

Sustainable development strategies in enterprise management: Innovation and responsibility

Alina Brychko,¹ Xiaoping Cui,² Tetiana Kharchenko,^{3*} Valeriy Tytarenko,⁴ Nataliia Pitel⁵

^{1,2,3}Department of Public Management and Administration, Faculty of Economics and Management, Sumy National Agrarian University, Sumy, Ukraine; tetyana_22_82@ukr.net (T.K.).

⁴Department of Enterprise Economics and Information Technologies, Educational and Research Institute of Management, Administration and Information Technologies, Lviv University of Business and Law, Lviv, Ukraine.

⁵Department of Economics, Management and Commercial Activity, Faculty of Economics, Central Ukrainian National Technical University, Kropyvnytskyi, Ukraine.

Abstract. This study seeks to determine the relationship between corporate social responsibility, innovation, environmental management, the regulatory environment, and digital infrastructure on sustainable enterprise performance globally from 2005–2023. Pesaran's cross-sectional dependence test indicated an issue of cross-sectional dependency among the series, so the second-generation unit root test of the cross-sectional augmented IPS (CIPS) presented by Pesaran was applied. The unit root test showed that few variables are stationary at level, while most are stationary at first difference, $I(0)/I(1)$. The Westerlund cointegration test was applied, and the results confirmed a long-run relationship among the variables. A mixed order of integration and the existence of cointegration are recommended for the use of cross-sectional autoregressive distributed lag (CS-ARDL). The CS-ARDL results show that corporate social responsibility, innovation, the regulatory environment, and digital infrastructure have a significantly positive relationship with sustainable enterprise performance. In contrast, management of the environment has a significantly negative relationship with sustainable enterprise performance globally. It is recommended that the policy on why organizations should employ sustainable practices states that it is necessary to encourage creativity, invest in better digital infrastructure, and implement more comprehensive legal regulations globally. Policymakers from lower-income and middle-class economies must invest in infrastructure development.

Keywords: CS-ARDL, Enterprise management, Environmental management, Innovation, Sustainable development.

1 | BACKGROUND

The perception of sustainable development compels an enterprise or organization to consider becoming an environmentally friendly business (Jarvis, 2023; Luo & Liu, 2024). Climate change, terrorism, and economic or political instability influence much of the demand for businesses to commit themselves to achieving sustainability. Thus, companies have begun to rethink how they do business, their approach to corporate social responsibility (CSR), and incorporating sustainable entrepreneurship strategies in their business models (Nuringsih, Maupa, & Taba, 2024). In addition, the opportunities regarding the green economy, which advocates for green investment and activities, have also assisted in these efforts. Nevertheless, it remains controversial, particularly between various income groups and countries, how far the same strategies have been translated into fundamental changes in the level of enterprise recovery. The interaction between innovation, regulation, and sustainability globally has to share a common challenge and benefit, influenced by different markets and regulations (Wu & Tham, 2023).

The accountability of assessing how efficient particular approaches are, especially regarding the efficiency of the enterprises in question, needs addressing (Kuczabski et al., 2023). Developed countries are usually the leaders in innovation and compliance, while middle- and low-income countries are limited in several aspects, such as infrastructure, governance, and financial capacity (Enaifoghe & Zezi-Magigaba, 2023). These inequalities prompt fundamental debates about the legitimacy and practicality of pursuing sustainability in value chain management in different economic contexts. Furthermore, while a lot has been said about the advantages of CSR and innovation for delivering sustainable outcomes, relatively little is known about how such approaches deliver tangible returns in practice, especially in poorer countries where the institutional framework may be fragile (Kolinets, 2023; Le, Tran, Lam, Tra, & Uyen, 2024). Figure 1 illustrates the difference in levels of CSR and sustainable enterprise performance between developed and developing countries.

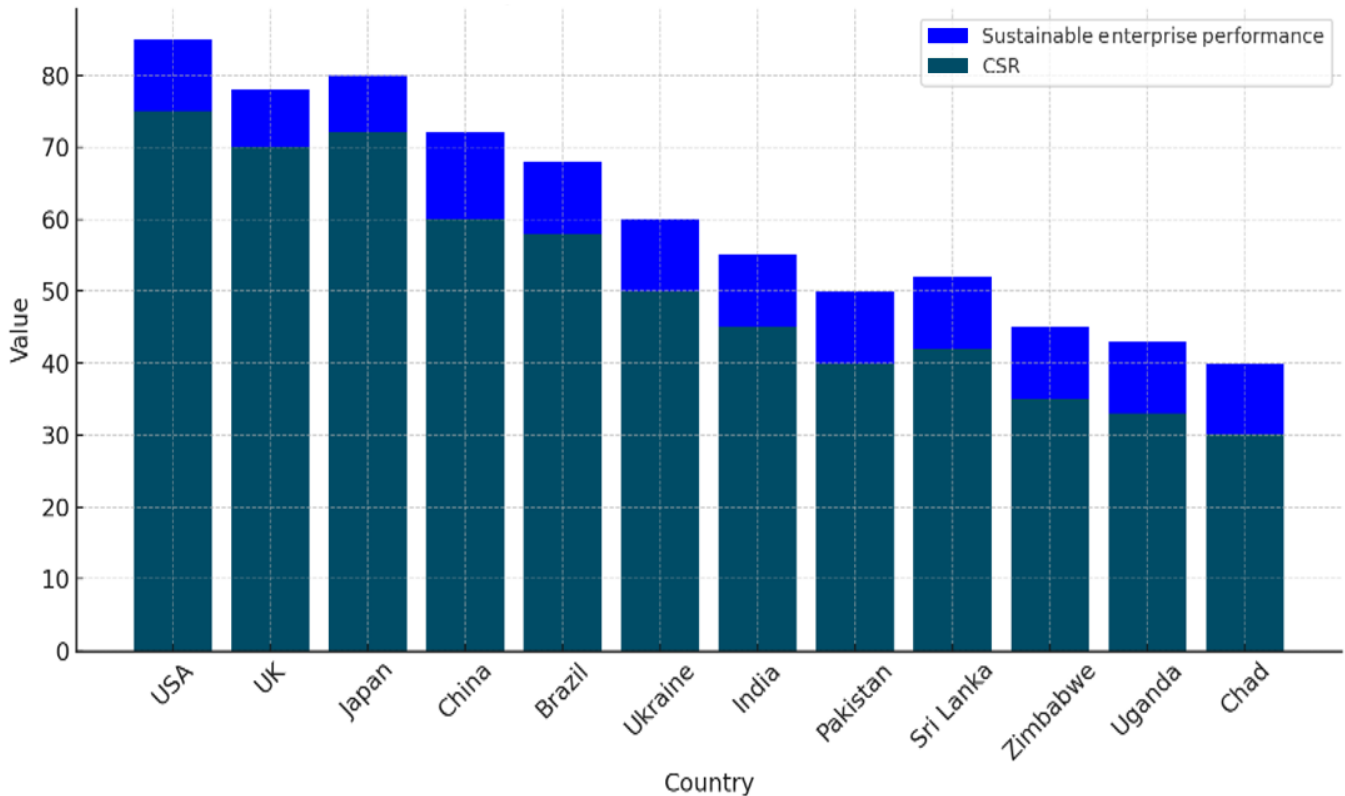


Figure 1: Sustainable enterprise performance and CSR across countries.

The main problem researched in this paper is the lack of empirical studies regarding the impact that sustainable development strategies, such as CSR, innovation, environmental practices, regulatory frameworks, and digital infrastructure, have on enterprise performance across countries of different incomes. It is important to investigate whether these strategies, which are commonly used in wealthier countries, can bring the same advantages in less developed and developing countries or whether other solutions are required.

This study examines two aspects: The first examines which CSR, innovation, environmental management, and regulatory compliance factors affect the performance of enterprises in countries with varying income levels. The second investigates the extent to which the level of digital infrastructure development affects the implementation of these strategies globally.

The main goal of the research is to analyze how enterprises' sustainable development strategies correlate with their performance in high-, middle-, and low-income countries and how country-specific factors, such as regulations or infrastructure, define these correlations.

This paper adds to the body of existing work by evaluating the efficacy of sustainable management practices across a country and its income level. In particular, it intends to fill an evidence gap in the effect of these strategies on the performance of enterprises in developing and lower-income countries, where there is often no such data. These results will be helpful for policymakers and business executives looking at sustainability initiatives within their respective contexts.

This study's comparison and cross-country perspective make it distinctive, as it embraces countries from different income levels with differing regulatory, technological, and economic circumstances. In this regard, the current research enhances the knowledge of how organizations can integrate into the environment while addressing issues of poverty in developing economies. The rest of the paper is structured as follows: Section 2 discusses the literature review; Section 3 contains the theoretical foundation, data, and methodology; Section 4 contains the results and discussion; and Section 5 concludes the study.

2 | LITERATURE REVIEW

Literature on modern research patterns is important (Boakye, Tingbani, Ahinful, Damoah, & Taurigana, 2020; Maraieva, 2022). In recent years, several studies have examined the relationship between sustainability-related variables and enterprise performance, particularly in diverse country contexts (Haleem, Farooq, & Boer, 2021; Sarfraz et al., 2023; Wang, 2022). Shihab and Bouabid (2024) investigated the influence of technological innovation on the sustainable development of specific nations, namely Iraq, Tunisia, Egypt, and Kuwait, from 2007 to 2020. The cross-sectional data approach was employed, utilizing the fixed effects model to assess the study variables. The findings demonstrated a positive and statistically significant impact of total capital formation and research and development (R&D) expenditure as a proportion of GDP-on-GDP growth. A negative correlation was identified between the labor force and gross domestic product (GDP). The study advised governments to augment infrastructure expenditure, invest in education and training, and bolster funds for research and development to facilitate sustainable development.

Feng, Li, Hu, and Deng (2024) employed the Broadband China Strategy pilot program as an exogenous shock to analyze the effect of digital infrastructure expansion on the carbon intensity of small companies and utilized a distinctive dataset from the National Tax Survey. The results indicated that the expansion of digital infrastructure resulted in a notable 9.04% rise in the carbon intensity of small enterprises. The results proved resilient over many assessments, with the increase ascribed to two primary factors: the competitive effect, which diminished the production of small enterprises, and alterations in energy composition, which elevated carbon emissions. Heterogeneity analysis revealed a more significant increase in carbon intensity for small companies in areas with lax environmental rules and sectors characterized by greater market concentration. The study suggested that the government should prioritize guaranteeing equitable competition on digital platforms and prevent dominant organizations from exploiting informational advantages to disadvantage small businesses.

Figure 2 shows the relationship between CO₂ emission levels and internet penetration rates across different countries. Generally, developed

countries exhibit higher levels compared to developing countries (Zhang & Meng, 2019).

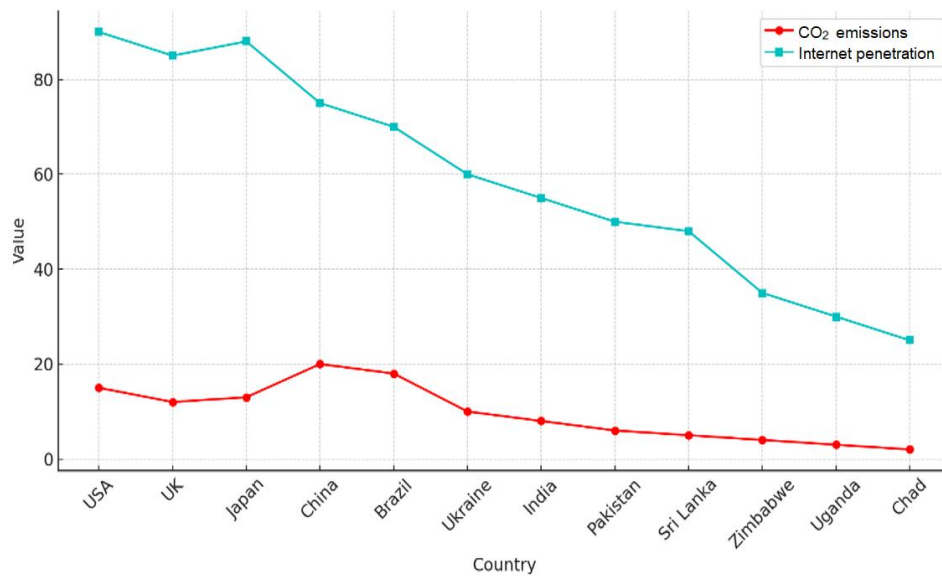


Figure 2: CO₂ emissions and internet penetration across countries.

Saputra, Subroto, Rahman, and Saraswati (2023) examined the impact of environmental management on sustainable performance within the wine sector. They specifically investigated the influence of environment management on sustainable performance mediated by green innovation and moderated by collaborative culture. A conceptual model was constructed, grounded in previous research, and evaluated by structural equation modeling (PLS-SEM) utilizing data from 202 Spanish vineyards. The findings indicated a positive correlation between environmental management and sustainable performance.

Shanyu (2022) investigated the influence of corporate social responsibility (CSR) on sustainable business performance in BRICS nations (Brazil, Russia, India, China, South Africa, Iran, Egypt, Ethiopia, and the United Arab Emirates). Data were obtained from the financial statements and CSR reports of leading publicly traded companies in BRICS nations. The research employed the random effects model (REM) and the generalized method of moments (GMM) to investigate the relationships among the variables. The findings demonstrated a positive correlation between CSR and sustainable company success in BRICS nations. These findings are significant for policymakers in the development of policies concerning CSR and sustainable company performance.

Liang, Li, Zhang, and Chen (2022) studied the influence of green innovation on organizational performance, emphasizing the moderating effect of government incentives, such as fiscal subsidies and preferential taxes. The empirical study utilized panel data from manufacturing enterprises listed on the Shanghai and Shenzhen A shares between 2011 and 2019 and revealed that green innovation substantially improved enterprise performance. The ordinary least squares (OLS) model with two-way fixed effects was utilized, with Tobin's Q as the dependent variable, to investigate the influence mechanisms of green innovation, financial subsidies, and tax incentives.

Both fiscal subsidies and preferential taxation were observed to enhance the positive correlation between green innovation and company performance, with tax incentives exhibiting a more significant impact when coupled with fiscal subsidies. The research indicated that preferential taxation exerts a greater influence in high-tech industries, but fiscal subsidies were more efficacious in traditional sectors. These findings provided significant recommendations for businesses and governments to foster green innovation and maximize the utilization of government funds to improve corporate performance.

In a multi-country analysis, Ghachem, Bastiy, and Zureigat (2022) used a dynamic panel model to assess the effect of CO₂ emissions on sustainable enterprise performance in the Organization for Economic Cooperation and Development (OECD) countries. They found that higher CO₂ emissions negatively affected long-term enterprise sustainability, as firms faced regulatory pressures and market penalties. Additionally, Fitriana and Wardhani (2020) investigated the role of regulatory quality on sustainable enterprise performance in southeast Asian economies using a generalized method of moments (GMM) approach. Their results showed that robust regulatory frameworks were crucial in encouraging firms to adopt sustainable practices, positively influencing their performance. Okundaye, Fan, and Dwyer (2019) studied the impact of digital infrastructure (internet penetration) on enterprise sustainability in Nigeria using a two-step system GMM model. Their research demonstrated that firms with access to better digital infrastructure were more likely to innovate and improve their sustainability metrics, particularly in resource-constrained environments.

3 | METHODOLOGY

3.1 | Data Source

The analysis involves sustainable enterprise performance (Singh & Kumar, 2022) as the dependent variable, while the independent variables employed are corporate social responsibility (Chkir, Hassan, Rjiba, & Saadi, 2021), innovation through R&D expenditure (Tung & Hoang, 2024), environmental management denoted by CO₂ emissions (Li, Xu, Li, Du, & Ye, 2021), regulatory quality (Bogdanova & Zhukova, 2022), and digital infrastructure (Zhou, Lan, Zhao, & Wang, 2024). Annual reports for sustainable enterprise performance, innovation, and environmental management were obtained from the World Development Indicators (WDI) (World Bank, 2024a), and the regulatory environment variables were obtained from the WGI database (World Bank, 2024b). Information on digital infrastructure and internet penetration was sourced from the International Telecommunication Union (ITU) (International Telecommunication Union, 2023).

3.1.1 | Theoretical Background

An organization whose management is based on CSR concepts can contribute positively to the firm's sustainability performance. Activities classified

as CSR enhance a corporation's trust and reputation with stakeholders and may even improve profitability in the long run, consistent with stakeholder theory (Málovics, Csigéné, & Kraus, 2008).

Based on the incremental theory of innovation, the growth in research and development expenditure demonstrates a company's long-term-oriented conceptual structure. There is enhanced competitiveness and productivity, which can be justified using Schumpeter's theory, which regards innovations as crucial for the prosperity of companies and the economy (Sweezy, 1943).

According to the environmental management perspective, sustaining an enterprise's positive performance is associated with a decrease in a firm's environmental impact. Changing the structure of CO₂ emissions is favorable in meeting many regulatory requirements but also helps improve the situation because costs and risks are decreased in the long run (Mahmud, Soetanto, & Jack, 2021).

According to regulatory theory, well-enforced regulations help to level the playing field for all market players and support their move toward sustainability. High-quality rules in the operating countries will likely increase firms' performance since they will be expected to observe social and environmental standards (Drahos, 2017).

Theories on digital transformation and technology adoption indicate that proper provision of the digital ecosystem enhances creativity and productivity. Internet penetration enables companies to adopt sophisticated technology, reorganize the existing supply chain, and enter new markets, effectively improving performance (Markus & Rowe, 2023).

3.2 | Empirical Model

Based on the theoretical linkages, the following panel data model can be formulated to examine the relationship between the independent variables and sustainable enterprise performance (SEP):

$$SEP_{it} = \beta_0 + \beta_1 CSR_{it} + \beta_2 INNOV_{it} + \beta_3 ENVM_{it} + \beta_4 REGEN_{it} + \beta_5 DIGI_{it} + \mu_i + \varepsilon_{it} \tag{1}$$

In Equation 1, SEP_{it} represents sustainable enterprise performance for country "i" at time "t", CSR_{it} represents corporate social responsibility, $INNOV_{it}$ represents innovation proxied by R&D expenditure, $ENVM_{it}$ represents environmental management measured by CO₂ emissions, $REGEN_{it}$ represents the regulatory environment proxied by regulatory quality, $DIGI_{it}$ represents digital infrastructure measured by internet penetration, β is the intercept, μ_i captures unobserved country-specific effects, and ε_{it} is the error term.

3.2.1 | Econometric Strategies

The Pesaran (2015) cross-sectional dependence test has proven to be most useful in studies using panel data where the observational units or cross-sections (countries, firms, etc.) may be intercorrelated. The test shows the existence of common shocks or spillover effects across cross sections, which is important in studies of economies of the world. Since cross-sectional dependence is considered, the test adds strength and appropriateness to estimating the subsequent step, ensuring it is necessary in global investigation (Lettau & Pelger, 2020).

The cross-sectionally augmented Im-Pesaran-Shin (CIPS) unit root test, introduced by Pesaran (2007), is a panel unit root test of the second generation. The structure includes cross-sectional dependence, making it more relevant for datasets that interact among cross-sections. Ordinary unit root tests ignore such dependencies, leading to unreliable findings. CIPS allows and accounts for and fixes standard shocks, which all countries or areas are bound to experience; this is important in research where several countries are being examined as one or where inter-county economic relations are studied (Dakhllalh, Rashid, Abdullah, & Dakhllalh, 2021).

Westerlund's cointegration test deals with cross-sectional dependency and heterogeneity. In this context, the test becomes advantageous, as not all the long-run relationships in a panel need to be the same. This makes it suitable for panels that have diverse long-run relationships. Identifying whether or not variables are cointegrated over a long period improves the reliability of the conclusions made concerning the structural and steady-state relationships between the variables (Ahmet, Halil, & Burcu, 2022).

The cross-sectionally augmented ARDL model is an extension of the ARDL framework that incorporates panel cross-sectional dependence and non-stationarity (Aljad, 2023). The critical advantage of the CS-ARDL approach is that it captures short-run and long-run dynamics between any number of variables and allows for different sets of cointegration vectors on the other units included in the estimated model. The CS-ARDL model is best suited to data in panel form in which cross-sectional dependencies are present, as it includes average values of the dependent and independent variables over the cross-section to the regression, which reduces biases. In mathematical form, the CS-ARDL model can be expressed as:

$$Y_{it} = \alpha_i + \sum_{p=0}^P \beta_{i,p} X_{it-p} + \sum_{q=0}^Q \lambda_{i,q} Y_{it-q} + \sum_{r=0}^R \gamma_r \bar{X}_{t-r} + \sum_{s=0}^S \delta_s \bar{Y}_{t-s} + \varepsilon_{it} \tag{2}$$

In Equation 2, Y_{it} is the dependent variable, X_{it} is the independent variable, \bar{X} and \bar{Y} are the cross-sectional averages, and ε_{it} is the error term.

4 | RESULTS AND DISCUSSION

There is a shortage of data showing how different sustainable development strategies, such as corporate social responsibility, innovation, environmental practices, regulatory quality, and digital infrastructure, impact the success of businesses in nations with different wealth levels. Investigating if these tactics, which have been extensively used in nations with higher incomes, have comparable results in situations with lower and moderate incomes is of the utmost importance.

The purpose of this study is to investigate how corporate social responsibility (CSR), innovation (INNOV), environmental management (ENVM), regulatory environment (REGEN), and digital infrastructure (DIGI) impacted sustainable enterprise performance (SEP) globally from 2005 to 2023. Below are the results of the various statistical tests conducted, including descriptive statistics, unit root test, cointegration test, and the CS-ARDL model.

Table 1: Descriptive statistics.

Variable	Mean	Standard deviation	Min.	Max.
SEP_{it}	3.53	1.57	0.93	6.54
CSR_{it}	2.45	1.02	0.85	4.65
$INNOV_{it}$	1.80	0.76	0.25	3.30
$ENVM_{it}$	4.50	2.40	1.10	8.90
$REGEN_{it}$	3.10	1.35	0.90	5.80
$DIGI_{it}$	4.12	2.04	1.02	7.92

The descriptive statistics in Table 1 summarize the variables used in the analysis. The mean values indicate the average level of each variable across the sample period (2005 to 2023). The standard deviations highlight the variability of each variable, with higher values indicating more dispersion across the dataset. For example, the mean of CSR spending is higher in high-income countries such as the USA and Japan than in lower-income countries such as Zimbabwe and Uganda. Innovation in business models, measured by R&D expenditure as a percentage of GDP, also shows significant variation, with developed countries consistently outperforming lower-income countries. This highlights the global resource and technological gaps that influence sustainable enterprise performance (Zrybnieva, Pichugina, Sigaieva, Saienko, & Korolov, 2023).

The Pesaran cross-sectional dependence test results in Table 2 suggest that cross-sectional dependence is present in the panel data at a 1% significance level. This indicates that shocks or changes in one country are likely to influence other countries, particularly given the global nature of economic and environmental sustainability trends.

Table 2: Cross-sectional dependence and unit root test results.

Variable	Pesaran CD		CIPS		
	Statistic	@Level	@ 1 st difference	Order of integration	
SEP _{it}	11.641 ^{***}	-3.12 ^{***}	----	I(0)	
CSR _{it}	32.549 ^{***}	-0.08	-3.65 ^{***}	I(1)	
INNOV _{it}	32.523 ^{***}	-1.02	-4.10 ^{***}	I(1)	
ENVM _{it}	33.421 ^{***}	-0.65	-5.00 ^{***}	I(1)	
REGEN _{it}	11.833 ^{***}	-0.32	-4.55 ^{***}	I(1)	
DIGI _{it}	25.158 ^{***}	-3.48 ^{***}	----	I(0)	

Note: *** shows the significance level at 1%. The critical value of CIPS at 10% = -2.56, at 5% = -2.78, and at 1% = -2.99.

Table 2 also shows the CIPS unit root test results. The outcomes show that at level, most of the independent variables are non-stationary, except SEP and DIGI. After considering the first difference, all variables become stationary, so this study has a mixed order of integration I(0)/I(1).

Table 3: Westerlund (2005) cointegration test results.

Ratio	Statistic	P-value
Variance ratio	3.25 ^{***}	0.003

Note: *** shows the significance level at 1%.

Table 3 illustrates the Westerlund (2005) cointegration test results, which confirm the existence of a long-run relationship between the independent variables and sustainable enterprise performance. This implies that changes in CSR, innovation, environmental management, regulatory environment, and digital infrastructure have long-term effects on enterprise performance.

Table 4: CS-ARDL long-run and short-run results.

Series	Coefficient		Standard error		P-value	
	Long-run	Short-run	Long-run	Short-run	Long-run	Short-run
CSR _{it}	0.25 ^{***}	0.122 ^{**}	0.09	0.045	0.000	0.015
INNOV _{it}	0.35 ^{***}	0.085 ^{**}	0.12	0.032	0.005	0.023
ENVM _{it}	-0.18 ^{**}	-0.091 ^{***}	0.07	0.029	0.020	0.005
REGEN _{it}	0.22 ^{**}	0.107 ^{**}	0.08	0.040	0.018	0.019
DIGI _{it}	0.45 ^{***}	0.130 ^{**}	0.10	0.050	0.000	0.012
ECT (-1)	----	-0.685 ^{***}	----	0.056	----	0.001
Adjusted R-squared	0.9870	----	----	----	----	----

Note: *** and ** show the levels of significance at 1% and 5%, respectively.

The estimated long-run relationship of the CS-ARDL model, presented in Table 4, indicates that expenditure on CSR has a positive and statistically significant influence on the sustainable performance of the enterprise with a coefficient of 0.45. This implies that if the level of CSR spending is raised by 1%, there will be a corresponding increase of 0.25% in the performance of the enterprise. Our results are similar to those obtained by Hernández, Yañez-Araque, and Moreno-García (2020) and Itoya, Owuze, Akhator, and Igboke (2022). This positive relationship indicates that enterprises engaged in social and environmental activities garner additional benefits in terms of reputation and consumer support, which is then reflected in better performance levels in the long run.

A quite robust, positive link exists between innovation in business models and enterprise performance, with a coefficient of 0.35. For every 1% increase in R&D expenditure, there is a corresponding 0.35% improvement in business performance. This result aligns with Leung and Sharma (2021) and Aarstad and Kvitastein (2020). It emphasizes the importance of innovation in the pursuit of monopoly out of very stiff competition so that companies are able to respond to the changing trends in demand and regulations, especially in developed economies such as the USA and Japan.

Environmental management (CO₂) practices show an inverse result in enterprise performance. A 1% increase in CO₂ decreases the sustainable enterprise performance by 0.18%. The results of this study are matched with the results of Wang, Zhang, Yang, Chen, and Yang (2023) and Li, Li, Gong, Wei, and Huang (2020). This reiterates the pressing need for businesses to engage in sustainable environmental practices, as those companies that are environmentally conscious reap benefits in the form of reduced costs, efficient operations, and positive relations with stakeholders.

The regulatory environment is one of the factors that also affects enterprise performance, though with a lower coefficient of 0.22. If the regulatory environment improves by 1%, the enterprise performance in abundance will improve by 0.22%. These results are the same as those of Shao, Hu, Cao, Yang, and Guan (2020) and Ma and Li (2021). It can be concluded that while regulatory compliance is essential for an enterprise's survival, its contribution to the business's success may be less than the contributions of CSR and innovation.

Digital infrastructure has a coefficient of 0.45, which signifies that a 1% increase in digital infrastructure leads to an increase of 0.45% in the performance of the enterprise. The results are similar to those of Gao, Yan, Zhou, and Mo (2023) and Li et al. (2023). This shows that to be competitive, the digital thrust is not an option but a necessity, although it is likely to be less direct and take longer to achieve global sustainable corporate performance, particularly in the case of a country with many middle- and lower-income groups who have not yet developed a strong digital infrastructure.

The CS-ARDL model of the error correction mechanism in the short term also integrates an error correction term. The error correction term is -0.685 , which is statistically significant at 1% and suggests that about 68.5% of the imbalance that arises from long-term deviations is absorbed in a year, such that equilibrium is attained at a relatively high rate.

5 | CONCLUSION

This study examined the impact of corporate social responsibility, innovation, environmental management, the regulatory environment, and digital infrastructure on sustainable enterprise performance across various country categories. The study analyzed data from high-income countries (USA, UK, Japan), upper-middle-income countries (China, Brazil, Ukraine), lower-middle-income countries (India, Pakistan, Sri Lanka), and low-income countries (Zimbabwe, Uganda, Chad) over the period from 2005 to 2023. Several econometric tests were employed, including the Pesaran (2021) cross-sectional dependence test, the CIPS unit root test, the Westerlund (2005) test, and the CS-ARDL model. The CS-ARDL results revealed that all studied variables have a significantly positive relationship with sustainable enterprise performance, except environmental management, both in the short and long runs. The error correction term was negative and significant, with a value of -0.685 , indicating a moderate adjustment speed back to equilibrium after short-term shocks.

The results section showed that CSR and innovation improved sustainable enterprise performance, supporting past studies on the importance of ethical corporate behavior and technological advances for long-term business growth. Unlike earlier studies, environmental management of CO₂ emissions had a less significant effect, suggesting that environmental compliance expenses may offset short-term performance advantages. This contradicts evidence showing a positive association between environmental sustainability and business performance. Regulatory quality and digital infrastructure were positively correlated, supporting earlier studies that governance and technology improve corporate efficiency.

The influence of environmental management was smaller than expected, possibly due to variable enforcement and the consequences of different environmental rules in the nations investigated. This requires more sophisticated policies that balance environmental responsibility and economic growth, especially in developing nations.

5.1 | Policy Recommendations

Based on the results of this study, a few policy recommendations can be made to improve enterprises' sustainable performance among countries with various income levels. Governments should enhance existing corporate social responsibility by encouraging businesses to engage sustainably. Tax breaks, financial assistance, or public award programs could motivate these companies to allocate resources to socially responsible and profitable activities (Redlko, Riznyk, Nikolaiev, Yatsenko, & Shuplat, 2024). They must also seek to foster development by offering research and development grants in environmentally friendly industries.

Additionally, policymakers from lower-income and middle-class countries should invest in infrastructure development because business productivity and innovative activities depend on the availability of the internet and other technological services. Defining clear and actionable regulatory quality through environmental laws will enhance the prospects of businesses achieving sustainability. Finally, reducing carbon dioxide emissions is achievable through carbon prices, sustainable development policies, and programs that make a country's economy attractive.

5.2 | Limitations

This study is not without limitation; it looks at only a few countries, which may lead to missing certain features in other areas. Future studies would be beneficial if more governments and industries were covered to increase generalizability. Furthermore, it would be interesting to relate sustainability with more independent parameters at the firm level or specific to the sector. Also, longitudinal studies should be performed to understand changes in the study variables over time, focusing on non-linear relationships and potential changes in structural breaks.

Institutional Review Board Statement:

The Sumy National Agrarian University (Ukraine) Ethical Committee approved this study on 10.10.2024 (Ref. No. 613/10/2024).

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