132-023-01196-x.

Teng, J. Z., M. K. Khan, M. I. Khan, M. Z. Chishti, and M. O. Khan. 2021. "Effect of Foreign Direct Investment on CO_2 Emission With the Role of Globalization, Institutional Quality With Pooled Mean Group Panel ARDL." *Environmental Science and Pollution Research* 28, no. 5: 5271–5282.

Tick, A., R. Saáry, and J. Kárpáti-Daróczi. 2022. "Conscious or Indifferent–Concerns on Digitalisation and Sustainability Among SMEs in Industry 4.0." *Serbian Journal of Management* 17, no. 1: 145–160. https://doi.org/10.5937/sjm17-36412.

Traoré, A., C. T. Ndour, and S. A. Asongu. 2024. "Promoting Environmental Sustainability in Africa: Evidence From Governance Synergy." *Climate and Development* 16, no. 4: 321–334. https://doi.org/10.1080/17565529.2023.2223560.

Trueba-Castañeda, L., F. M. Somohano-Rodríguez, and B. Torre-Olmo. 2024. "Does Digitalisation Enable Small and Medium-Sized Enterprises to Become More Sustainable?" *Corporate Social Responsibility and Environmental Management* 31, no. 5: 4893–4909. https://doi.org/10.1002/csr.2838.

United Nations. 2015. *Transforming Our World: the 2030 Agenda for Sustainable Development(A/RES/70/1)*. UN General Assembly.

US Small Business Administration. 2023. Frequently Asked Questions. SBA Office of Advocacy https://advocacy.sba.gov/wp-content/uploads/2023/03/Frequently-Asked-Questions-About-Small-Business-March-2023-508c.pdf.

Van Auken, H., A. Madrid-Guijarro, and D. Garcia-Perez-de-Lema. 2008. "Innovation and Performance in Spanish Manufacturing SMEs." *International Journal of Entrepreneurship and Innovation Management* 8, no. 1: 36–56. https://doi.org/10.1504/IJEIM.2008.018611.

Wang, C. L., and P. K. Ahmed. 2007. "Dynamic Capabilities: a Review and Research Agenda." *International Journal of Management Reviews* 9, no. 1: 31–51. https://doi.org/10.1111/j.1468-2370.2007.00201.x.

Weinert, N., S. Chiotellis, and G. Seliger. 2011. "Methodology for Planning and Operating Energy-Efficient Production Systems." *CIRP Annals* 60, no. 1: 41–44. https://doi.org/10.1016/j.cirp.2011.03.015.

Wenzel, F. 2017. "Sustainable Digital Business: Crucial Success Factor for Small and Medium-Sized Enterprises and Start-Ups." In *Sustainability in a Digital World*. CSR, Sustainability, Ethics & Governance, edited by T. Osburg and C. Lohrmann, 131–143. Springer. https://doi.org/10.1007/978-3-319-54603-2_11.

White, H. 1980. "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity." *Econometrica* 48, no. 4: 817–838. https://doi.org/10.2307/19129349.

Wright, M., I. Filatotchev, R. E. Hoskisson, and M. W. Peng. 2005. "Strategy Research in Emerging Economies: Challenging the Conventional Wisdom." *Journal of Management Studies* 42: 1–33. https://doi.org/10.1111/j.1467-6486.2005.00487.x.

Wu, C. H., S. B. Tsai, W. Liu, S. Xue-Feng, R. Sun, and M. Wacławek. 2021. "Eco-Technology and Eco-Innovation for Green Sustainable Growth." *Ecological Chemistry and Engineering* 28, no. 1: 7–10. https://doi.org/10.2478/eces-2021-0001.

Yang, Y., X. Yang, Z. Xiao, and Z. Liu. 2023. "Digitalization and Environmental Performance: an Empirical Analysis of Chinese Textile and Apparel Industry." *Journal of Cleaner Production* 382: 135338. https://doi.org/10.1016/j.jclepro.2022.135338.

Yu, Y., and M. Qayyum. 2022. "Dynamics Between Carbon Emission, Imported Cultural Goods, Human Capital, Income, and Energy Consumption: Renewed Evidence From Panel VAR Approach." *Environmental Science and Pollution Research* 29, no. 38: 58360–58377. https://doi.org/10.1007/s11356-022-19862-z.

Zhou, K. Z., G. Y. Gao, and H. Zhao. 2017. "State Ownership and Firm Innovation in China: an Integrated View of Institutional and Efficiency Logics." *Administrative Science Quarterly* 62, no. 2: 375–404. https://doi.org/10.1177/0001839216674457.

Zott, C. 2003. "Dynamic Capabilities and the Emergence of Intraindustry Differential Firm Performance: Insights From a Simulation Study." *Strategic Management Journal* 24, no. 2: 97–125. https://doi.org/10.1002/smj.288.

Table A1

Variable	Items	References
ENVIRONMENTAL	Indicate whether your company has used, in 2021, any of the following environmental criteria and, if so, indicate their degree of importance for your company, please rate from 1 to 5 (1 is low important, 5 is very important): 1. Environmental criteria in the selection of suppliers 2. Environmental criteria in the management of plastic packaging and derivatives 3. Environmental criteria in the design of processes 4. Environmental criteria for energy management 5. Environmental criteria for water management 6. Environmental criteria for waste management 7. Environmental certifications (e.g., ISO14001/EMAS)	United Nations (2015); Jansson et al. (2017); Cantele and Zardini (2020); Ndubisi et al. (2021)
DIGITALIZATION	What technologies do you use in your company and how important are they? Please indicate the degree of importance for your company on a scale from 1 to 5, where 1 is not very important to 5 very important: 1. ERPs (integrated management systems) 2. Corporate intranet 3. Services to cover cybersecurity 4. Big data and data analysis software 5. Robotization, sensorization 6. Localization, Internet of things	Matt et al. (2015); Heavin and Power (2018)
IQ	Six indicators of governance established by the World Bank, the Worldwide Governance Indicators	Cahan et al. (2016); Boura et al. (2020); Rahi et al. (2023)
SIZE	Number of employees	Van Auken et al. (2008); Duréndez et al. (2016); García-Pérez-de-Lema et al. (2016); González-Cruz et al. (2021)
AGE	Firm age	
GDP and INFLATION	Country GDP and inflation	Van Auken et al. (2008); Duréndez et al. (2016); García-Pérez-de-Lema et al. (2016); González-Cruz et al. (2021)
SECTORIAL DUMMIES		