Green Economy Practices and Innovation among Nigerian Firms

Alamu Abideen Salawu[1*], Bolaji Morolake[2]

[1,2]Innovation and Technology Policy Department (ITPD), Nigerian Institute of Social and Economic Research (NISER), PMB 5, UI Post Office, Ibadan, Nigeria

***Email:** alamu2000ng@gmail.com[1]

Abstract

This study examines the association between green economy practices and product innovation among Nigerian firms. Using data from the 2025 Nigeria World Bank Enterprise Survey, the study constructs a Green Economy Practices Index based on firms' adoption of carbon dioxide monitoring, energy management, and on-site solar energy. A Probit regression model with robust standard errors was employed to assess the relationship between green economy practices and product innovation, controlling for women ownership, website ownership, firm size, firm age, and export status. The results show that green economy practices have a positive but statistically insignificant association with product innovation (AME = 0.0115, p = 0.384). Website ownership is positively and marginally associated with innovation, while firm size has a significant negative association. The study concludes that green economy adoption alone provides limited evidence of higher product innovation. Policies promoting green investment, energy efficiency, renewable energy, and productive digitalisation are recommended.

Keywords

Green economy practices, innovation, sustainability, energy management, Nigerian firms

Introduction

Innovation is widely recognized as a fundamental driver of firm competitiveness, productivity, and economic development (OECD, 2018). Firms increasingly rely on innovation to introduce new products and services, improve production processes, access new markets, and respond to technological and environmental changes. The relationship between environmental sustainability and innovation has received considerable theoretical and empirical attention. In particular, the Porter Hypothesis proposes that appropriately designed environmental regulations and initiatives can stimulate innovation, improve resource efficiency, and potentially strengthen firm competitiveness rather than simply impose additional costs on firms (Porter & van der Linde, 1995). Similarly, the eco-innovation literature suggests that environmental pressures and sustainability objectives can motivate firms to adopt new technologies, redesign production

Submission: 26 July 2026; **Acceptance:** 9 September 2026; **Available online:** September 2026

processes, and develop environmentally friendly products (Rennings, 2000; Chen et al., 2006; Dangelico & Pujari, 2010). Thus, green economy practices may serve not only as environmental management strategies but also as mechanisms through which firms build their technological and innovative capabilities.

The relationship between green practices and innovation is particularly relevant in developing economies, where firms often operate under significant resource, technological, infrastructural, and institutional constraints. In Nigeria, the importance of this relationship is heightened by persistent environmental challenges, unreliable electricity supply, dependence on fossil-fuel-based energy sources, and increasing industrial and commercial activities. These challenges have increased the pressure on firms to improve energy efficiency, diversify energy sources, manage emissions, and adopt more sustainable production practices (Adeoti, 2017; Akinwale & Grobler, 2019). At the same time, Nigerian firms face strong pressure to improve productivity and competitiveness through innovation. Green investments could therefore represent an important pathway for simultaneously addressing environmental challenges and strengthening firms' innovation capabilities.

Despite the growing international literature on environmental sustainability and innovation, important empirical gaps remain in the Nigerian context. Existing Nigerian studies have largely examined issues such as renewable energy, environmental management, energy constraints, and technological adoption separately, with comparatively limited attention to whether a broader set of green economy practices translates into firm-level innovation. This study therefore addresses a specific empirical gap by examining whether firms that adopt green economy practices are more likely to engage in innovation and by identifying the specific environmental practices that contribute to innovative outcomes among Nigerian firms. This is particularly important given the need for evidence-based policies that can integrate environmental sustainability with industrial competitiveness and technological development. Accordingly, this study examines the relationship between green economy practices and firm-level innovation in Nigeria. Specifically, it addresses the following research question: What is the effect of green economy practices on innovation among Nigerian firms? The study contributes to the literature by providing firm-level evidence on the green economy- innovation nexus in Nigeria.

Methodology

This study adopted a quantitative cross-sectional research design to examine the relationship between green economy practices and innovation among firms in Nigeria. The design permits empirical assessment of firm-level environmental practices and innovation outcomes using standardized survey data collected at a specific point in time. The analysis uses firm-level observations from the 2025 Nigeria World Bank Enterprise Survey (WBES). While the design is appropriate for identifying statistical associations, the cross-sectional data do not permit definitive causal conclusions because reverse causality, omitted variables, and other forms of endogeneity may exist.

Variables extracted for this study covered innovation, CO_2 emissions monitoring, energy management, on-site solar panel adoption, firm size, firm age, export status, website ownership, and women ownership. The use of the WBES provides broad firm-level coverage and standardized

measurement, although the single survey wave limits the ability to establish temporal ordering between green practices and innovation.

The target population comprised private-sector firms covered by the 2025 Nigeria WBES, including firms operating in the manufacturing and service sectors. The analytical sample was obtained by retaining firms with valid information on innovation, the Green Economy Practices Index (GEPI), and the control variables required for the main specification. 1,043 firms were used for the principal analysis. Observations with missing information on variables required for a particular model were excluded through case-wise deletion. Consequently, the number of observations may vary across specifications. Although this approach ensures that each estimation uses complete information for the variables included, exclusion of missing observations may introduce selection bias if missingness is systematically related to firm characteristics.

Model Specification

The study examines whether green economy practices are associated with the probability that a firm engages in innovation.

The latent propensity to innovate is specified as:

$$Innovation_i^* = \beta_0 + \beta_1 GEPI_i + \beta_2 \ln(Size_i) + \beta_3 Age_i + \beta_4 Export_i + \beta_5 Website_i + \beta_6 WomenOwner_i + \beta_7 Manufacturing_i + \varepsilon_i$$

The observed outcome is defined as $Innovation_i = 1$ if $Innovation_i^* > 0$ and 0 otherwise. Because innovation is binary, a Probit model is estimated:

$$P(Innovation_i = 1|X_i) = \Phi(\beta_0 + \beta_1 GEPI_i + \beta_2 \ln(Size_i) + \beta_3 Age_i + \beta_4 Export_i + \beta_5 Website_i + \beta_6 WomenOwner_i + \beta_7 Manufacturing_i)$$

where $\Phi(.)$ is the cumulative distribution function of the standard normal distribution. Probit coefficients indicate the direction of the association with the latent propensity for innovation; therefore, average marginal effects are also reported for interpretation in probability terms.

Measurement and Construction of Variables

Innovation is a binary variable coded 1 where a firm introduced a product/service or process innovation during the reference period and 0 otherwise.
The main explanatory variable, GEPI, is constructed from three environmental practices available in the 2025 Nigeria WBES: CO_2 emissions monitoring, energy management, and on-site solar panel adoption. Each component is coded 1 for adoption and 0 otherwise, and the three indicators are summed:

$$GEPI_i = CO2Monitor_i + EnergyManagement_i + Solar_i$$

The index ranges from 0 to 3, with higher values indicating a greater breadth of green practice adoption. The three components are equally weighted because they represent complementary dimensions of green economy practices and there is no strong theoretical basis for assigning different weights. A one-unit increase therefore represents adoption of one additional green practice. A disaggregated specification also enters the three components separately to identify which practices are most strongly associated with innovation. Firm size is measured as the natural logarithm of employees; firm age is the number of years in operation; export status is coded 1 for exporting firms and 0 otherwise; website ownership is coded 1 where an operational website exists and 0 otherwise; women ownership is coded 1 where women participate in ownership and 0 otherwise; and manufacturing sector is coded 1 for manufacturing firms and 0 for service firms.

The estimates should be interpreted as conditional associations rather than causal effects. Green practices and innovation may be jointly determined, while unobserved factors such as managerial capability, technological capacity, environmental awareness, and financial resources may affect both outcomes. The cross-sectional design does not provide sufficient temporal or exogenous variation to fully address these concerns. Causal identification would require longitudinal data, valid instruments, or experimental/quasi-experimental methods.

Results and Discussion

The results in Table 1 show that the adoption of green economy practices among Nigerian firms remains relatively low. Energy management was the most widely adopted practice (46.02%), followed by CO_2 emissions monitoring (31.06%) and on-site solar panel adoption (22.43%).

The Probit results in Table 2 show that green economy practices were positively but not significantly associated with product innovation among Nigerian firms ($\beta = 0.0366$, $p = 0.384$; AME = 0.0115). Women ownership and exporter status also had positive but statistically insignificant associations with product innovation. Website ownership was positively associated with product innovation and marginally significant at the 10% level ($\beta = 0.1615$, $p = 0.069$; AME = 0.0508), suggesting that firms with websites had an estimated 5.1 percentage-point higher probability of product innovation.

In contrast, firm size was negatively and significantly associated with product innovation ($\beta = -0.1707$, $p = 0.010$; AME = −0.0537), while firm age had a small negative but insignificant association. The model was statistically significant (Wald $\chi^2(6) = 18.34$, $p = 0.0054$), although the pseudo R^2 was relatively low (0.0151). These findings indicate associations rather than causal effects, given the cross-sectional nature of the data.

Table 1. The adoption of green economy practices

Green Economy Practice	Frequency	Percentage (%)
CO_2 emissions monitoring	324	31.06
Energy management measures	480	46.02
On-site solar panels	234	22.43
Total firms	1,043	100.00

Table 2. Probit Regression Results for Product Innovation

Variable	Probit Coefficient	Robust SE	z-statistic	p-value	Average Marginal Effect	SE of ME
Green Economy Practices Index	0.0366	0.0420	0.87	0.384	0.0115	0.0132
Women ownership	0.1255	0.1006	1.25	0.212	0.0394	0.0316
Website ownership	0.1615	0.0889	1.82	0.069	0.0508	0.0278
Firm size (ln)	-0.1707	0.0663	-2.57	0.010	-0.0537	0.0207
Firm age	-0.0003	0.0003	-1.34	0.180	-0.0001	0.0001
Exporter	0.1770	0.1777	1.00	0.319	0.0556	0.0558
Constant	-0.5700	0.1134	-5.03	<0.001	—	—
Observations	1,030					
Wald $\chi^2(6)$	18.34			0.0054		
Pseudo R^2	0.0151					
Log pseudolikelihood	-573.1243					

*** p < 0.01, ** p < 0.05, * p < 0.10

Summary of Discussion

The findings indicate that green economy practices have a positive but statistically insignificant association with product innovation among Nigerian firms. The Green Economy Practices Index was positive but not statistically significant, suggesting that the overall breadth of green practice adoption does not, by itself, provide strong evidence of higher product innovation. Website ownership showed a positive and marginally significant association with innovation, while women ownership and export status were positive but insignificant. These results suggest that access to digital presence may support firms' innovation opportunities, although the evidence remains relatively weak.

Firm size was the only control variable with a statistically significant association with product innovation, and the relationship was negative. Firm age also had a negative but insignificant association with innovation. Generally, the model was jointly significant, but its relatively low pseudoR^2 indicates that other firm-level factors may explain substantial variation in product innovation. Given the cross-sectional design, the findings should be interpreted as associations rather than causal relationships. The results therefore highlight the need for policies that promote green finance, energy efficiency, renewable energy and productive digitalisation, alongside further research using longitudinal or causal approaches.

Conclusion

In conclusion, the study finds limited evidence of a significant relationship between overall green economy practices and product innovation among Nigerian firms. While the direction of the relationship is positive, it is not statistically significant, and therefore strong claims that green practices cause innovation cannot be made. Website ownership shows a modest positive association with innovation, whereas firm size is negatively associated with product innovation. The study recommends strengthening support for green investment and productive digitalisation while encouraging future research using longitudinal data and causal methods to better establish the relationship between green economy practices and firm innovation.

Acknowledgements

There are no grant or funding bodies to be acknowledged for preparing this paper.

References

Aboelmaged, M. (2018). Direct and indirect effects of eco-innovation, environmental orientation, and supplier collaboration on hotel performance: An empirical study. *Journal of Cleaner Production, 184*, 537–549. https://doi.org/10.1016/j.jclepro.2018.02.192

Aboelmaged, M., & Hashem, G. (2019a). Absorptive capacity and green innovation adoption in SMEs. *International Journal of Innovation Management, 23*(7), Article 1950067. https://doi.org/10.1016/j.jclepro.2019.02.150

Aboelmaged, M., & Hashem, G. (2019b). Absorptive capacity and green innovation adoption in SMEs: The mediating effects of sustainable organisational capabilities. *Journal of Cleaner Production, 220*, 853–863. https://doi.org/10.1016/j.jclepro.2019.02.150

Adeoti, J. O. (2017). Technology and environmental sustainability in Nigerian manufacturing firms. *African Journal of Science, Technology, Innovation and Development, 9*(2), 145–156. https://hdl.handle.net/10520/EJC10587

Akinwale, Y. O., & Grobler, W. C. (2019). Education, openness and innovation in Nigeria. *Journal of Open Innovation: Technology, Market, and Complexity, 5*(2), Article 20. https://doi.org/10.1353/jda.2019.0003

Brush, C. G., Greene, P. G., Balachandra, L., & Davis, A. E. (2019). The gender gap in venture capital—Progress, problems, and perspectives. *Venture Capital, 21*(2–3), 115–136. https://doi.org/10.1080/13691066.2017.1349266

Cainelli, G., De Marchi, V., & Grandinetti, R. (2015). Does the development of environmental innovation require different resources? Evidence from Spanish manufacturing firms. *Journal of Cleaner Production, 94*, 211–220. https://doi.org/10.1016/j.jclepro.2015.02.008

Chen, Y. S., Lai, S. B., & Wen, C. T. (2006). The influence of green innovation performance on corporate advantage in Taiwan. *Journal of Business Ethics, 67*(4), 331–339. https://doi.org/10.1007/s10551-006-9025-5

Dangelico, R. M., & Pujari, D. (2010). Mainstreaming green product innovation: Why and how companies integrate environmental sustainability. *Journal of Product Innovation Management, 27*(4), 471–486. https://doi.org/10.1007/s10551-010-0434-0

De Marchi, V. (2012). Environmental innovation and R&D cooperation: Empirical evidence from Spanish manufacturing firms. *Research Policy, 41*(3), 614–623. https://doi.org/10.1016/j.respol.2011.10.002

Del Río, P., Peñasco, C., & Romero-Jordán, D. (2016). What drives eco-innovators? A critical review of the empirical literature based on econometric methods. *Journal of Cleaner Production, 112*, 2158–2170. https://doi.org/10.1016/j.jclepro.2015.09.009

Doran, J., & Ryan, G. (2016). The importance of the diverse drivers and types of environmental innovation for firm performance. *Business Strategy and the Environment, 25*(2), 102–119. https://doi.org/10.1002/bse.1860

Hart, S. L. (1995). A natural-resource-based view of the firm. *Academy of Management Review, 20*(4), 986–1014. https://doi.org/10.2307/258963

Horbach, J. (2008). Determinants of environmental innovation—New evidence from German panel data sources. *Research Policy, 37*(1), 163–173. https://doi.org/10.1016/j.respol.2007.08.006

Horbach, J., Rammer, C., & Rennings, K. (2012). Determinants of eco-innovations by type of environmental impact: The role of regulatory push/pull, technology push and market pull. *Ecological Economics, 78*, 112–122. https://doi.org/10.1016/j.ecolecon.2012.04.005

Huergo, E., & Jaumandreu, J. (2004). Firms' age, process innovation and productivity growth. *International Journal of Industrial Organization, 22*(4), 541–559. https://doi.org/10.1016/j.ijindorg.2003.12.002

Kesidou, E., & Demirel, P. (2012). On the drivers of eco-innovations: Empirical evidence from the UK. *Research Policy, 41*(5), 862–870. https://doi.org/10.1016/j.respol.2012.01.005

OECD. (2011). *Towards green growth*. OECD Publishing. https://doi.org/10.1787/9789264111318-en

OECD. (2018). *Oslo manual 2018: Guidelines for collecting, reporting and using data on innovation* (4th ed.). OECD Publishing. https://doi.org/10.1787/9789264304604-en

Porter, M. E., & van der Linde, C. (1995). Toward a new conception of the environment–competitiveness relationship. *Journal of Economic Perspectives, 9*(4), 97–118. https://doi.org/10.1257/jep.9.4.97

Rennings, K. (2000). Redefining innovation—Eco-innovation research and the contribution from ecological economics. *Ecological Economics, 32*(2), 319–332. https://doi.org/10.1016/S0921-8009(99)00112-3

Schumpeter, J. A. (1934). *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle*. Harvard University Press.

United Nations Environment Programme. (2011). *Towards a green economy: Pathways to sustainable development and poverty eradication*. United Nations Environment Programme. https://www.unep.org/resources/report/towards-green-economy-pathways-sustainable-development-and-poverty-eradication

Wooldridge, J. M. (2020). *Introductory econometrics: A modern approach* (7th ed.). Cengage Learning.

World Bank. (2012). *Inclusive green growth: The pathway to sustainable development*. World Bank. http://documents.worldbank.org/curated/en/368361468313515918

Xie, X., Huo, J., & Zou, H. (2019). Green process innovation, green product innovation, and corporate financial performance: A content analysis method. *Journal of Business Research, 101*, 697–706. https://doi.org/10.1016/j.jbusres.2019.01.010