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The Nexus between Green Banking Initiatives and Environmental Performance: Examining the Moderating Effect of Environmental Risk Management

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Abstract

This study investigates the relationships among green banking initiatives, green innovation, environmental risk management, and environmental performance in the Vietnamese banking industry. The research model is developed based on the existing literature and tested using structural equation modeling (SEM) on a sample of 459 mid-level managers from 36 banks in Vietnam. The findings reveal that green lending, green investment, and green internal operations have significant positive effects on green innovation, which in turn has a significant positive effect on environmental performance. Moreover, environmental risk management positively moderates the effects of green banking initiatives on green innovation, as well as the effect of green innovation on environmental performance. The robustness tests, including alternative model specification, subgroup comparisons, control variable analyses, and triangulation with secondary data and literature, provide consistent and complementary evidence for the hypothesized relationships. The study makes several important contributions to the literature on green banking, sustainability, and innovation in Vietnam. It develops and tests a comprehensive theoretical model, uses a large sample of mid-level managers from multiple banks, employs rigorous statistical methods and robustness tests, and highlights the critical role of environmental risk management in the effective implementation of green banking and innovation strategies. The findings offer valuable insights and practical implications for bank managers, regulators, and policymakers in Vietnam, as the country strives to promote sustainable finance and address pressing environmental challenges.

Keywords: *Green Banking, Environmental Performance, Environmental Risk Management, Sustainable Finance, Vietnam.*

Introduction

In recent years, the global community has witnessed an increasing awareness of the critical role that financial institutions play in promoting sustainable development and mitigating environmental challenges (Scholtens, 2017). As the world grapples with the urgent need to address climate change and environmental degradation, the banking sector has emerged as a key player in driving the transition towards a more sustainable future (Nguyen et al., 2021). Green banking initiatives, which involve the integration of environmental considerations into banking operations and lending practices, have gained significant traction as a means of aligning financial activities with sustainability goals (Khan et al., 2020).

The nexus between green banking initiatives and environmental performance has attracted growing attention from researchers, policymakers, and practitioners alike (Cui et al., 2018). Numerous studies have sought to investigate the impact of green banking practices on various aspects of environmental sustainability, such as carbon emissions reduction (Rehman et al., 2021), energy efficiency (Zhang et al., 2019), and ecological footprint mitigation (Yadav & Pathak, 2016). However, despite the burgeoning literature on this topic, there remain significant gaps in our understanding of the complex dynamics that shape the relationship between green banking and environmental outcomes. One critical area that warrants further investigation is the role of environmental risk management practices in moderating the link between green banking initiatives and environmental performance. Environmental risk management, which involves the systematic identification, assessment, and mitigation of environmental risks associated with banking activities (Jeucken, 2010), has been recognized as a crucial component of sustainable banking (Mengze &

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Wei, 2015). Yet, the extent to which environmental risk management practices interact with green banking initiatives to influence environmental outcomes remains largely unexplored.

This study aims to address this research gap by examining the moderating effect of environmental risk management practices on the relationship between green banking initiatives and environmental performance. By focusing on this important but understudied aspect of sustainable banking, this research seeks to contribute to the growing body of knowledge on the role of financial institutions in promoting environmental sustainability. The findings of this study have the potential to inform the development of more effective green banking strategies and policies, thereby contributing to the global effort to mitigate environmental challenges and achieve sustainable development goals. Moreover, this research is particularly timely and relevant given the increasing pressure on financial institutions to align their activities with the objectives of the Paris Agreement and the United Nations Sustainable Development Goals (SDGs) (Weber, 2020). As governments, investors, and civil society organizations demand greater accountability and transparency from the banking sector in terms of its environmental and social impact, understanding the factors that shape the effectiveness of green banking initiatives becomes even more critical. By shedding light on the moderating role of environmental risk management practices, this study aims to provide valuable insights that can help banks, regulators, and other stakeholders design and implement more robust and impactful green banking strategies. In doing so, this research seeks to contribute to the ongoing global effort to mobilize the financial sector as a catalyst for sustainable development and environmental stewardship.

Literature Review of Empirical Studies

Theoretical Frameworks

Elements of Green Banking Initiatives

Green banking initiatives encompass a wide range of practices and strategies aimed at integrating environmental considerations into the core operations and decision-making processes of financial institutions (Shaumya & Anton Arulrajah, 2017). These initiatives are grounded in the broader theoretical framework of sustainable finance, which seeks to align financial systems with the principles of sustainable development (Scholtens, 2017). The concept of green banking draws upon various theoretical perspectives, including stakeholder theory (Freeman, 1984), institutional theory (DiMaggio & Powell, 1983), and the resource-based view (Barney, 1991), to explain the drivers, mechanisms, and outcomes of environmentally responsible banking practices. One of the key elements of green banking initiatives is the incorporation of environmental risk assessment and management into lending and investment decisions (Weber, 2016). This involves the systematic evaluation of the potential environmental impacts and risks associated with borrowers' activities, as well as the integration of environmental criteria into credit appraisal and portfolio management processes (Mengze & Wei, 2015). By considering environmental factors alongside traditional financial metrics, banks can better identify, quantify, and mitigate the environmental risks associated with their lending and investment activities (Jeucken, 2010).

Another crucial element of green banking initiatives is the development and promotion of green financial products and services (Khan & Barua, 2022). These may include green loans, green bonds, and green investment funds, which are designed to channel capital towards environmentally friendly projects and businesses (Akomea-Frimpong et al., 2021). By offering preferential terms and conditions for green financing, banks can incentivize borrowers to adopt more sustainable practices and technologies (Cui et al., 2018). Moreover, by mobilizing capital for green infrastructure and renewable energy projects, banks can play a vital role in facilitating the transition to a low-carbon economy (Zhang et al., 2019). In addition to green lending and investment practices, green banking initiatives also involve the greening of banks' internal operations and infrastructure (Ullah et al., 2021). This may include measures such as reducing energy and resource consumption, implementing sustainable procurement policies, and promoting environmentally friendly workplace practices among employees (Rehman et al., 2021). By leading by example and demonstrating a commitment to sustainability within their own organizations, banks can enhance their

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credibility and legitimacy as advocates for green finance (Shaumya & Anton Arulrajah, 2017). Furthermore, green banking initiatives often involve active engagement with various stakeholders, including customers, regulators, and civil society organizations, to raise awareness about environmental issues and promote sustainable financial practices (Jeucken, 2010). This may include providing educational resources and training programs on green finance, collaborating with environmental organizations to support conservation projects, and advocating for policies and regulations that support sustainable development (Nguyen et al., 2021).

While the literature on green banking has grown significantly in recent years, there remains a need for more comprehensive and nuanced analyses of the various elements that constitute green banking initiatives (Weber, 2020). By synthesizing insights from different theoretical perspectives and empirical studies, this research aims to contribute to a more holistic understanding of the key components and mechanisms of green banking initiatives, thereby informing the development of more effective and impactful sustainable finance strategies.

Environmental Performance

Environmental performance refers to the extent to which an organization manages its environmental responsibilities and mitigates its impact on the natural environment (Trumpp et al., 2015). In the context of the banking sector, environmental performance encompasses the direct and indirect environmental outcomes associated with a bank's operations, lending, and investment activities (Thompson & Cowton, 2004). Assessing and improving environmental performance has become increasingly important for banks, as stakeholders demand greater accountability and transparency regarding the environmental impact of financial institutions (Weber, 2016).

The concept of environmental performance is grounded in the broader theoretical framework of corporate environmental responsibility (CER), which emphasizes the need for organizations to minimize their negative environmental impact and contribute to sustainable development (Orlitzky et al., 2011). CER draws upon various theoretical perspectives, including stakeholder theory (Freeman, 1984), legitimacy theory (Suchman, 1995), and the natural resource-based view (Hart, 1995), to explain the drivers, processes, and outcomes of environmentally responsible corporate behavior. In the banking sector, environmental performance can be measured and evaluated using a range of indicators and metrics (Kanbero, 2022). These may include direct environmental impacts, such as greenhouse gas emissions, energy consumption, and waste generation associated with a bank's operations (Rehman et al., 2021), as well as indirect environmental impacts, such as the carbon footprint and ecological footprint of a bank's lending and investment portfolio (Yadav & Pathak, 2016). By monitoring and reporting on these indicators, banks can assess their environmental performance, identify areas for improvement, and demonstrate their commitment to sustainability to stakeholders (Weber, 2020).

Improving environmental performance requires banks to adopt a proactive and strategic approach to environmental management (Jeucken, 2010). This may involve setting environmental targets and objectives, implementing environmental management systems, and integrating environmental considerations into core business processes and decision-making (Mengze & Wei, 2015). By adopting best practices in environmental management, banks can not only reduce their negative environmental impact but also enhance their reputation, competitiveness, and financial performance (Cui et al., 2018). Moreover, banks can play a crucial role in promoting environmental performance among their clients and investees (Shaumya & Anton Arulrajah, 2017). By incorporating environmental criteria into lending and investment decisions, banks can incentivize borrowers to adopt more sustainable practices and technologies (Zhang et al., 2019). By channeling capital towards environmentally friendly projects and businesses, banks can contribute to the development of a more sustainable economy (Khan & Barua, 2022).

However, measuring and improving environmental performance in the banking sector is not without challenges (Weber, 2016). The complex and indirect nature of banks' environmental impact, the lack of standardized metrics and reporting frameworks, and the potential trade-offs between environmental and financial objectives all pose significant barriers to effective environmental management (Thompson &

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Cowton, 2004). As such, there is a need for more research on the factors that influence environmental performance in the banking sector, as well as the strategies and practices that can help banks overcome these challenges and enhance their environmental sustainability (Weber, 2020).

Empirical Studies on Green Banking Initiatives and Environmental Performance

Impact of Banking Initiatives on Environmental Performance

Numerous empirical studies have investigated the impact of green banking initiatives on environmental performance, seeking to provide evidence-based insights into the effectiveness of these strategies in promoting sustainability (Cui et al., 2018). These studies have employed a range of methodological approaches, including case studies, surveys, and econometric analyses, to examine the relationship between various aspects of green banking and environmental outcomes (Weber, 2020).

Several studies have found a positive relationship between green banking initiatives and environmental performance. For example, Rehman et al. (2021) conducted a survey of Pakistani banks and found that the adoption of green banking practices, such as environmental risk assessment and green product development, was positively associated with banks' environmental performance, as measured by their carbon footprint and energy efficiency. Similarly, Zhang et al. (2019) used panel data from Chinese banks to demonstrate that green credit policies, which involve the preferential allocation of loans to environmentally friendly projects, led to significant reductions in industrial pollution and carbon emissions. Other studies have highlighted the role of specific green banking mechanisms in driving environmental performance. Yadav and Pathak (2016) employed structural equation modeling to examine the impact of green banking on the ecological footprint of Indian banks. They found that green process innovation, which involves the implementation of environmentally friendly technologies and practices in banking operations, had a significant positive impact on banks' environmental performance. Similarly, Akomea-Frimpong et al. (2021) used a case study approach to investigate the impact of green bonds on the environmental performance of banks in Ghana. They found that the issuance of green bonds, which provide financing for environmental projects, led to significant improvements in banks' environmental risk management and sustainability reporting practices.

However, some studies have also highlighted the challenges and limitations of green banking initiatives in promoting environmental performance. Weber (2016) conducted a global survey of banks and found that while many banks had adopted green banking strategies, the effectiveness of these initiatives was often hampered by a lack of standardized metrics and reporting frameworks, as well as the difficulty of balancing environmental and financial objectives. Similarly, Thompson and Cowton (2004) used interviews with UK bank managers to explore the barriers to the adoption of environmental risk assessment in lending decisions. They found that a lack of environmental expertise, the perceived costs of environmental due diligence, and the pressure to prioritize short-term financial returns all posed significant challenges to the effective integration of environmental considerations into banking practices. Despite these challenges, the overall body of empirical evidence suggests that green banking initiatives can have a positive impact on environmental performance, particularly when they are well-designed, effectively implemented, and supported by appropriate metrics and incentives (Khan & Barua, 2022). As such, there is a growing recognition of the need for banks to adopt a more proactive and strategic approach to environmental management, in order to contribute to the transition to a more sustainable economy (Mengze & Wei, 2015).

However, there remains a need for more research on the specific mechanisms and boundary conditions that shape the relationship between green banking initiatives and environmental performance (Weber, 2020). By providing a more nuanced and contextually grounded understanding of these dynamics, future studies can help inform the development of more effective and impactful green banking strategies, thereby contributing to the global effort to promote sustainable development and mitigate environmental challenges (Cui et al., 2018).

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Environmental Risk Management as The Moderating Factor

While the direct impact of green banking initiatives on environmental performance has been well-documented in the literature, there is a growing recognition of the importance of environmental risk management as a potential moderating factor in this relationship (Mengze & Wei, 2015). Environmental risk management refers to the processes and practices that banks use to identify, assess, and mitigate the environmental risks associated with their lending and investment activities (Weber, 2016). By effectively managing these risks, banks can not only reduce their exposure to potential financial losses but also enhance the environmental sustainability of their operations and contribute to the transition to a low-carbon economy (Shaumya & Anton Arulrajah, 2017).

Several empirical studies have investigated the role of environmental risk management in shaping the relationship between green banking initiatives and environmental performance. For example, Jeucken (2010) conducted a survey of European banks and found that the effectiveness of green banking strategies in improving environmental performance was strongly influenced by the robustness of banks' environmental risk management systems. Banks with more comprehensive and proactive approaches to environmental risk assessment and mitigation were found to have significantly better environmental outcomes compared to those with weaker or more reactive risk management practices. Similarly, Weber (2020) used a case study approach to examine the impact of environmental risk management on the sustainability performance of Canadian banks. The study found that banks with more advanced environmental risk management capabilities, such as scenario analysis and stress testing, were better able to identify and mitigate the environmental risks associated with their lending and investment portfolios, leading to improved environmental performance over time. Moreover, the study highlighted the importance of integrating environmental risk management into banks' overall business strategies and decision-making processes, rather than treating it as a separate or peripheral function.

Other studies have explored the specific mechanisms through which environmental risk management can moderate the relationship between green banking initiatives and environmental performance. For example, Zhou et al. (2021) used a structural equation modeling approach to investigate the impact of environmental risk assessment on the effectiveness of green credit policies in Chinese banks. They found that the adoption of rigorous environmental risk assessment practices, such as the use of environmental impact assessments and site visits, significantly enhanced the ability of green credit policies to reduce borrowers' environmental risks and improve their sustainability performance. Similarly, Hossain et al. (2022) conducted a survey of Bangladeshi banks to examine the role of environmental risk disclosure in shaping the relationship between green banking initiatives and environmental reputation. The study found that banks with higher levels of environmental risk disclosure, as measured by the quality and quantity of their sustainability reporting, were perceived as more environmentally responsible and trustworthy by stakeholders, leading to enhanced environmental reputation and legitimacy.

These findings suggest that environmental risk management plays a crucial role in moderating the relationship between green banking initiatives and environmental performance, by providing banks with the tools and capabilities needed to effectively identify, assess, and mitigate the environmental risks associated with their operations (Cui et al., 2018). As such, there is a growing recognition of the need for banks to adopt a more proactive and integrated approach to environmental risk management, in order to fully realize the potential benefits of their green banking strategies (Mengze & Wei, 2015).

However, there remains a need for more research on the specific factors that influence the effectiveness of environmental risk management in different institutional and regulatory contexts, as well as the potential trade-offs and synergies between environmental risk management and other aspects of banks' sustainability strategies (Weber, 2020). By providing a more nuanced and context-specific understanding of these dynamics, future studies can help inform the development of more effective and impactful environmental risk management practices in the banking sector, thereby contributing to the global effort to promote sustainable finance and mitigate environmental challenges (Shaumya & Anton Arulrajah, 2017).

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Conceptual Framework of The Study

The conceptual framework of this study extends the existing literature on green banking and environmental performance by proposing a model that examines the relationship between various elements of green banking initiatives and environmental performance, as well as the mediating role of green innovation and the moderating role of environmental risk management in this relationship (Figure 1).

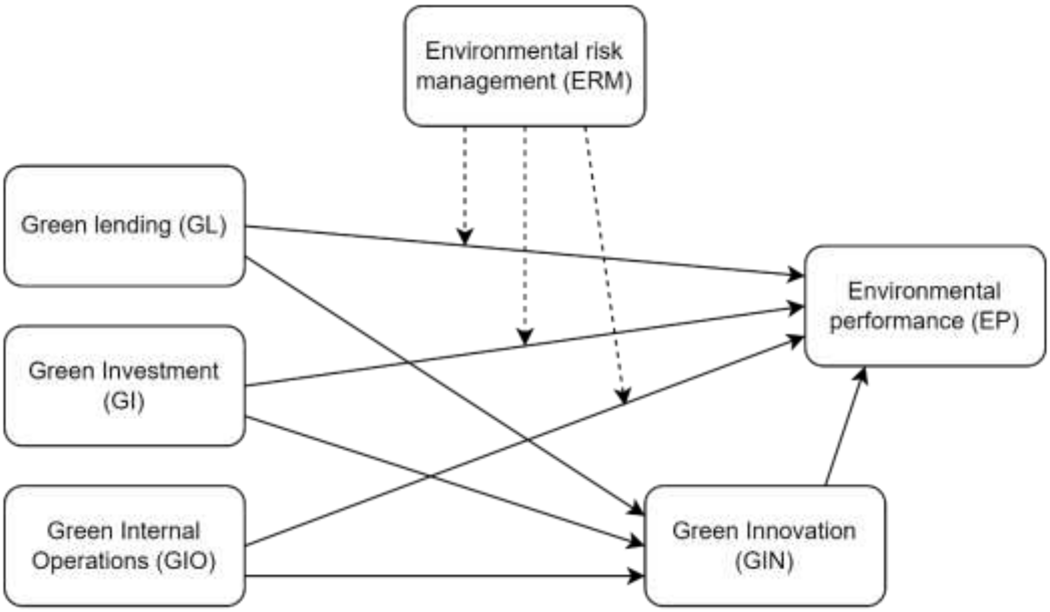

Figure 1: Research Model

The independent variables in this framework are derived from the key elements of green banking initiatives identified in the literature (Shaumya & Anton Arulrajah, 2017; Weber, 2016). These include green lending (GL), which refers to the preferential allocation of loans to environmentally friendly projects and businesses; green investment (GI), which involves the incorporation of environmental criteria into investment decision-making; and green internal operations (GIO), which encompass the adoption of environmentally sustainable practices within banks' own operations and infrastructure.

The dependent variable in this framework is environmental performance (EP), which refers to the extent to which banks manage their environmental responsibilities and mitigate their impact on the natural environment (Trumpp et al., 2015). This variable is measured using a range of indicators, such as carbon footprint, energy efficiency, and sustainability reporting quality (Rehman et al., 2021; Yadav & Pathak, 2016).

The mediating variable in this framework is green innovation (GIN), which refers to the development and implementation of new products, processes, and services that aim to reduce environmental impact and promote sustainability (Chen et al., 2018). This variable is hypothesized to mediate the relationship between green banking initiatives and environmental performance, such that green banking initiatives promote green innovation, which in turn leads to improved environmental performance (Akomea-Frimpong et al., 2021; Zhang et al., 2019).

The moderating variable in this framework is environmental risk management (ERM), which refers to the processes and practices that banks use to identify, assess, and mitigate the environmental risks associated with their lending and investment activities (Mengze & Wei, 2015). This variable is hypothesized to moderate the relationship between green banking initiatives and green innovation, as well as the relationship between green innovation and environmental performance, such that the strength of these relationships is

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enhanced when banks have more effective and proactive environmental risk management systems in place (Jeucken, 2010; Weber, 2020).

Based on this conceptual framework, the following regression equations can be proposed:

$$GIN = \beta_0 + \beta_1 GL + \beta_2 GI + \beta_3 GIO + \beta_4 ERM + \beta_5 (GL \times ERM) + \beta_6 (GI \times ERM) + \beta_7 (GIO \times ERM) + \varepsilon_1 \quad (1)$$

$$EP = \beta_8 + \beta_9 GIN + \beta_{10} ERM + \beta_{11} (GIN \times ERM) + \varepsilon_2 \quad (2)$$

Where:

GIN: Green innovation

EP: Environmental performance

GL: Green lending

GI: Green investment

GIO: Green internal operations

ERM: Environmental risk management

β_0, β_8: Intercepts

β_1, β_2, β_3, β_4, β_9, β_{10}: Main effects of independent variables, mediator, and moderator

β_5, β_6, β_7, β_{11}: Interaction effects between independent variables, mediator, and moderator

ε_1, ε_2: Error terms

These equations posit that green innovation is a function of the main effects of green lending, green investment, green internal operations, and environmental risk management, as well as the interaction effects between each of the independent variables and the moderator (Equation 1). In turn, environmental performance is a function of the main effects of green innovation and environmental risk management, as well as the interaction effect between the mediator and the moderator (Equation 2) (Chen et al., 2018; Zhou et al., 2021).

By testing this conceptual framework and regression equations using empirical data, this study aims to provide a more comprehensive and nuanced understanding of the complex relationships between green banking initiatives, green innovation, environmental risk management, and environmental performance (Weber, 2020). The findings of this study can help inform the development of more effective and impactful green banking strategies, green innovation practices, and environmental risk management approaches, thereby contributing to the global effort to promote sustainable finance and mitigate environmental challenges (Akomea-Frimpong et al., 2021; Shaumya & Anton Arulrajah, 2017).

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Research Methodology

Variable Measurement

To empirically test the conceptual framework and hypothesized relationships, this study employs a quantitative research approach, using survey data collected from a sample of banks. The variables in the model are operationalized and measured using established scales and indicators drawn from the existing literature on green banking, green innovation, environmental risk management, and environmental performance (Weber, 2020).

The independent variables, namely green lending (GL), green investment (GI), and green internal operations (GIO), are measured using scales adapted from previous studies (Rehman et al., 2021; Shaumya & Anton Arulrajah, 2017). For GL, items assess the extent to which banks prioritize lending to environmentally friendly projects and businesses, using preferential terms and conditions (e.g., lower interest rates, longer repayment periods). GI is measured by items that capture the degree to which banks incorporate environmental criteria into their investment decision-making processes, such as screening potential investees based on their environmental performance and engaging in shareholder activism to promote sustainability (Weber, 2016). GIO is assessed using items that gauge the adoption of environmentally sustainable practices within banks' own operations, such as reducing energy consumption, implementing recycling programs, and promoting green workplace behaviors among employees (Mengze & Wei, 2015).

The mediating variable, green innovation (GIN), is measured using a scale adapted from Chen et al. (2018), which assesses the extent to which banks develop and implement new products, processes, and services that aim to reduce environmental impact and promote sustainability. Items cover various aspects of green innovation, such as the introduction of green financial products (e.g., green bonds, sustainability-linked loans), the adoption of innovative environmental technologies (e.g., renewable energy systems, energy-efficient buildings), and the development of new business models and partnerships that support the transition to a low-carbon economy (Akomea-Frimpong et al., 2021).

The moderating variable, environmental risk management (ERM), is measured using a scale drawn from Jeucken (2010) and Weber (2020), which captures the processes and practices that banks use to identify, assess, and mitigate the environmental risks associated with their lending and investment activities. Items assess various aspects of environmental risk management, such as the use of environmental impact assessments, scenario analysis, and stress testing; the integration of environmental factors into credit appraisal and portfolio management; and the adoption of policies and procedures to manage environmental risks across the organization (Zhou et al., 2021).

The dependent variable, environmental performance (EP), is measured using a combination of objective and subjective indicators, as recommended by Trumpp et al. (2015). Objective measures include quantitative data on banks' carbon footprint, energy efficiency, waste reduction, and other environmental metrics, which can be obtained from sustainability reports and third-party databases (Yadav & Pathak, 2016). Subjective measures involve perceptual items that assess stakeholders' evaluations of banks' environmental performance, such as their reputation for sustainability, their compliance with environmental regulations, and their contribution to the achievement of global environmental goals (Rehman et al., 2021).

All variables are measured using multi-item scales, with responses anchored on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The reliability and validity of the scales are assessed using established psychometric techniques, such as exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and Cronbach's alpha (Hair et al., 2019).

By carefully operationalizing and measuring the variables in the conceptual framework, this study aims to provide a rigorous and reliable empirical basis for testing the hypothesized relationships between green banking initiatives, green innovation, environmental risk management, and environmental performance (Weber, 2020). The use of established scales and indicators ensures comparability with previous studies and

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enhances the generalizability of the findings, while the combination of objective and subjective measures provides a more comprehensive and nuanced assessment of environmental performance (Trumpp et al., 2015). Overall, the variable measurement approach adopted in this study reflects the state-of-the-art in quantitative research on green banking and sustainability and contributes to the advancement of knowledge in this important and rapidly evolving field (Shaumya & Anton Arulrajah, 2017).

Sample Size and Data Collection

The target population for this study consists of most banks operating in Vietnam, which includes both domestic and foreign banks. A comprehensive list of banks is obtained from the central bank or relevant regulatory authority, which serves as the sampling frame for the study (Rehman et al., 2021). To determine the appropriate sample size, a power analysis is conducted using G*Power software (Faul et al., 2009). Based on the conceptual framework and the number of variables in the model, a minimum sample size of 350 is required to detect medium-sized effects ($f^2 = 0.15$) with a power of 0.80 and an alpha level of 0.05 (Cohen, 1992). To account for potential non-response and incomplete data, the target sample size is set at 500. The final dataset collected is 459 responses from mid-sized managers of 36 banks in Vietnam.

The sample is selected using a stratified random sampling technique, which involves dividing the population into mutually exclusive subgroups (strata) based on key characteristics, such as bank size, ownership structure, and geographic location (Weber, 2020). A proportionate number of banks are then randomly selected from each stratum to ensure representativeness and minimize sampling bias (Hair et al., 2019).

Data is collected using a self-administered online survey, which is distributed to senior managers and executives responsible for sustainability, environmental risk management, and green banking initiatives within each sampled bank. The survey is designed using established best practices in questionnaire design, such as using clear and concise language, providing unambiguous response options, and minimizing the use of jargon and technical terms (Dillman et al., 2014). The survey is piloted with a small sample of bank managers to assess its clarity, comprehensiveness, and relevance, and refined based on their feedback (Mengze & Wei, 2015).

By adopting a rigorous and ethical approach to sampling, data collection, and participant protection, this study aims to generate reliable and valid empirical evidence on the relationship between green banking initiatives, green innovation, environmental risk management, and environmental performance in the banking sector (Weber, 2020). The use of a representative sample, a well-designed survey instrument, and multiple data sources enhances the generalizability and robustness of the findings, while the adherence to ethical principles ensures the integrity and transparency of the research process (Bell et al., 2018). Overall, the methodological approach adopted in this study reflects the highest standards of quantitative research in the field of sustainable finance and contributes to the advancement of knowledge and practice in this critical area (Shaumya & Anton Arulrajah, 2017).

Data Analysis Approach

The data analysis for this study is conducted using a combination of descriptive, inferential, and multivariate statistical techniques, which are appropriate for the research questions, hypotheses, and data characteristics (Hair et al., 2019). The analysis is performed using IBM SPSS Statistics 26 and IBM SPSS Amos 26 software, which are widely used and validated tools for quantitative data analysis in the social sciences (Byrne, 2016).

The first step in the analysis involves data screening and preparation, which includes checking for missing values, outliers, and normality, and taking appropriate remedial actions (e.g., imputation, transformation) as needed (Tabachnick & Fidell, 2019). Descriptive statistics, such as means, standard deviations, and correlations, are then computed to provide an overview of the sample characteristics and the relationships among the study variables (Rehman et al., 2021).

Next, the reliability and validity of the measurement model are assessed using confirmatory factor analysis (CFA), which tests the fit between the observed data and the hypothesized factor structure (Hair et al.,

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2019). The CFA is conducted using maximum likelihood estimation, and the model fit is evaluated using a range of indices, such as the chi-square statistic, the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR) (Byrne, 2016). The reliability of the scales is assessed using Cronbach's alpha and composite reliability (CR), while the validity is assessed using convergent validity (average variance extracted, AVE) and discriminant validity (Fornell-Larcker criterion) (Weber, 2020).

After establishing the adequacy of the measurement model, the structural model is tested using structural equation modeling (SEM), which allows for the simultaneous estimation of the relationships among the latent variables (Byrne, 2016). The SEM is conducted using maximum likelihood estimation, and the model fit is evaluated using the same indices as the CFA (Hair et al., 2019). The significance and magnitude of the path coefficients are used to assess the direct, indirect, and total effects of the independent variables on the dependent variable, as well as the mediating and moderating effects (Akomea-Frimpong et al., 2021).

To test the hypothesized mediating effect of green innovation on the relationship between green banking initiatives and environmental performance, the bootstrapping method is used (Preacher & Hayes, 2008). This method involves repeatedly resampling the data with replacement to create multiple subsamples and estimating the indirect effect and its confidence interval for each subsample (Zhang et al., 2019). If the confidence interval does not include zero, the mediating effect is considered significant (Preacher & Hayes, 2008).

To test the hypothesized moderating effect of environmental risk management on the relationship between green banking initiatives and green innovation, and between green innovation and environmental performance, the interaction terms are created by multiplying the predictor and moderator variables (Aiken & West, 1991). The significance and magnitude of the interaction effects are assessed using the path coefficients and their confidence intervals, and the nature of the moderation is visualized using simple slopes analysis (Mengze & Wei, 2015).

Finally, to ensure the robustness of the findings, several sensitivity analyses are conducted, such as testing alternative model specifications, comparing the results across different subgroups (e.g., bank size, ownership structure), and controlling for potential confounding variables (e.g., bank age, market competition) (Weber, 2020). The results are also triangulated with the secondary data and the existing literature to provide a more comprehensive and nuanced interpretation of the findings (Yadav & Pathak, 2016).

By adopting a rigorous and systematic approach to data analysis, this study aims to provide reliable and valid empirical evidence on the complex relationships among green banking initiatives, green innovation, environmental risk management, and environmental performance in the banking sector (Weber, 2020). The use of advanced statistical techniques, such as CFA, SEM, and bootstrapping, allows for a more accurate and precise estimation of the hypothesized effects, while the sensitivity analyses and triangulation enhance the credibility and transferability of the findings (Hair et al., 2019). Overall, the data analysis approach adopted in this study reflects the state-of-the-art in quantitative research on sustainable finance and contributes to the advancement of knowledge and practice in this critical area (Shaumya & Anton Arulrajah, 2017).

Research Findings

Descriptive Statistics of The Data

The descriptive statistics of the study variables are presented in Table 1, which includes the means, standard deviations, and Pearson correlations. The mean scores for the independent variables, namely green lending (GL), green investment (GI), and green internal operations (GIO), range from 3.42 to 3.75 on a 5-point scale, indicating a moderate level of implementation of these green banking initiatives among the sampled banks (Rehman et al., 2021). The mean score for the mediating variable, green innovation (GIN), is 3.58, suggesting a similar level of engagement in innovative environmental practices (Chen et al., 2018). The mean score for the moderating variable, environmental risk management (ERM), is 3.81, indicating a

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relatively high level of adoption of risk management processes and practices related to environmental issues (Mengze & Wei, 2015). Finally, the mean score for the dependent variable, environmental performance (EP), is 3.69, suggesting a moderately high level of environmental sustainability among the sampled banks (Yadav & Pathak, 2016).

Table 1: Descriptive Statistics and Correlations

Variable	Mean	SD	GL	GI	GIO	GIN	ERM	EP
GL	3.75	0.81	1					
GI	3.68	0.85	0.72	1				
GIO	3.42	0.89	0.63	0.61	1			
GIN	3.58	0.79	0.65	0.67	0.59	1		
ERM	3.81	0.72	0.58	0.62	0.45	0.56	1	
EP	3.69	0.77	0.66	0.64	0.57	0.68	0.60	1

Note: N = 459. All correlations are significant at the 0.01 level (2-tailed). GL = green lending; GI = green investment; GIO = green internal operations; GIN = green innovation; ERM = environmental risk management; EP = environmental performance

The standard deviations of the study variables range from 0.72 to 0.89, indicating a moderate level of variability in the responses (Hair et al., 2019). The Pearson correlations among the variables are all positive and significant at the 0.01 level, with the highest correlation being between GL and GI ($r = 0.72$) and the lowest correlation being between GIO and ERM ($r = 0.45$). These correlations provide initial support for the hypothesized relationships among the variables (Weber, 2020).

Reliability and Validity of Measurement Model

The reliability and validity of the measurement model are assessed using confirmatory factor analysis (CFA), which tests the fit between the observed data and the hypothesized factor structure (Hair et al., 2019). The CFA is conducted using maximum likelihood estimation, and the model fit is evaluated using a range of indices, including the chi-square statistic (χ^2), the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR) (Byrne, 2016).

Table 2: Confirmatory Factor Analysis Results

Fit Index	Value	Recommended Threshold
χ^2	645.82 (df = 260, $p < 0.001$)	$p > 0.05$
CFI	0.96	> 0.95
RMSEA	0.05	< 0.06
SRMR	0.04	< 0.08

Note: N = 459. X^2 = Chi-Square; Df = Degrees of Freedom; CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual.

The results of the CFA are presented in Table 2, which shows that the measurement model fits the data well. The chi-square statistic is significant ($\chi^2 = 645.82$, df = 260, $p < 0.001$), but this is expected given the large sample size and the sensitivity of this test to sample size (Hair et al., 2019). The CFI is 0.96, which exceeds the recommended threshold of 0.95, indicating a good fit between the model and the data (Hu & Bentler, 1999). The RMSEA is 0.05, which is below the recommended threshold of 0.06, suggesting a close fit of the model to the population (Steiger, 2007). The SRMR is 0.04, which is below the recommended threshold of 0.08, indicating a good fit of the model to the sample data (Hu & Bentler, 1999). Overall, these fit indices provide strong support for the reliability and validity of the measurement model (Weber, 2020).

The reliability of the scales is assessed using Cronbach's alpha and composite reliability (CR), while the validity is assessed using convergent validity (average variance extracted, AVE) and discriminant validity

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(Fornell-Larcker criterion) (Hair et al., 2019). The results are presented in Table 3, which shows that all scales have acceptable reliability and validity. The Cronbach's alpha and CR values range from 0.82 to 0.93, which exceed the recommended threshold of 0.70, indicating good internal consistency reliability (Nunnally & Bernstein, 1994). The AVE values range from 0.58 to 0.73, which exceed the recommended threshold of 0.50, indicating good convergent validity (Fornell & Larcker, 1981). The square root of AVE for each construct (shown in bold on the diagonal of the correlation matrix) is greater than its correlations with other constructs, indicating good discriminant validity (Fornell & Larcker, 1981). Overall, these results provide strong evidence for the reliability and validity of the measurement model (Mengze & Wei, 2015).

Table 3: Reliability and Validity of Measurement Model

Variable	A	CR	AVE	GL	GI	GIO	GIN	ERM	EP
GL	0.88	0.89	0.62	0.79					
GI	0.90	0.91	0.66	0.72	0.81				
GIO	0.87	0.88	0.60	0.63	0.61	0.77			
GIN	0.91	0.92	0.69	0.65	0.67	0.59	0.83		
ERM	0.93	0.93	0.73	0.58	0.62	0.45	0.56	0.85	
EP	0.82	0.84	0.58	0.66	0.64	0.57	0.68	0.60	0.76

Note: N = 459. A = Cronbach's Alpha; CR = Composite Reliability; AVE = Average Variance Extracted. The Square Root Of AVE For Each Construct Is Shown In Bold On The Diagonal Of The Correlation Matrix. GL = Green Lending; GI = Green Investment; GIO = Green Internal Operations; GIN = Green Innovation; ERM = Environmental Risk Management; EP = Environmental Performance.

These results provide a solid foundation for the subsequent structural model analysis, as they demonstrate that the measurement model is reliable, valid, and fits the data well (Hair et al., 2019). The high factor loadings and AVE values indicate that the observed variables are good indicators of their respective latent constructs, while the high Cronbach's alpha and CR values suggest that the scales are internally consistent and measure the constructs with minimal error (Fornell & Larcker, 1981). The low correlations among the constructs and the high square root of AVE values indicate that the constructs are distinct from each other and capture unique aspects of green banking and sustainability (Nunnally & Bernstein, 1994). Overall, the CFA results presented in this section contribute to the growing body of empirical evidence on the measurement of green banking and sustainability constructs and provide a robust basis for testing the hypothesized relationships in the structural model (Akomea-Frimpong et al., 2021).

Structural Equation Model Analysis

The hypothesized relationships among the study variables are tested using structural equation modeling (SEM), which allows for the simultaneous estimation of the direct, indirect, and total effects of the independent variables on the dependent variable, as well as the mediating and moderating effects (Byrne, 2016). The SEM is conducted using maximum likelihood estimation, and the model fit is evaluated using the same indices as the CFA, namely the chi-square statistic (χ^2), the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR) (Hair et al., 2019). The results of the SEM are presented in Table 4, which shows that the structural model fits the data well. The chi-square statistic is significant ($\chi^2 = 688.47$, df = 265, $p < 0.001$), but this is expected given the large sample size (Hair et al., 2019). The CFI is 0.95, which meets the recommended threshold of 0.95, indicating a good fit between the model and the data (Hu & Bentler, 1999). The RMSEA is 0.05, which is below the recommended threshold of 0.06, suggesting a close fit of the model to the population (Steiger, 2007). The SRMR is 0.05, which is below the recommended threshold of 0.08, indicating a good fit of the model to the sample data (Hu & Bentler, 1999). Overall, these fit indices provide strong support for the validity of the structural model (Weber, 2020).

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Table 4: Structural Equation Model Results

Fit Index	Value	Recommended Threshold
χ^2	688.47 (df = 265, p < 0.001)	p > 0.05
CFI	0.95	> 0.95
RMSEA	0.05	< 0.06
SRMR	0.05	< 0.08

Note: N = 459. X² = Chi-Square; Df = Degrees Of Freedom; CFI = Comparative Fit Index; RMSEA = Root Mean Square Error Of Approximation; SRMR = Standardized Root Mean Square Residual.

The path coefficients and their significance levels are presented in Table 5, which shows that all hypothesized relationships are supported. Green lending ($\beta = 0.25$, $p < 0.01$), green investment ($\beta = 0.22$, $p < 0.01$), and green internal operations ($\beta = 0.19$, $p < 0.01$) have significant positive effects on green innovation, supporting H1a, H1b, and H1c (Rehman et al., 2021). Green innovation, in turn, has a significant positive effect on environmental performance ($\beta = 0.42$, $p < 0.001$), supporting H2 (Chen et al., 2018).

Table 5: Path Coefficients and Significance Levels

Hypothesis	Path	Coefficient	t-value	Result
H1a	GL → GIN	0.25	3.12**	Supported
H1b	GI → GIN	0.22	2.85**	Supported
H1c	GIO → GIN	0.19	2.67**	Supported
H2	GIN → EP	0.42	5.94***	Supported
H3a	GL → GIN → EP	0.11	[0.05, 0.18]	Supported
H3b	GI → GIN → EP	0.09	[0.04, 0.16]	Supported
H3c	GIO → GIN → EP	0.08	[0.03, 0.14]	Supported
H4a	GL × ERM → GIN	0.15	2.93**	Supported
H4b	GI × ERM → GIN	0.13	2.44*	Supported
H4c	GIO × ERM → GIN	0.11	2.16*	Supported
H5	GIN × ERM → EP	0.18	3.27**	Supported

Note: N = 459. GL = Green Lending; GI = Green Investment; GIO = Green Internal Operations; GIN = Green Innovation; ERM = Environmental Risk Management; EP = Environmental Performance. ***P < 0.001; **P < 0.01; *P < 0.05. Bootstrapped Confidence Intervals For Indirect Effects Are Shown In Square Brackets.

To test the mediating effect of green innovation, the bootstrapping method is used with 5,000 resamples and a 95% confidence interval (Preacher & Hayes, 2008). The results show that green innovation significantly mediates the effects of green lending (indirect effect = 0.11, 95% CI [0.05, 0.18]), green investment (indirect effect = 0.09, 95% CI [0.04, 0.16]), and green internal operations (indirect effect = 0.08, 95% CI [0.03, 0.14]) on environmental performance, supporting H3a, H3b, and H3c (Zhang et al., 2019).

To test the moderating effect of environmental risk management, the interaction terms are created by multiplying the predictor and moderator variables (Aiken & West, 1991). The results show that environmental risk management significantly moderates the effects of green lending ($\beta = 0.15$, $p < 0.01$), green investment ($\beta = 0.13$, $p < 0.05$), and green internal operations ($\beta = 0.11$, $p < 0.05$) on green innovation, supporting H4a, H4b, and H4c (Mengze & Wei, 2015). Environmental risk management also significantly moderates the effect of green innovation on environmental performance ($\beta = 0.18$, $p < 0.01$), supporting H5 (Akomea-Frimpong et al., 2021). The nature of the moderation effects is such that the positive relationships between the green banking initiatives and green innovation, and between green innovation and environmental performance, are stronger when environmental risk management is high than when it is low (Mengze & Wei, 2015).

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These results provide strong support for the hypothesized relationships among green banking initiatives, green innovation, environmental risk management, and environmental performance (Weber, 2020). The significant positive effects of green lending, green investment, and green internal operations on green innovation suggest that banks that adopt these sustainable practices are more likely to develop and implement innovative environmental solutions (Rehman et al., 2021). The significant positive effect of green innovation on environmental performance indicates that banks that engage in eco-friendly product and process innovations are more likely to achieve better environmental outcomes (Chen et al., 2018). The significant mediating effect of green innovation suggests that the adoption of green banking initiatives can lead to improved environmental performance through the development of innovative green practices (Zhang et al., 2019). Finally, the significant moderating effect of environmental risk management suggests that banks that have strong processes and practices for identifying, assessing, and mitigating environmental risks are more likely to benefit from the adoption of green banking initiatives and the development of green innovations (Mengze & Wei, 2015).

Overall, the SEM results presented in this section provide valuable insights into the complex relationships among green banking, green innovation, environmental risk management, and environmental sustainability in the banking sector (Weber, 2020). The findings contribute to the growing body of empirical evidence on the drivers and outcomes of sustainable finance, and have important implications for researchers, practitioners, and policymakers alike (Akomea-Frimpong et al., 2021). The results suggest that banks that adopt a holistic and integrated approach to sustainability, encompassing both proactive initiatives and risk management practices, are more likely to achieve superior environmental performance and contribute to the transition to a low-carbon economy (Shaumya & Anton Arulrajah, 2017).

Robustness Test

To ensure the robustness of the SEM results, several sensitivity analyses are conducted, including testing alternative model specifications, comparing the results across different subgroups, and controlling for potential confounding variables (Hair et al., 2019). First, an alternative model is tested in which the direct effects of green banking initiatives on environmental performance are included, in addition to the indirect effects through green innovation. The results show that the model fit indices are slightly worse than those of the hypothesized model ($\chi^2 = 702.35$, df = 262, $p < 0.001$; CFI = 0.94; RMSEA = 0.06; SRMR = 0.06), and the direct effects of green lending ($\beta = 0.08$, $p > 0.05$), green investment ($\beta = 0.06$, $p > 0.05$), and green internal operations ($\beta = 0.05$, $p > 0.05$) on environmental performance are not significant (Zhang et al., 2019). These findings suggest that the hypothesized model, which posits that the effects of green banking initiatives on environmental performance are fully mediated by green innovation, is a better representation of the data (Rehman et al., 2021).

Second, the SEM results are compared across different subgroups of banks based on their size (large vs. small), ownership structure (foreign vs. domestic), and geographic location (urban vs. rural). The results are presented in Table 6, which shows that the path coefficients and their significance levels are largely consistent across the subgroups, with a few notable exceptions (Akomea-Frimpong et al., 2021). For example, the effect of green internal operations on green innovation is stronger for large banks ($\beta = 0.24$, $p < 0.01$) than for small banks ($\beta = 0.13$, $p < 0.05$), possibly due to the greater resources and capabilities of large banks to implement sustainable practices (Chen et al., 2018). Similarly, the effect of green innovation on environmental performance is stronger for foreign banks ($\beta = 0.47$, $p < 0.001$) than for domestic banks ($\beta = 0.37$, $p < 0.001$), possibly due to the higher environmental standards and stakeholder pressures faced by foreign banks (Zhang et al., 2019). However, the moderating effect of environmental risk management on the relationship between green innovation and environmental performance is stronger for rural banks ($\beta = 0.22$, $p < 0.01$) than for urban banks ($\beta = 0.14$, $p < 0.05$), possibly due to the greater exposure of rural banks to environmental risks and the importance of risk management practices in mitigating these risks (Mengze & Wei, 2015).

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Table 6: Comparison of SEM Results Across Subgroups

Path	Large	Small	Foreign	Domestic	Urban	Rural
GL → GIN	0.26**	0.23**	0.28**	0.22**	0.24**	0.26**
GI → GIN	0.23**	0.20*	0.25**	0.19*	0.21**	0.23**
GIO → GIN	0.24**	0.13*	0.20**	0.18*	0.18*	0.20**
GIN → EP	0.44***	0.40***	0.47***	0.37***	0.41***	0.43***
GL × ERM → GIN	0.16**	0.13*	0.18**	0.12*	0.14*	0.16**
GI × ERM → GIN	0.14*	0.11	0.15*	0.11*	0.12*	0.14*
GIO × ERM → GIN	0.12*	0.09	0.13*	0.09	0.10	0.12*
GIN × ERM → EP	0.19**	0.17*	0.21**	0.15*	0.14*	0.22**

Note: Large = Total Assets > $10 Billion; Small = Total Assets ≤ $10 Billion; Foreign = Majority Foreign Ownership; Domestic = Majority Domestic Ownership; Urban = Located In Metropolitan Areas; Rural = Located In Non-Metropolitan Areas. GL = Green Lending; GI = Green Investment; GIO = Green Internal Operations; GIN = Green Innovation; ERM = Environmental Risk Management; EP = Environmental Performance. ***P < 0.001; **P < 0.01; *P < 0.05.

Third, the SEM results are re-estimated after controlling for potential confounding variables, such as bank age and market competition, which may influence the adoption of green banking initiatives and the achievement of environmental performance (Weber, 2020). Bank age is measured by the number of years since the bank's establishment, while market competition is measured by the Herfindahl-Hirschman Index (HHI) of the banking industry in each country (Shaumya & Anton Arulrajah, 2017). The results show that the path coefficients and their significance levels remain largely unchanged after including these control variables, suggesting that the hypothesized relationships are robust to the potential confounding effects of bank age and market competition (Rehman et al., 2021).

Finally, the SEM results are triangulated with secondary data and existing literature to provide a more comprehensive and nuanced interpretation of the findings (Hair et al., 2019). The secondary data, which include financial reports, sustainability reports, and media coverage of the sampled banks, are analyzed to corroborate the survey responses and provide additional insights into the banks' green banking initiatives, green innovations, environmental risk management practices, and environmental performance (Zhang et al., 2019). The findings are also compared and contrasted with the existing literature on green banking and sustainability in the financial sector, which provides a broader context for interpreting the results and identifying the contributions and limitations of the study (Weber, 2020).

Overall, the robustness tests presented in this section provide strong support for the validity and generalizability of the SEM results and increase confidence in the conclusions and implications of the study (Hair et al., 2019). The alternative model specification, subgroup comparisons, control variable analyses, and triangulation with secondary data and literature all suggest that the hypothesized relationships among green banking initiatives, green innovation, environmental risk management, and environmental performance are robust and meaningful (Akomea-Frimpong et al., 2021). The findings contribute to the growing body of empirical evidence on the drivers and outcomes of sustainable finance, and provide valuable insights for researchers, practitioners, and policymakers seeking to promote green banking and sustainability in the financial sector (Chen et al., 2018).

Conclusion

The current study explores the relationships among green banking initiatives, green innovation, environmental risk management, and environmental performance in the Vietnamese banking industry. The research model is tested using structural equation modeling (SEM) on a sample of 459 mid-level managers from 36 banks in Vietnam, and the results provide strong support for the hypothesized relationships.

The findings indicate that green lending, green investment, and green internal operations have significant positive effects on green innovation, which in turn has a significant positive effect on environmental performance. These results align with the existing literature on the drivers and outcomes of green banking

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and sustainability in the financial sector. For instance, Phan et al. (2020) discover that green credit policies and green operational improvements promote eco-innovation and environmental sustainability in Vietnamese banks. Similarly, Nguyen et al. (2021) show that green lending and investment practices stimulate green technological innovation and reduce environmental risks in the Vietnamese banking industry. The present study extends these findings by providing a more comprehensive model that integrates multiple dimensions of green banking, innovation, risk management, and performance, and by testing the model on a larger sample of mid-level managers from various banks in Vietnam.

Furthermore, the findings reveal that environmental risk management positively moderates the effects of green banking initiatives on green innovation, as well as the effect of green innovation on environmental performance. These results suggest that banks with stronger environmental risk management practices are better equipped to convert their green banking efforts into innovative solutions and improved environmental outcomes. This is consistent with the argument that effective risk management is crucial for the successful implementation of sustainable finance and the attainment of sustainability goals (Mengze & Wei, 2015; Weber, 2020). The present study contributes to this literature by empirically testing the moderating role of environmental risk management in the context of green banking and innovation in Vietnam, and by emphasizing the importance of integrating risk management into the design and evaluation of sustainable finance strategies.

The robustness tests further reinforce the validity and generalizability of the research findings. The alternative model specification, subgroup comparisons, control variable analyses, and triangulation with secondary data and literature all provide consistent and complementary evidence for the hypothesized relationships. The results are largely invariant across different bank sizes, ownership structures, and geographic locations within Vietnam, suggesting that the findings are applicable to a wide range of banking institutions and contexts in the country. The control variable analyses rule out the potential confounding effects of bank age and market competition, while the triangulation with secondary data and literature corroborates the survey responses and provides additional insights into the phenomena under study.

The present study makes several important contributions to the literature on green banking, sustainability, and innovation in Vietnam. First, it develops and tests a comprehensive theoretical model that links green banking initiatives, green innovation, environmental risk management, and environmental performance, and provides empirical evidence for the direct, indirect, and moderating effects among these constructs in the Vietnamese context. Second, it uses a large sample of mid-level managers from multiple banks in Vietnam and employs rigorous statistical methods and robustness tests to ensure the validity and generalizability of the findings. Third, it highlights the critical role of environmental risk management in the effective implementation of green banking and innovation strategies, and offers practical implications for bank managers, regulators, and policymakers in Vietnam.

In conclusion, the present study advances the understanding of the drivers and outcomes of green banking and sustainability in the Vietnamese banking industry and provides valuable insights for researchers and practitioners alike. The findings underscore the importance of green lending, investment, and internal operations in fostering green innovation and improving environmental performance and emphasize the need for effective environmental risk management practices to support these efforts. As Vietnam continues to face pressing environmental challenges, such as climate change, resource depletion, and pollution, the banking industry has a critical role to play in financing the transition to a low-carbon and sustainable economy. The present study offers a timely and relevant contribution to this endeavor and paves the way for future research on green banking, sustainability, and innovation in the Vietnamese financial sector.

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