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The Impact of Green Innovation on Spain Banks' Sustainability

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ABSTRACT

Banks in Spain are a key pillar of the national economy and face increasing pressure to adopt sustainable practices. This research designs and empirically tests a model to enhance the sustainability of Spanish banks by examining the impact of green innovation on the three pillars of sustainability: environmental, social, and economic. The study's population comprises all 187 members of the Spanish Fintech and Insurtech Association (AEFI), from which a sample was chosen using a probabilistic sampling technique. Data was collected via questionnaires and analyzed using Structural Equation Modeling (SEM) with SMART-PLS 4. The findings reveal that green innovation has a significant and positive direct impact on environmental, economic, and social sustainability. This study provides crucial theoretical contributions by validating a model based on Ecological Modernization Theory and the Resource-Based View, and offers practical implications for bank managers, highlighting green innovation as a strategic tool for improving holistic sustainability performance.

Keywords: Green Innovation, Sustainability, Banks of Spain.

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1. Introduction

The global banking industry is navigating a complex landscape characterized by significant challenges to profitability, including sustained low-interest rates, the management of troubled assets, and mounting regulatory pressure. In response, banks are accelerating their digital transformation by digitizing operations and reducing physical capacity to enhance efficiency and manage costs (Murinde et al., 2022; Gounari et al., 2024). In Spain, the demand for online banking is driven by demographic factors such as income, education level, and age, alongside the widespread availability of information and communication technology (ICT). The adoption of these digital channels is further spurred by the need for banks to improve efficiency in a post-crisis economic environment (Valero et al., 2020; Carbó Valverde et al., 2020).

In parallel with this digital shift, there is a growing recognition that sustainable organizations must look beyond economic profits and acknowledge their social and environmental responsibilities to stakeholders and the public. Many businesses now actively promote their commitment to sustainable development to enhance their corporate reputation and build long-term value (Waddock & Graves, 1997; Kavadis & Thomsen, 2023). This study analyzes the effect of green innovation on the economic, environmental, and social sustainability of Spanish banks. Green innovation, defined as a novel approach to developing tools, services, and processes to address environmental challenges, is positioned as a critical enabler for achieving these integrated sustainability goals (Macchiavello & Siri, 2022; Zhang & Ma, 2021). Achieving the UN's Sustainable Development Goals (SDGs) requires a deep understanding of how green innovation can be leveraged to advance the environmental, social, and economic sustainability of the financial sector (Gallego-Sosa et al., 2021). This study will examine green innovation as a direct impact on the environmental, economic, and social sustainability of banks in Spain.

2. Problem statement

The digital transformation of the banking sector is fundamentally altering how financial products and services are sold, driven by consumer demand for digital channels and the institutional need for greater efficiency. While the literature suggests that green innovations are powerful drivers for making the financial sector more sustainable, there remains a significant gap in the academic research on how, specifically, green innovation contributes to the long-term viability and triple-bottom-line (TBL) sustainability of banks (Zhou et al., 2022; Pizzi et al., 2021). There is a notable lack of empirical guidance for this rapidly expanding market, which is crucial for the survival and success of banks in any competitive landscape.

This study aims to address that gap by adopting Elkington's (1997) three-fold definition of sustainability and examining how green innovation aligns with each pillar. Limited empirical studies have investigated the impact of green innovation on sustainability when it is conceptualized based on the TBL framework of environmental, social, and economic dimensions (Siddik et al., 2023). Measuring sustainability itself is a major challenge, as the concept is often subjective and fragmented across the literature, with most models focusing only on a single dimension. Therefore, this research provides critical insights by conceptualizing and empirically validating the impact of green innovation on all three aspects of sustainability, offering a holistic and necessary perspective for banks in Spain (Ahmad et al., 2023).

To conceptualize sustainability, this study adopts Elkington's three-fold definition of sustainability and examines how green innovation would comply with each of them (Elkington, 1997). Based on Siddik et al. (2023), limited empirical studies exist on the impact of green innovation on sustainability conceptualized based on the Triple-Bottom-Line (TBL) as environmental, social, and economic. To bridge this research gap, this study provides critical insights to conceptualize and empirically validate green innovation and sustainability (environmental, social, and economic) within the context of banks in Spain. One of the most crucial challenges in evaluating banks' sustainability is measuring it, and this study measures sustainability as a multidimensional concept (Geylan, 2021). In the literature, the concept of sustainability is subjective and widely fragmented, spanning multiple dimensions that are both relevant and necessary for drawing meaningful conclusions (Udeagha & Ngepah, 2023). Several scholars have proposed models for measuring sustainability, but most focus on specific dimensions (e.g., environmental) (Shahzad et al., 2021). Hence, it is necessary to incorporate economic, environmental, and social aspects together to measure banks' sustainability.

3. Research Questions

- Is there any impact of green innovation on environmental sustainability?

- Is there any impact of green innovation on economic sustainability?
- Is there any impact of green innovation on social sustainability?

4. Research Objectives

- To examine the impact of green innovation on environmental sustainability.
- To examine the impact of green innovation on economic sustainability.
- To examine the impact of green innovation on social sustainability.

5. Literature Review

5.1 Green Innovation

Green innovation has emerged as a topic of significant interest among accounting and economics scholars. It refers to the development and implementation of eco-friendly practices, products, and management systems, encompassing innovations in green processes and management (Jain et al., 2020). In the financial sector, this has led to the rise of "green finance," where organizations seek to reduce their negative environmental impact while creating positive contributions (Udeagha & Ngepah, 2023). Firms, especially in the financial industry, can derive substantial benefits from green innovation in their pursuit of sustainability and eco-friendly operations. According to Khattak (2023), green innovation not only improves a firm's environmental performance but also fosters its growth into a more capable and resilient organization. This is supported by findings that demonstrate green innovation and environmental sustainability practices are key to achieving long-term sustainable operations (Chouaibi & Chouaibi, 2021; Rehman et al., 2021).

According to research, firms, especially those in the financial industry, can greatly benefit from green innovation when it comes to sustainability and eco-friendly operations. Using green innovation, Khattak, (2023) argues that it encourages companies to grow into capable organizations while also improving their environmental performance. The findings demonstrated that companies might achieve sustainable operations by implementing concepts of green innovation and environmental sustainability. According to the research of Chouaibi and Chouaibi (2021), when green innovation is present and acts as a moderator, societal and ethical strengths boost company value, while deficiencies have the reverse effect. The connection between SP and lean production was mediated by green innovation. For the purpose of this study, green innovation will be examined as an independent variable directly impacting sustainability in the context of banks in Spain.

5.2 Sustainability

Sustainable development, famously defined by the World Commission on Environment and Development (WCED) as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs," has become a central paradigm for modern business (WCED, 1987). This concept is operationalized through the Triple Bottom Line (TBL) framework, which assesses performance across three integrated dimensions: environmental, social, and economic (Elkington, 1997). The environmental pillar involves protecting the Earth by reducing pollution and waste. The economic pillar reflects the traditional need for profitability and financial viability. Finally, the social pillar requires a company to contribute to the well-being of its community and stakeholders, which is essential for securing a permanent and trusted place in the market (Shahzad et al., 2021; Geylan, 2021).

One of the most basic aspects of sustainability is its impact on the economy. Every company, no matter how it's structured, needs to make more money than it spends if it wants to stay in business. There is no disagreement from Elkington's TBL (1997). The economic line is only a shortcut for the old-fashioned way that a company figures out its profit. The fact that several large financial companies have been around for quite some time suggests that this line of sustainability is one that business models can meet, allowing them to stay in business and potentially expand substantially.

Additionally, social sustainability—the third line of the TBL—may not appear to be as crucial to a company's market existence as environmental and economic sustainability at first glance. Nevertheless, it is an integral component of TBL. According to the TBL model, for a company to achieve a permanent place in the market and ensure its sustainability, it should also contribute to the social well-being of the people while retaining profitability. In this study, the sustainability of

the banks in Spain is conceptualized based on the TBL into environmental sustainability, social sustainability, and economic sustainability (Spaargaren, 1997).

5.3 Hypothesis Development

The linkages between green innovation, environmental sustainability, social sustainability, and economic sustainability are discussed in this section. Furthermore, the hypotheses to be tested in the context of banks in Spain will be formulated next. The model of the recent study is shown in Figure 1.

5.3.1 Green Innovation and Sustainability

Green Innovation and Sustainability Environmental sustainability and green innovation are new concepts, and research has highlighted the importance of environmentally conscious innovations and technology in easing social and environmental tasks (Lu et al., 2022). Economic benefits that can confer a competitive edge and commercial gain from environmentally friendly products are two main advantages of employing environmentally friendly technology in business (Wang et al., 2021). Green innovation and technology are inevitable in the day-to-day operations of any company that has an environmental management system (Imran et al., 2021). Furthermore, green innovation in firms is seen as fundamentally influenced by environmental policies and regulations (Fang et al., 2022). Environmentally conscious and caring businesses improve the efficiency of green innovation while decreasing pollution and deterioration of the environment. Environmental and social sustainability are said to be linked to green innovation in a firm's environmental management system (Rehman et al., 2021).

When it comes to home energy usage and individual mobility, green innovation also aids in the construction of sustainable communities. Housing developments and societies that disregard environmental concerns endanger both their residents and the social safety net they rely on. For example, according to Ullah et al. (2023), sustainable communities are the result of operational activities that prioritize green technology and innovation. This approach reduces the negative impact of pollution and the environment on communities and societies. A cleaner manufacturing system and a safe environment are important necessities for communities and societies. According to the resource-based perspective theory, an organization's most valuable assets for enhancing its social and environmental performance, as well as its public image, are its innovative green processes and products (Gupta et al., 2021). Hence, the following hypotheses were developed from this research:

H1: Green innovation has a direct and positive impact on environmental sustainability.

H2: Green innovation has a direct and positive impact on economical sustainability. H3: Green innovation has a direct and positive impact on social sustainability.

6. Theoretical Framework

This study draws upon the ecological modernization theory (EMT) and resource-based view (RBV) to assess the effects of a firm's green innovation on sustainability (Spaargaren, 1997; Ahmad et al., 2023). Moreover, the TBL approach is applied in this study to conceptualize sustainability as three pillars (environment, economic, and social) (Elkington, 1997). The ecological modernization theory (EMT) posits that environmental issues triggered by economic growth may be resolved by increasing resource efficiency through technological advances such as green innovation. Ecological modernization conveys the optimistic message that the existing institutional structure is capable of meeting the challenge of ecological sustainability. The suggested model will be empirically evaluated in financial institutions in Spain (Kristensen & Mosgaard, 2020).

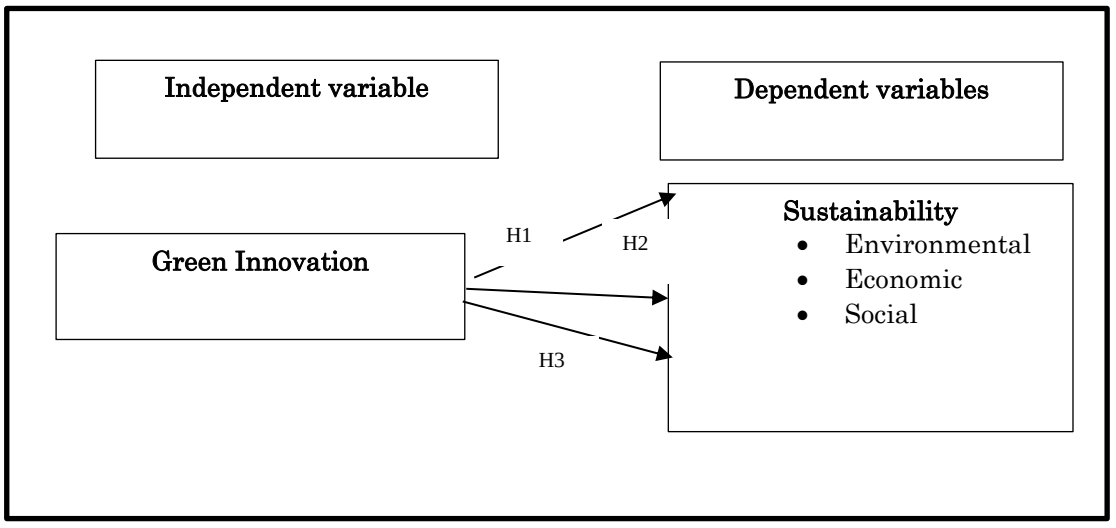

Figure 1: Theoretical Framework

7. Research Methodology

7.1 Design and Procedures

This study took an empirical approach to examining possible links between green innovation, environmental sustainability, economic sustainability, and social sustainability. The study was based primarily on quantitative data collected from the members of the Spanish Fintech and Insurtech Association (AEFI). The data was collected from members of the Statistics of the Spanish Central Bank (Banco de España BDE). The study also made use of secondary data from previous studies that had already explored the same topics (David-West et al., 2020; Srouji et al., 2023). SPSS and SMART-PLS were used to analyze the collected data as descriptive indicators and cause-effect indicators, respectively (Hair et al., 2017).

7.2 Population and Sample

The population of this study includes all members of the Spanish Fintech and Insurtech Association (AEFI). The Spanish Fintech and Insurtech Association, which aims to create a favorable environment for Fintech and Insurtech companies in Spain, currently has 186 members representing different verticals within the FinTech ecosystem, as stated on the AEFI website (https://www.asociacionfintech.es/en/). The sampling technique used in this study was probabilistic sampling, ensuring all members of the population had the same probability of being selected. Questionnaires were administered using Google Forms, and data was collected online from all AEFI members. The sampling method was adapted from the study of Bittini et al. (2022).

7.3 Measurement

The measures of green innovation, the independent variable of the study, were adapted from the study by Srouji et al. (2023) and measured by six items. Environmental sustainability measurement was adapted from Tian et al. (2023), with four items. Economic sustainability was measured by three items adapted from Dwivedi et al. (2021). Finally, social sustainability was measured by five items adapted from Wang & Dai (2018), Kassinis & Soteriou (2003), and Gimenez et al. (2012). A five-point Likert scale, ranging from strongly agree to strongly disagree, was used to rate the responses, based on Sekaran & Bougie (2016).

7.4 Data Analysis

This section presents findings from the SMART-PLS path modeling analysis of the data. The results of the descriptive statistics and the measurement model evaluation display internal consistency reliability, discriminant validity, and convergent validity. The structural model analysis, performed to establish causality, is also presented (Hair et al., 2014).

7.4.1 Structural Equation Modelling (SEM)

The evaluation of PLS-SEM path model findings adopted a two-step approach. This process involves (1) evaluating the measurement model, which includes checking the items' reliability and validity, and (2) evaluating the structural model, which includes testing the significance of the path coefficients and calculating the R^2 value (Fornell & Larcker, 1981; Purwanto, 2021).

7.4.2 Measurement Model Evaluation

The measurement model of the study involves determining the reliability of individual items, as well as the internal consistency of reliability, discriminant validity, content validity, and convergent validity, as suggested by Hair et al.(2017). The measurement model of the study is displayed in Figure 2.

The outer loadings of each of the latent variables are used to measure item reliability. The results indicate that all items in this study had loadings that satisfied the acceptable level of 0.40. Internal consistency reliability is the degree to which all components of a given scale measure the construct being measured, as depicted in Figure 2 of the measurement model. Cronbach's alpha and the composite reliability coefficient are commonly used indices for measuring internal consistency and reliability, especially for multi-component scales. Thus, internal consistency, composite reliability, and Cronbach's alpha are displayed in Table 1.

Table 1: Assessment for Measurement Model

Construct	Items (Indicators)	Loading	Internal consistency (CR) >0.70	Convergent validity (AVE) >0.50	Reliability (Cronbach's Alpha) >0.70
Economic Sustainability	ECO1	0.844	0.887	0.725	0.811
	ECO2	0.87			
	ECO3	0.838			
Environmental Sustainability	ENV1	0.884	0.937	0.789	0.911
	ENV2	0.893			
	ENV3	0.91			
	ENV4	0.866			
Social Sustainability	SOC1	0.631	0.866	0.568	0.804
	SOC2	0.655			
	SOC3	0.867			
	SOC4	0.858			
	SOC5	0.725			
Green Innovation	GI1	0.89	0.947	0.749	0.933
	GI2	0.87			

	GI3	0.839			
	GI4	0.808			
	GI5	0.901			
	GI6	0.88			

As Hair et al. (2017) advised, the composite reliability coefficient should not be less than 0.70 to evaluate internal consistency of reliability. The composite reliability coefficients of the study's constructs are all above the minimum reliability threshold of 0.70, indicating good internal consistency of the latent variables. According to Hair et al. (2017), AVE determines convergent validity. AVE values of 0.5 or higher are generally acceptable. The Average Variance Extracted (AVE) coefficients in Table 1 show convergent validity for all constructs in this investigation.

In addition to reliability, Table 1 displays the discriminant validity of the study variables, which indicates that a construct's measurement model is free from redundant items and is empirically distinct from other constructs. To assess the discriminant validity of the measuring model, Smart-PLS used three measures: Cross loading, Fornell and Larcker, and Heterotrait-Monotrait Ratio.

The first discriminant validity measure is cross-loadings. Fornell & Larcker (1981) and Purwanto (2021) state that for each item, there must be more factor loading on the associated construct than correlation with the other constructs (cross-loading). Thus, cross-loading explains discriminate validity. Table 2 shows the measurement model variable cross-loading analysis results.

Table 2: Cross-loadings for Overall Measurement Model

	Economical Sustainability	**Environmental Sustainability**	**Green Innovation**	**Social Sustainability**	
ECO1		0.844	0.732	0.579	0.446
ECO2		0.87	0.495	0.476	0.426
ECO3		0.838	0.431	0.506	0.509
ENV1	0.542		0.884	0.402	0.419
ENV2	0.531		0.893	0.39	0.367
ENV3	0.646		0.91	0.498	0.385
ENV4	0.622		0.866	0.494	0.348
GI1	0.598	0.498		0.89	0.515
GI2	0.601	0.534		0.87	0.524
GI3	0.546	0.35		0.839	0.586
GI4	0.411	0.34		0.808	0.481
GI5	0.497	0.425		0.901	0.457
GI6	0.516	0.46		0.88	0.421
SOC1	0.498	0.278	0.433		0.631
SOC2	0.367	0.382	0.324		0.655

SOC3	0.35	0.354	0.433		0.867
SOC4	0.294	0.289	0.468		0.858
SOC5	0.494	0.315	0.473		0.725

The cross-loadings shown in Table 2 demonstrate that each item's factor loading on its related construct was stronger than its correlation with the other constructs, thus proving the study measurements' discriminant validity. Fornell–Larcker is the second discriminant validity criterion. Table 3 shows variable correlation utilizing the Fornell-Larcker approach to test measurement model discriminant validity.

Table 3: Variable Correlation-Root Square of AVE

	Economical Sustainability	**Environmental Sustainability**	**Green Innovation**	**Social Sustainability**	
Economical Sustainability		0.851			
Environmental Sustainability	0.664		0.888		
Green Innovation	0.615	0.507		0.865	
Social Sustainability	0.539	0.427	0.576		0.754

Fornell and Bookstein (1982) state that discriminant validity occurs when the calculated square root of AVE is greater than the correlation between the factors accounting for each pair. As was the case in this study's correlation matrix, the value should be greater than the other off-diagonal elements in the rows and columns. This showed that the criteria for the measures' discriminating validity had been met.

7.4.3 Structural Model Findings

The structural parameter evaluation does not consider the size and significance of the structural parameter estimates, as shown in the path diagrams by one-headed arrows. This assessment concludes by verifying the structural model's accuracy based on hypothesized relationships between identified and assessed variables. This study estimated the structural model using PLS-SEM and bootstrapping with 5000 replicates to test hypotheses. This included inner model R^2, F^2, and p-value tests (Hair et al., 2014).

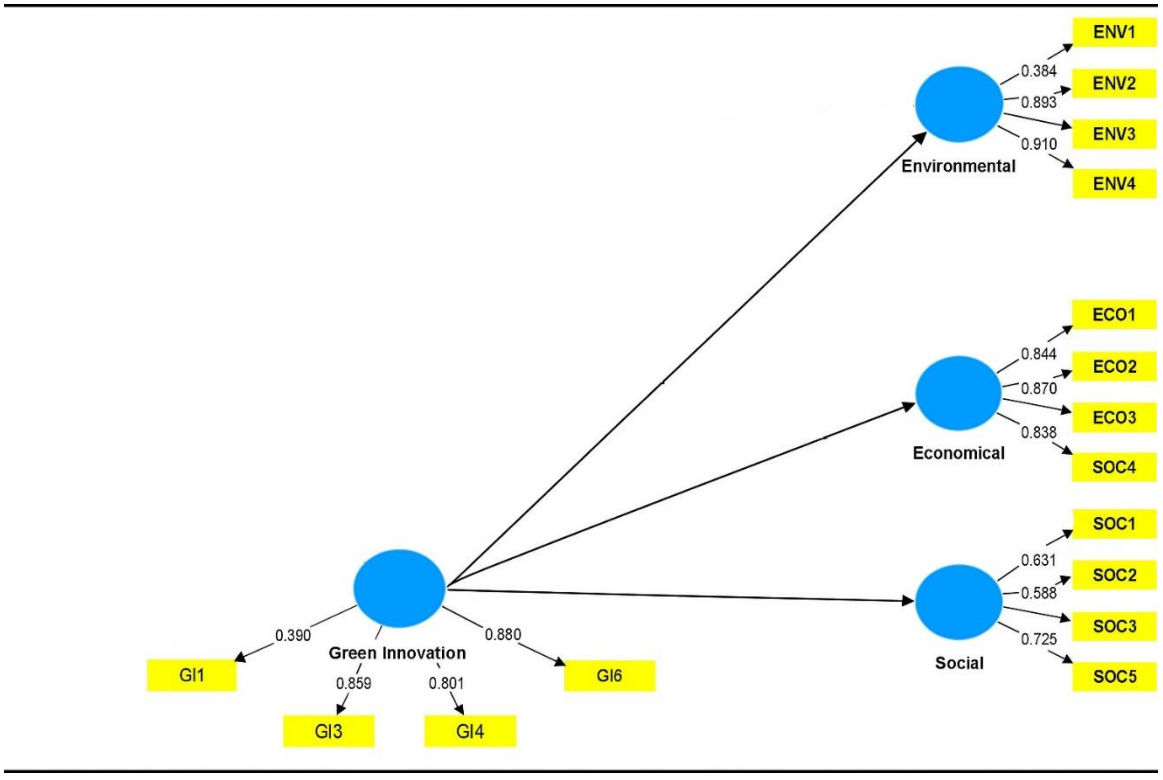

Figure 2: The Structural Model Findings

Calculating R^2 is done when changes between two variables in the correlation exist. Table 4 shows the results of this analysis, generated using the Smart-PLS algorithm function.

Table 4: R^2 of the Endogenous Variables

Variables Relation	**R^2**	**R^2 Adjusted**
Environmental sustainability	0.346	0.338
Economical sustainability	0.483	0.477
Social sustainability	0.339	0.331

Based on the findings of the structural model with R^2 values and path coefficients:

- Green innovation may account for 34.6% of the variation of environmental sustainability among banks in Spain.
- Green innovation may account for 48.3% of the variation of economical sustainability among banks in Spain.
- Green innovation may account for 33.9% of the variation of social sustainability among banks in Spain.

It is necessary to examine the significance of important links after establishing their existence between constructs (Hair et al., 2014). Consequently, Cohen (1988) offers a benchmark for evaluating the extent of an effect. The effect size F^2 is an approach that can be used to assess the significance of a predictor's influence on an endogenous variable. The F^2 statistic is used to assess the significance of an exogenous construct's contribution to an endogenous one. Based on Cohen (1988), F^2 values of 0.35, 0.15, and 0.02 are regarded as high, medium, and small effect sizes, respectively. Table 5 presents the assessments of the coefficient of effect size F^2.

Table 5: Effect Size of the Exogenous Constructs

Latent Construct Relation	F^2	Effect Size
Green Innovation -> Environmental sustainability	0.085	Medium
Green Innovation -> Economical sustainability	0.184	Medium
Green Innovation -> Social sustainability	0.261	Medium

As described in Table 5, the effect size of green innovation on the endogenous variables ranged from small to medium based on Cohen (1988).

7.4.4 Hypotheses Testing (Path Coefficient

) This section discusses the findings of the path coefficient used to examine the hypotheses of the study. The findings of direct effects (H1 to H3) are presented in Table 6. The numbers in parentheses represent the p-value, and the values next to the parentheses represent the coefficient value (beta value).

Table 6: Structural Model Assessment for the direct effect hypotheses

		Path coefficient Beta	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Decision
H1	Green Innovation -> Environmental sustainability	0.291	0.106	2.741	0.006	Supported
H2	Green Innovation -> Economical sustainability	0.382	0.086	4.417	0.000	Supported
H3	Green Innovation -> Social sustainability	0.513	0.091	5.652	0.000	Supported

Notes: Significant level at ** = $p < 0.05$.

Assessment of the whole model is presented in Table 6. All three direct effect hypotheses were supported by the data. The supported hypotheses were: H1, related to the impact of green innovation on environmental sustainability; H2, about the effect of green innovation on economic sustainability; and H3, about the impact of green innovation on social sustainability among banks in Spain.

8. Discussion and Conclusion

The study results demonstrated a beneficial influence of green innovation on environmental, social, and economic sustainability in Spanish banks. In more detail, all three direct effect hypotheses were supported. The study supported the significant impact of green innovation on environmental, economic, and social sustainability among banks in Spain, which is consistent with many studies in the literature, such as Xu et al.(2023).

9. Implications

This study contributes to the literature on green innovation and sustainability in several ways. Firstly, the study developed a new model drawing upon ecological modernization theory (EMT), resource-based view (RBV), and the TBL approach to examine the impact of green innovation on environmental, social, and economic sustainability in the context of banks in Spain. Using the EMT framework, the study demonstrates that technological innovation such as green innovation promotes ecological modernization, supporting businesses in mitigating environmental impacts and boosting their social

responsibility. Moreover, consistent with the RBV of firms (Siddik et al., 2023), study findings shed light on the importance of technology as essential resources in acquiring financial institutions' performance and sustainability. In response to Bittini et al. (2022) its call for an empirical study on firms' sustainability, the study was conducted on banks in Spain as they implement green innovation to improve their environmental, social, and economic sustainability. Given the dearth of literature on green innovation and sustainability, this study fills gaps by providing empirical evidence on the role of green innovation in enhancing businesses' sustainability. Third, although there is voluminous literature on the linkage between financial factors and sustainability (Chueca Vergara & Ferruz Agudo, 2021; Ellili, 2023), there is a paucity of literature on the effect of financial factors on firms' environmental, social, and economic sustainability in one model (Bartolacci et al., 2020). This study also contributes to this domain by providing evidence that green innovation can directly influence banks' TBL sustainability. Finally, by conducting this study on banks in Spain, it contributes to the growing stream of literature on green innovation and sustainability in the context of Spain as a developed country in the financial context.

10. Limitations and Future Research

The findings emphasize the importance of green innovation in maintaining the sustainability of banks in Spain. Although the study has many practical and theoretical contributions, some limitations can be considered in future research in the field of green innovation and sustainability in the financial sector. Firstly, a cross-sectional design was applied in this study, which only captures participants' perspectives at a single point in time; future studies may benefit from longitudinal research designs to more accurately indicate cause-and-effect relationships. Another limitation of this study relates to the methodology; the current study only used a quantitative approach to define the impact of the study variables. Future research in the field of green innovation and sustainability can focus on "depth" rather than "quantitative width". A qualitative approach may provide new insights and a deeper comprehension of the issue at hand. Qualitative and quantitative approaches complement each other to achieve more results. Success in the global financial market depends on financial technology, especially in big financial institutions like banks; thus, future studies should evaluate aspects related to banks' sustainability: environmentally, economically, and socially. Research on green innovation and sustainability in Spanish banks is urgently needed. The banking sector in Spain may engage in a diverse range of financial activities and services directly connected to society and government. More future studies on the linkages between green innovation and sustainability in financial institutions in Spain are recommended with other mediating or moderating variables.

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This article does not contain any studies with human participants or animals performed by any of the authors.

Consent for publication
Not applicable.

Competing interests
All authors declare no competing interests.

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Biographies