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Sustainability and Banking Stability in GCC Economies:

Threshold Effect of Green Innovation, Bank Competition and Institutional Quality

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Sustainability and banking stability in GCC economies: threshold effect of green Innovation, bank competition and institutional Quality

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Abstract This study aims to analyze the non-linear effect between ESG performance and bank stability. More precisely, it aims to explore the threshold effect of green innovation, bank competition, and institutional quality on the link between ESG performance and banking stability. To do this, the sample of this study contains 49 banks operating in the GCC region during the period 2017-2023. The study applies a Dynamic Panel Threshold Regression (DPTR) model to assess whether green innovation, bank competition, and institutional quality act as a threshold mechanism that transforms the ESG–stability nexus. The outcomes reveal a statistically significant green innovation threshold at 0.334 (33.4%), below which ESG exerts a negative effect on bank stability. Above this threshold, it begins to improve bank stability. In addition, the results show that there is a threshold effect of bank competition on this nexus. The threshold value estimated at 0.360, beyond which (low competition) ESG weakens bank stability. Finally, the outcomes indicate the existence of a threshold effect (estimated at 0.250) of institutional quality. More precisely, in case of high institutional quality (beyond the 0.250), ESG performance enhances the GCC bank stability. For policymakers, these results underline the strategic importance of green innovation, bank competition, and institutional quality to strengthen CSR practices to ensure sustainability and banking stability.

Keywords: ESG scores, green innovation, bank competition, institutional quality, bank stability, GCC region, DPTR.

1. Introduction

In a financial environment characterized by increased complexity and strengthened regulatory requirements, ESG (Environmental, Social, and Governance) performance is emerging as a strategic lever for banking stability. In a context marked by recurring financial crises and increased regulatory pressure, banks that integrate responsible practices tend to strengthen their resilience to systemic risks. Indeed, sound governance and proactive management of environmental and social issues reduce exposure to litigation, improve reputation, and foster stakeholder trust. This dynamic creates a virtuous circle where ESG performance is not limited to an ethical requirement but becomes a determining factor in the financial strength and sustainability of banking institutions (Liaqat et al., 2026).

In a banking environment marked by major economic and regulatory shifts, ESG practices and corporate social responsibility (CSR) are no longer limited to peripheral initiatives but have become strategic pillars of financial institutions' operating models. Integrating ESG criteria into

financing processes, risk management, and governance addresses a dual imperative: mitigating systemic risks and meeting the growing expectations of regulators, investors, and clients regarding transparency and sustainability. This approach translates into investments in low-carbon projects, support for responsible businesses, and the adoption of practices that promote long-term resilience. By aligning with international standards, banks not only strengthen their competitiveness but also contribute to global financial stability, demonstrating that ESG performance is now a key driver of sustainability in an uncertain and development-oriented economic environment (e.g., Chiaramonte et al., 2022; Liaqat et al., 2026). However, despite the growing recognition of the importance of ESG practices in banking activities, their implementation remains a considerable challenge for some institutions. Integrating these criteria requires substantial investments in compliance, reporting, and organizational transformation, which can generate high costs and weigh on short-term profitability. This financial pressure, when not accompanied by an appropriate strategy, risks undermining the stability of the banking sector, particularly for institutions whose margins are already constrained (Khémiri & Alsulami, 2023; Mallek et al., 2024).

Theoretically, the link between ESG performance and banking stability can be interpreted through two contrasting approaches. On the one hand, agency theory suggests that integrating ESG practices could harm banking stability due to the high initial costs associated with their adoption. These expenditures, often perceived as unproductive in the short term, can reduce profitability and exacerbate tensions between shareholders and managers, who are keen to maximize immediate value (Friedman, 1970; Jensen & Meckling, 1976). However, stakeholder theory offers an opposing view: ESG performance strengthens banking stability by consolidating the trust of key stakeholders, limiting reputational risks, and improving resilience to economic shocks. According to this perspective, ESG is not simply a cost, but a strategic investment that promotes the long-term sustainability and soundness of financial institutions (Freeman, 1984).

Empirically, recent research on the impact of ESG practices on banking stability remains limited. Some studies highlight their strategic role in crisis prevention by strengthening the resilience, transparency, and competitiveness of financial institutions. They suggest that integrating ESG criteria fosters stakeholder confidence and reduces reputational and regulatory risks (Chiaramonte et al., 2022; Wang et al., 2024; Choi et al., 2024; Gehrig et al., 2024, Luh et al., 2024; Liaqat et al., 2026). However, other studies reach opposing conclusions, emphasizing that the high costs associated with implementing ESG practices can weigh on profitability and,

ultimately, undermine banking stability (e.g., Bruno et al., 2024; Salim et al., 2023; Di Tommaso & Thornton, 2020). This divergence underscores the complexity of the link between ESG and financial soundness and justifies the need for in-depth analyses to mitigate potential risks.

In addition, other studies have explored the effects of other factors such as institutional quality, bank competition and innovation on bank stability (e.g., Shabir et al., 2021; Nchofoung et al., 2024; Gold & Tregenna, 2025; Liaqat et al., 2026). Institutional quality is widely recognized as a major determinant of banking stability. Previous work has demonstrated its central role in reducing economic risks and consolidating the banking sector (Khémiri et al., 2024; Liaqat et al., 2026). It is also a key pillar for fostering ESG performance by creating a regulatory and organizational framework conducive to transparency and accountability. Similarly, banking concentration can play a beneficial role by facilitating the implementation of ESG initiatives and strengthening stability, provided it is accompanied by increased vigilance to avoid the risks associated with market dominance (Shabir et al., 2021). Furthermore, green innovation contributes to reducing financial and environmental risks by directing investments towards sustainable technologies and improving energy efficiency (Nchofoung et al., 2024). However, these innovations must be supported by sound financial institutions capable of providing adequate funding, effective governance, and prudent risk management to ensure the stability and sustainability of the banking system (Gold & Tregenna, 2025).

According to existing literature, ESG performance, green innovation, bank competition, institutional quality, and are key factors in bank stability. This article therefore aims to explore, firstly, the non-linear relationship between ESG performance and bank stability, and secondly, to analyze the threshold effects of green innovation, bank competition, and institutional quality on the relationship between ESG performance and the stability of banks operating in GCC countries.

To achieve these aims, this study efforts to bridge this gap by investigating the subsequent research questions: (i) Do green innovation, bank competition, and institutional quality moderate the effect of ESG performance on bank stability, and does this moderation reveal a threshold effect? (ii) What are the critical levels of green innovation, bank competition, and institutional quality at which ESG performance ceases to promote bank stability and begins to hinder it? How can policymakers in the GCC countries supervise green innovation, bank competition, and institutional quality to improve sustainable performance and foster bank stability?

This article contributes to existing literature in two ways. First, the existing literature has not explored the non-linear relationship between ESG performance and bank stability in GCC countries. Second, to our knowledge, this is the first attempt to examine the threshold effects of green innovation, bank competition, and institutional quality on the relationship between ESG performance and bank stability.

Using the Dynamic Panel Threshold Regression (DPTR) model, the key findings indicate that the nexus between ESG performance and bank stability is nonlinear. More precisely, green innovation, bank competition, and institutional quality have a threshold effect on the ESG performance-bank stability nexus up to a threshold beyond which ESG performance begins to enhance bank stability. This study, therefore, targets Islamic bank regulators and managers.

The structure of the paper is as follows: Section 2 deals with the literature review and development of hypotheses; Section 3 describes the research design, Section 4 describes the results and discussion, and Section 5 concludes the study.

2. Literature review and hypotheses development

2.1. Sustainable performance and bank stability

Examining the relationship between sustainability performance and banking stability is part of a research dynamic that goes beyond the simple study of corporate social responsibility (CSR) to utilize more robust theoretical frameworks. In the banking literature, two main approaches dominate: stakeholder and agency theories. These two approaches are based on contradictory perspectives regarding the impact of ESG initiatives on banking stability.

Under stakeholder theory, sustainability performance of firms depends not only on shareholder satisfaction but also on all stakeholders who interact with it: customers, employees, regulators, investors, and civil society (Freeman, 1984). This approach broadens the traditional conception of value by integrating social and environmental dimensions, considered essential for maintaining legitimacy and trust in a complex economic environment. From this perspective, integrating ESG criteria appears as a proactive strategy aimed at meeting multiple expectations and anticipating regulatory and societal pressures. ESG practices contribute to building reputational capital, reducing regulatory risks, and improving transparency, thereby strengthening the institution's credibility with stakeholders. This increased trust translates into organizational and financial stability, as it reduces the likelihood of large-scale withdrawals, facilitates access to sustainable financing, and protects the company against external shocks. In

short, stakeholder theory views ESG not as a constraint, but as a strategic lever that fosters long-term resilience and competitiveness (Barnea & Rubin, 2010; Liaqat et al., 2026).

Agency theory is based on the separation of ownership and control, which creates information asymmetry and conflicting interests between shareholders and managers. Within this framework, managers possess discretionary power that can incentivize them to adopt opportunistic behaviors, such as investing in ESG initiatives for personal reasons—to improve their image, enhance their reputation, or respond to societal pressures—rather than to maximize shareholder value (Jensen & Meckling, 1976). These decisions, while presented as socially responsible, can generate high agency costs related to unnecessary spending, operational complexity, and the allocation of resources to unprofitable projects. This theory also highlights the risk of information asymmetry, which can lead managers to justify superficial or poorly aligned ESG commitments, sometimes to mask poor performance. This phenomenon can lead to overinvestment in ESG projects, to the detriment of more profitable strategic opportunities, and increase the company's financial vulnerability (Stulz, 1990). In this context, ESG is not inherently beneficial. It can become a source of fragility when it is exploited by managers to serve their own interests, without creating value for shareholders (Jensen, 1986).

In practice, the relationship between the integration of environmental, social, and governance (ESG) criteria and bank stability is attracting increasing interest in academic research. However, the results remain heterogeneous. Some previous studies have found that sustainable performance plays a stabilizing role, thus strengthening bank resilience (e.g., Chiaramonte et al., 2022; Wang et al., 2024; Choi et al., 2024; Gehrig et al., 2024, Luh et al., 2024). However, other studies have shown the opposite (e.g., Bruno et al., 2024; Salim et al., 2023; Di Tommaso & Thornton, 2020).

More specifically, most recent research highlights the positive impact of ESG initiatives on the resilience of financial institutions. Analyzing a sample of European banks operating in 21 countries between 2005 and 2017, Chiaramonte et al., (2022) show that overall ESG scores and their sub-components contribute to reducing bank fragility, particularly during financial crises. This study underscores the importance of integrating ESG strategies to strengthen banks' reputations, avoid regulatory sanctions, and improve funding strategies. It confirms the validity of stakeholder theory. Similarly, Wang et al., (2024) show that ESG performance increases the economic value of Chinese banks and reduces the risk of failure. They further emphasize the beneficial role of governance as a key determinant in this process. Likewise, Gehrig et al. (2024) confirm, using a global sample, that ESG strategies mitigate systemic risks by improving the

resilience of financial institutions. Choi et al., (2024) observe a similar effect in South Korea, with a particularly strong influence of the environmental pillar, highlighting the growing importance of climate issues in financial stability. The same finding was detected by Gehrig et al., (2024). Finally, Luh et al., (2024) offer a novel perspective by demonstrating that the presence of female leaders in Ghanaian banks promotes the publication of ESG information and improves social and governance performance, making these institutions more attractive to responsible investors.

Despite these encouraging results, some studies highlight potentially adverse consequences linked to the integration of ESG criteria. For instance, Bruno et al., (2024) find that high ESG scores can be correlated with a higher level of non-performing loans in listed European banks, due to governance issues and controversies. From a study conducted on emerging markets, Salim et al., (2023) observe that ESG investments can increase banking risk. Their study supports the predictions of agency theory, which suggests that ESG initiatives divert resources from core activities, thereby increasing costs and volatility. Similarly, Di Tommaso & Thornton (2020) find that high ESG scores can reduce the value of banks, which aligns with the overinvestment theory, according to which ESG commitments can limit value-creating investments.

Some studies adopt a more nuanced approach, emphasizing that the impact of ESG practices is not uniform and depends heavily on the institutional and regulatory context. For instance, Soana (2011) concludes that engagement in ESG initiatives has no significant impact on the stability of Italian banks. The author attributes the neutrality between ESG criteria and banking stability to the benefits of integrating ESG criteria, which can be offset by the additional costs they generate, particularly in highly regulated environments. From a comparative perspective, Jiang et al., (2025) highlight a heterogeneity of effects in China. The authors observe that, on the one hand, ESG performance has a positive influence on the stability of state-owned banks, but, on the other hand, tends to have a negative impact on regional banks. This divergence is explained by a regulatory arbitrage phenomenon that favors institutions with sufficient resources to implement ambitious ESG policies. Finally, Liu & Xie (2024) provide further insight by showing that integrating ESG practices can help reduce liquidity risk. According to their findings, this effect is primarily achieved by strengthening stakeholder confidence and improving financial performance, thereby giving banks greater resilience to external shocks.

Other recent work suggests that the relationship between ESG performance and financial (financial performance) or banking stability indicators is not strictly linear but rather exhibits complex and sometimes contradictory effects (Saif-Alyousfi et al., 2023; Attia et al., 2023; Khémiri & Alsulami, 2023; Mallek et al., 2024; Liaqat et al., 2026). Only a few studies have explored this dimension, focusing on variables such as stock market returns or banking diversification. For example, Khémiri & Alsulami (2023) shed further light on this by demonstrating that, in the Gulf region, the relationship between CSR reporting and the stability of Islamic banks is quadratic. This finding confirms that the impact of ESG practices on banking stability does not follow a linear trajectory but depends on critical thresholds and contextual factors such as governance structure and the regulatory framework. Furthermore, Saif-Alyousfi et al., (2023) analyzed the impact of these practices. ESG on bank diversification globally. Their results reveal a non-linear relationship: environmental and social dimensions have a negative effect, while governance plays a positive role. In developed countries, the influence of ESG on diversification is strengthened by the quality of environmental communication and the robustness of governance mechanisms. The authors emphasize that an incentive framework for sustainable finance could attract more investors and improve bank valuations. Similarly, Attia et al., (2023) find that the relationship between ESG and the financial performance of international tourism companies is not linear.

Mallek et al., (2024) examine the linear and non-linear impact of ESG components on bank stock returns in the MENA region, incorporating bank size as a moderating variable. Using a sample of 59 banks across 12 countries between 2010 and 2021, their regression analyses Generalized quantile analysis shows that the relationship between ESG and returns takes the form of a U or an inverted U. This result reflects the existence of threshold effects: a moderate improvement in ESG scores boosts performance, but beyond a certain level, the costs associated with implementing ESG practices can reduce gains. Furthermore, the size of banks amplifies the positive effect of ESG criteria on returns, suggesting that large institutions have sufficient resources to absorb these costs.

Finally, Liaqat et al., (2026) show that ESG performance influences bank stability in a contextual manner. Using a global sample of 660 banks covering the period 2002–2023, the authors find that ESG strengthens stability primarily in individualistic cultures, while high levels of uncertainty avoidance, power distance, and long-term orientation reduce this effect. Strong formal institutions play a positive moderating role. The study identifies liquidity and funding costs as key transmission channels and reveals significant differences between pre- and

post-Paris Agreement periods, as well as between developed and emerging economies. These findings underscore the need to tailor ESG strategies to specific cultural and institutional contexts.

The relationship between ESG performance and banking stability appears highly dependent on key contextual factors, including institutional quality, green innovation, and banking concentration. Robust institutional governance is a key lever for amplifying the stabilizing effect of ESG practices by reducing regulatory and reputational risks (North, 1990; Shin et al., 2023; Attia et al., 2023; Jiang et al., 2025; Liaqat et al., 2026). At the same time, green innovation fosters the creation of competitive advantages and improves banks' resilience to environmental shocks, although its impact depends on the level of technological integration and regulatory incentives (Chen et al., 2024; Wu et al., 2025). Finally, the structure of the banking market plays a crucial role. In concentrated systems, ESG tends to enhance stability by mitigating systemic risks, while in fragmented markets, compliance costs can weaken smaller institutions (Xing et al., 2024). These arguments underscore that understanding the magnitude of these three factors is essential to grasping the heterogeneity of ESG effects and guiding appropriate strategies for improved banking resilience.

Existing literature has largely neglected the study of the non-linear nexus between ESG performance and banking stability in the MENA region, despite the strategic importance of this topic. This neglect is significant because the region's institutional and economic specificities, combined with increasing but uneven adoption of ESG practices, can generate complex effects. This research aims to fill this gap by examining whether the impact of ESG on banking stability follows a non-linear trajectory, characterized by critical thresholds or diminishing returns. On this basis, Hypothesis 1 could be reformulated as follows:

Hypothesis 1 (H1). *There is a nonlinear association between sustainable performance and banking stability.*

2.2. Green innovation

Schumpeter’s theory of innovation, reinforced by recent work by Nchofoung et al. (2024), highlights the central role of entrepreneurs in creating economic value through the introduction of and investment in in innovative technologies, methods, or products capable of gaining market share. This approach is not limited to the act of innovating; it describes a dynamic process where innovations go through different stages of adoption before becoming fully integrated into society.

In practice, the study of the relationship between green innovation and stability has focused particularly on the macroeconomic level (e.g., Nchofoung et al., 2024; Gold & Tregenna, 2025). According to Gold & Tregenna (2025), green innovation plays a crucial role in improving environmental performance, particularly by reducing carbon emissions when accompanied by robust financial development and incentive-based tax policies. However, its effectiveness largely depends on the quality of institutions: strong structures, based on transparency, accountability, and effective policies, are essential to maximizing its benefits. Conversely, weak institutions can hinder adoption and limit the impact of these innovations, thus perpetuating institutional risk. Similarly, an underdeveloped financial system acts as a brake, restricting access to necessary financing and increasing financial risks. The expansion of green finance therefore appears as a key lever for accelerating the transition. Finally, Gold & Tregenna (2025) emphasize that competitiveness and sustainability can only be achieved through public-private partnerships and institutional strengthening, to build a low-carbon economy aligned with global sustainable development goals. However, at the microeconomic level, this relationship remains underexplored, as most recent studies focus on examining the linear and non-linear relationship between green innovation and ESG performance (e.g., Xu et al., 2025; Suo & Qiao, 2025; Dong et al., 2025; Yu & Jin, 2026).

Hypothesis 2 (H2). *There is a threshold effect of innovation on the ESG– banking stability nexus.*
H2(a) *Under agency theory, in lower regime (high level of green innovation), ESG negatively affects banking stability.*
H2(b) *Under stakeholder theory, in upper regime (low level of green innovation), ESG positively affects banking stability.*

2.3. Bank competition

Banking competition plays a crucial role in financial stability, especially during periods of economic uncertainty. When credit demand declines, banks seek to maintain their profitability in a highly competitive environment. This pressure often leads them to adopt riskier strategies, such as investing in volatile assets or loosening their lending policies, thereby increasing their financial fragility (González et al., 2017).

Theoretically, the relationship between banking competition and financial stability has generated significant theoretical debate, resulting in three main approaches. The first, known as *the competition fragility hypothesis*, argues that increased competition reduces banks' franchise value, incentivizing them to take more risk to maintain profitability, which in turn increases the likelihood of instability (Keeley, 1990; Hellmann et al., 2000; Carletti & Hartmann, 2002). Conversely, *the stability-related competition hypothesis* posits that competition improves

efficiency, reduces financing costs, and decreases borrower default risk, thus contributing to the stability of the banking system (Boyd & De Nicoló, 2005; Anginer et al., 2012; Vives, 2016). Finally, the trade-off theory offers a more nuanced view: the effect of competition on stability depends on the institutional framework, the quality of regulation, and market structure, suggesting that strong institutions and effective supervision can mitigate the risks associated with increased competition (Beck et al., 2013; Vives, 2016).

Several studies confirm that competitive dynamics directly influence banking stability, amplifying the effects of economic shocks and policy uncertainties (e.g., Fang et al., 2014; Bermpei et al., 2018; Moudud-Ul-Huq, 2020; Uddin et al., 2020; Van Duuren et al., 2020; Dutta and Saha, 2021; Shabir et al., 2021). For instance, Shabir et al., (2021) showed that the negative effect of economic policy uncertainty on banking stability could be amplified through reduced banking competition. Based on this previous literature, the fourth hypothesis can be formulated as follows:

Hypothesis 3 (H3). *There is a threshold effect of bank competition on the ESG– banking stability nexus.*
H3(a) *Under stakeholder theory, in lower regime (high competition), ESG positively affects banking stability.*
H3(b) *Under agency theory, in upper regime (low competition), ESG negatively affects banking stability.*

2.4. Institutional quality

Under institutional economics, the quality of institutions reflects a country's capacity to establish clear rules, reduce uncertainty, and protect property rights, thereby creating a predictable environment that facilitates trade, lowers transaction costs, and supports business competitiveness, fostering economic performance and stability (North, 1990). Considered as the "rules of the game" structuring economic and social interactions (North, 1990), institutions encompass both formal constraints, such as regulations and public policies, and informal constraints, such as cultural norms and social values. These two dimensions directly influence how companies design their sustainable development strategies, shaping the adoption of ESG practices and their impact on financial performance and stability (e.g., Attia et al., 2023; Liaqat et al., 2026).

Although North (1990) highlighted the role of institutions in reducing uncertainty and structuring economic exchanges, institutional theory extends this reflection by explaining how these pressures shape organizational behavior. It shows that companies adapt their practices,

particularly in CSR and ESG, to preserve their legitimacy in environments marked by formal and informal constraints (Scott, 2008).

More precisely, within the framework of institutional theory, companies do not operate in isolation. They adapt to the pressures of their environment to maintain their legitimacy (Scott, 2008). These pressures can be regulatory, social, or strategic. For example, legal obligations such as Directive 95/2014/EU mandate the publication of non-financial information, but when these conflict with cultural norms, they can result in purely symbolic compliance (Bebbington et al., 2012; Posadas et al., 2023). Social and cultural expectations also play a key role. National culture, with its characteristics such as individualism or uncertainty aversion, directly influences ESG engagement and explains the differences between countries (e.g., Hofstede, 1984; Garcia-Sanchez et al., 2016; Nicolò et al., 2024; Pizzi et al., 2023). In the banking sector, these values shape not only ESG strategies but also their financial impact (Claudio and Gallo, 2025; Liaqat et al., 2026). Finally, in uncertain environments, companies often prefer to imitate market leaders, which standardize reporting practices without guaranteeing a real improvement in performance (Posadas et al., 2023; Dimaggio and Powell, 2004).

In similar institutional environments, companies tend to align their ESG behaviors to meet external expectations and preserve their legitimacy (Posadas et al., 2023; Shin et al., 2023). This conformity strengthens social acceptance and economic stability (Dumitru et al., 2017). However, institutional quality acts as a filter: robust and transparent institutions foster the genuine integration of ESG criteria, while contexts marked by corruption or rigid cultural norms can lead to superficial commitments (Bebbington et al., 2012; Sari et al., 2021; Khémiri et al., 2025; Liaqat et al., 2026).

National culture, as an informal institution, plays a central role in the perception of responsible behavior (Hofstede, 1984; Garcia-Sanchez et al., 2016). Dimensions such as individualism, uncertainty aversion, and power distance influence stakeholder pressure and explain disparities in ESG engagement between countries (Nicolò et al., 2024; Pizzi et al., 2023). In the banking sector, these cultural values directly shape ESG strategies and their financial effectiveness (Claudio & Gallo, 2025). When formal institutions are weak or uncertain, companies often adopt mimetic behaviors, imitating market leaders to reduce uncertainty. This imitation standardizes ESG reporting without guaranteeing a substantial improvement in performance (Dimaggio and Powell, 2004b; Posadas et al., 2023; Setianto et al., 2025).

In practice, Khémiri et al. (2023) found that institutional quality moderates the non-linear relationship between CSR and Islamic bank stability in GCC countries. Similarly, Attia et al. (2023) showed that the non-linear relationship between ESG and the performance of tourism companies is moderated by national governance. Liaqat et al. (2026) demonstrated that institutional quality plays a crucial role, thus contributing to reducing the risk of insolvency. In addition, Setianto et al. (2025) have shown that the effect of financial inclusion on banking stability in developed and developing countries depends on the level of institutional development. The authors demonstrated that below a certain threshold of institutional quality, the impact is insignificant, but above it, it becomes positive and significant. This study underscores that strengthening institutional quality is essential to maximizing the benefits of financial inclusion for economic stability. In a study of banks in 78 countries conducted between 2005 and 2019, Shabir et al. (2021) found that economic policy uncertainty reduces banking stability, especially during crises. Their study indicates a threshold effect: strong institutional quality mitigates this negative impact, while weak banking competition exacerbates it. This suggests that economic policy uncertainty has a detrimental effect on stability in all countries, highlighting the need for further reforms to mitigate risks and strengthen institutions. In this case, the third hypothesis is presented as follows:

Hypothesis 4 (H4). *There is a threshold effect of institutional quality on the ESG– banking stability nexus.*
H4(a) *Under agency theory, in lower regime (high level of institutional quality), ESG negatively affects banking stability.*
H4(b) *Under stakeholder theory, in upper regime (low level of institutional quality), ESG positively affects banking stability.*

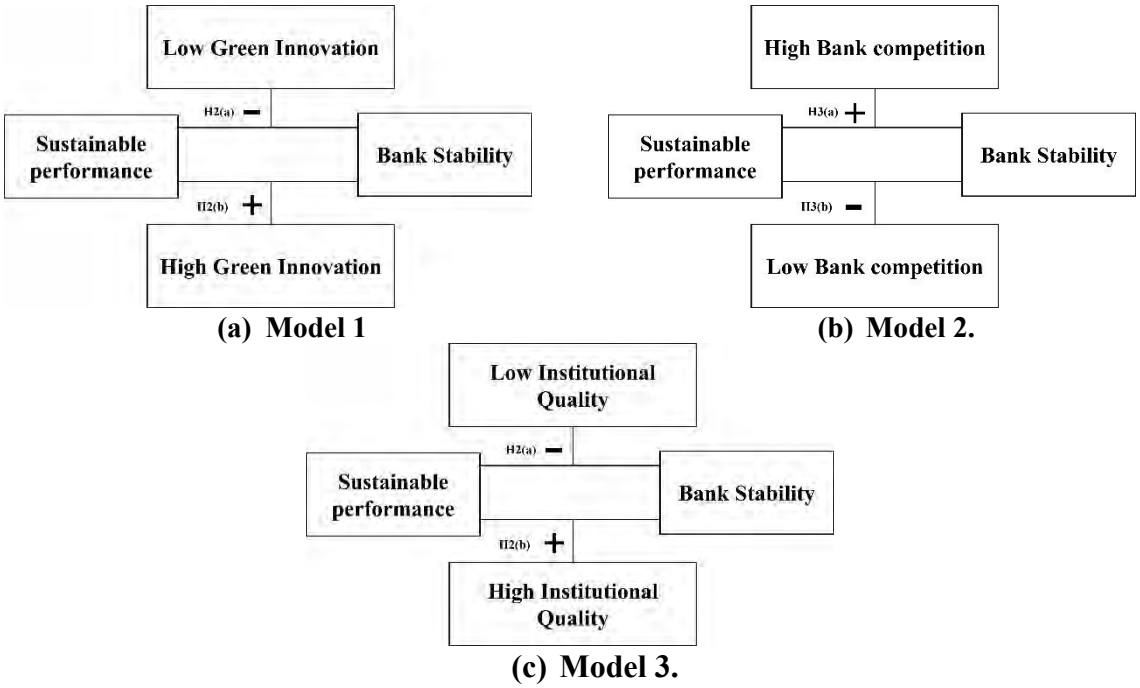

Figure 1. Conceptual framework

3. Research methodology

3.1. Data

The sample selected consists of 49 listed banks operating in five GCC countries (Kuwait, Oman, Qatar, Saudia Arabia, and UAE) during the period 2017-2023. Banking data is obtained from the annual individual bank balance sheets published in the Refinitiv Eikon database. The country-level data came from the World Bank's World Development Indicators and Worldwide Governance Indicators. The choice of sample depends essentially on the availability of data on ESG scores. Table 1 summarizes the breakdown of the banks in each country. To minimize the influence of outliers on this study, all bank-level variables are winsorized at the 1st and 99th percentiles.

Table 1. Breakdown of Banks

Country	Number of banks	%
Kuwait	8	16.33%
Oman	6	12.24%
Qatar	8	16.33%
Saudi Arabia	10	20.41%
UAE	17	34.69%
Total	49	100%

3.2. Variables

3.2.1. Dependent variable

To quantify the banking stability, the study follows several studies (e.g., Khémiri et al. (2024), employing ZSCORE. This indicator measures the insolvency probability at the bank-level. This probability is lower while the Z-score value is higher, and vice versa. The formulation of the ZSCORE is as follows:

$$ZSCORE_{cit} = \frac{\frac{net\ income_{cit}}{ta_{cit}} + \frac{equity_{cit}}{ta_{cit}}}{\sigma\left(\frac{net\ income_{cit}}{ta_{cit}}\right)} \quad (1)$$

With,

$\frac{net\ income_{cit}}{ta_{cit}}$ represents the return on assets (ROA) of bank i at time t,

$\frac{equity_{cti}}{ta_{cti}}$ is measured by the ratio of total equity to total assets,

and $\sigma\left(\frac{net\ income_{cit}}{ta_{cit}}\right)$ is the standard deviation of ROA. The standard deviation is determined by applying a three-year rolling window.

3.2.2. Main independent variable

Refinitiv calculates more than 630 indicators relating to ESG issues at company level, of which a subset of 186 indicators has been identified as being particularly comparable and significant across business sectors. These indicators contribute to the overall evaluation and rating of companies. The assessments of the various categories are structured around three main pillars: environmental, social and corporate governance. The score assigned to the ESG pillar is determined by a relative sum of the weights assigned to the different categories, with these weights varying by sector for the environmental and social dimensions. For governance, however, the weights remain constant across all sectors. The relative weights of the various

pillars are normalized in the form of percentages, varying from 0 to 100. Therefore, following several studies (see, among others, Li et al., 2024; Khalid et al., 2024; Sang et al., 2024; Lu & Cheng, 2024), this score (ESG) has employed to measure sustainable performance.

3.2.3. Transition variables

- *Green innovation*

To measure green innovation, this study used the Global Innovation Index (GII). This index assesses innovation in the context of stable but slow global economic growth, reduced funding for innovation, and low productivity. It reveals the world's most innovative economies by ranking the innovation performance of approximately 130 countries and highlighting their strengths and weaknesses in this area. The GII assigns each economy a score between 0 and 100, where higher values indicate stronger innovation performance. A score closer to 0 reflects very low innovation capacity, while a score near 100 represents the highest observed level of innovation among countries.

- *Bank competition*

To measure the bank market power, we follow Salah & Chafai (2021), and Li & Peng (2024) using the Lerner index. This index indicates the level of monopoly control in the market by quantifying the extent of difference between price and marginal cost. It measures as follows:

$$Lerner_{it} = \frac{P_{it} - MC_{it}}{P_{it}} \tag{2}$$

Where P_{it} indicates the standard output price of bank i at year t measured by the ratio of total income to total assets; MC denotes the marginal cost. The Lerner index varies from 0 to 1 and indicates how far price is from marginal cost. A higher Lerner index means more monopoly power and less competitiveness. The Lerner index is zero in a perfectly competitive market. However, since we cannot observe marginal cost directly, we will derive it from a cost function to estimate it. Following Li and Peng (2024), we specify a translog cost function to derive the bank's cost function and take its first-order derivative to get the bank's marginal cost. In real-world markets, financial institutions do not always lie on the efficiency frontier and may find it hard to produce at levels that are in line with the optimal frontier. Therefore, this paper applies the panel stochastic frontier model to estimate the bank's cost function. The translog cost function (TCF) used by the bank can be specified as follows:

$$\ln cost_{it} = \beta_0 + \beta_y \ln ta_{it} + \sum_{n=1}^{3} \beta_n \ln w_{nit} + \frac{1}{2}\beta_{yy} \left(\ln ta_{it}\right)^2 + \frac{1}{2}\sum_{n=1}^{3}\sum_{m=1}^{3} \beta_{nm} \ln w_{nit} \ln w_{nit} + \sum_{n=1}^{3} \beta_{ny} \ln ta_{it} \ln w_{nit} + \delta_i + \varepsilon_{it} - \nu_{it} \quad (3)$$

Where, $Cost_{it}$ is the total cost of bank i in year t; ta_{it} denotes the total assets (i.e., output) of bank i in year; w_{it} signifies the three-input price: (i) capital (non-operating expenses to fixed assets), (ii) labor (management expenses to fixed assets), and (iii) funds (interest expenses to total deposits). δ_i stands for the year fixed effect, ε_{it} is the random error term, and ν_{it} represents the production inefficiency term. Table A2 summarizes the results of TCF regression.

However, in TCF, the principles of symmetry, cost exhaustion and homogeneity must be respected by input prices. Therefore, it is important to satisfy these constraints in equation 3. These constraints are followed by $\sum_n^3 \beta_n = 1$; $\sum_n^3 \beta_{nm} = 0, \forall m$; $\sum_n^3 \beta_{ny} = 0$. In this case, the marginal cost of banking is calculated by inserting these constraints into equation 2 as follows:

$$M.cost = \frac{\partial cost_{it}}{\partial ta_{it}} = \frac{cost_{it}}{ta_{it}} \times \frac{\partial \ln cost_{it}}{\partial \ln ta_{it}} = \frac{cost_{it}}{ta_{it}} \times \left(\beta_y + \beta_{yy} \ln ta_{it} + \sum_{n=1}^{3} \beta_{ny} \ln w_{it}\right) \quad (4)$$

After estimating the marginal cost, we calculate the Lerner index using equation 2. The results are reported in table A1 for each year and country.

- *Institutional quality*

To examine the impact of institutional quality on sustainable growth, we utilized a composite measure (IQ) that includes all (six) dimensions of worldwide governance indicators. The six dimensions of IQ are defined as follows: Voice and accountability (VA), political stability (PS), government quality (GE), regulatory quality (RQ), rule of law (RL), and control of corruption (CC). A higher score means better country governance. According to Kaufmann et al. (2011), there is a high correlation between IQ dimensions. After running the PCA, we performed the Bartlett's sphericity test and KMO test to examine the data's applicability for factor analysis. The results of these two tests are reported in table A3. The P-values of the Bartlett sphericity test are all less than 0.05 (0.00) and the KMO value is equal to 0.665, which showed that the data is applicable to the PCA (Panel B). The results of total variance explained indicating that the first principal component explains about 69% of the variance of the corresponding sample (Panel A).

3.2.4. Control variables

Following several previous studies (e.g., Khémiri et al., 2024; Chafai and Alsulami, 2025), several control variables have included in the baseline model. Table 1 summarizes the definitions of variables.

Table 1. Variable definition.

Variables	Acronyms	Definition	Source
Dependent variable			
Bank stability	Bstability	ZSCORE =ROA+EQUITY/st.dev.(ROA)	Refinitiv Eikon and authors' own calculation
Independent variable			
Sustainable performance	ESG	ESG score	Refinitiv Eikon
Transition variables			
Green innovation	GII	Global innovation index	WIPO
Bank competition	Bcomp	Lerner Index	Refinitiv Eikon
Institutional quality	IQ	Composite variable. PCA is used for calculating the composite variable. IQ is normalized using min-max normalization.	WGI, Kaufmann et al. (2011)
Control variables			
Board size	BS	The number of bord size	Refinitiv Eikon
Bank loans	Loans	The ratio of total debt total assets	Refinitiv Eikon
Bank cost	Cost	ratio of cost to income	Refinitiv Eikon
Bank size	Size	The natural logarithm of total assets	Refinitiv Eikon
GDP growth	GDP	GDP growth rate (annual %)	WDI
Inflation	INF	Consumer prices index (annual %)	WDI

Note: WGI is World Governance indicators; WDI is World Development Indicators.

3.3. Econometric models

To test the different hypotheses (1, 2, 3 and 4), this study employs the dynamic panel threshold regression (DPTR) model, developed by Seo and Shin (2016). This method seeks to address issues related to dynamic panel heterogeneity and possible endogeneity. Endogeneity can arise from reverse causality, where ESG performance influences bank stability (e.g., Luh et al., 2024), but bank stability can also impact ESG. For more details, see Seo and Shin (2016). The following equations present the econometric models.

$$\begin{aligned}\text{Bstability}_{cit} = {} & (\beta_1 \text{Bstability}_{cit-1} + \beta_2 ESG_{cit} + \beta_3 BS_{cit} + \beta_4 Loans_{cit} + \beta_5 \text{Cos}\, t_{cit} \\ & + \beta_6 Size_{cit} + \beta_7 INF_{ct} + \beta_8 GDP_{ct}) 1 \cdot (GII_{ct} \le \gamma) \\ & + (\lambda_1 \text{Bstability}_{cit-1} + \lambda_2 ESG_{cit} + \lambda_3 BS_{cit} + \lambda_4 Loans_{cit} + \lambda_5 \text{Cos}\, t_{cit} \\ & + \lambda_6 Size_{cit} + \lambda_7 INF_{ct} + \lambda_8 GDP_{ct}) 1 \cdot (GII_{ct} > \gamma) + \varepsilon_{it}\end{aligned} \tag{5}$$

$$\begin{aligned}\text{Bstability}_{cit} = &(\beta_1 \text{Bstability}_{cit-1} + \beta_2 ESG_{cit} + \beta_3 BS_{cit} + \beta_4 Loans_{cit} + \beta_5 \text{Cos}t_{cit} \\ &+ \beta_6 Size_{cit} + \beta_7 INF_{ct} + \beta_8 GDP_{ct}) 1\cdot(Bcomp_{cit} \le \gamma) \\ &+ (\lambda_1 \text{Bstability}_{cit-1} + \lambda_2 ESG_{cit} + \lambda_3 BS_{cit} + \lambda_4 Loans_{cit} + \lambda_5 \text{Cos}t_{cit} \\ &+ \lambda_6 Size_{cit} + \lambda_7 INF_{ct} + \lambda_8 GDP_{ct}) 1\cdot(Bcomp_{cit} > \gamma) + \varepsilon_{it}\end{aligned} \tag{6}$$

$$\begin{aligned}\text{Bstability}_{cit} = &(\beta_1 \text{Bstability}_{cit-1} + \beta_2 ESG_{cit} + \beta_3 BS_{cit} + \beta_4 Loans_{cit} + \beta_5 \text{Cos}t_{cit} \\ &+ \beta_6 Size_{cit} + \beta_7 INF_{ct} + \beta_8 GDP_{ct}) 1\cdot(IQ_{ct} \le \gamma) \\ &+ (\lambda_1 \text{Bstability}_{cit-1} + \lambda_2 ESG_{cit} + \lambda_3 BS_{cit} + \lambda_4 Loans_{cit} + \lambda_5 \text{Cos}t_{cit} \\ &+ \lambda_6 Size_{cit} + \lambda_7 INF_{ct} + \lambda_8 GDP_{ct}) 1\cdot(IQ_{ct} > \gamma) + \varepsilon_{it}\end{aligned} \tag{7}$$

where Bstanility_{cit} is the endogenous variable, ESG_{cit} is the time-varying regressor. The γ designates the threshold parameter. $1\cdot(\square)$ is an indicator function. GII_{ct}, $Bcomp_{cit}$, and IQ_{ct} are the threshold variables.BS, Loans, Cost, Size, INF, and GDP are the control variables. The $\varepsilon_{it}\left(\mu_i + \nu_{it}\right)$ are the error components, where μ_i is the individual fixed effects and ν_{it} is the idiosyncratic random disturbance. The β and λ are the coefficients of all independent variables for the lower and upper regimes, respectively.

4. Fundings and discussion

4.1. Descriptive Analysis

Table 2 describes descriptive statistics for all variables. The mean, standard deviations and number of observations are presented. The average Bstability represents 1.252 in GCC banking sector. In terms of ESG score, the GCC banking sector has an ESG of 28% on average, indicating a relatively weak sustainable performance. In addition, the estimated average GII is 0.357, indicating a moderate level of innovation in these countries. This statistic reflects an incomplete transition to a knowledge-based economy and a persistent dependence on hydrocarbons. Furthermore, the average Bcomp, assessed at 0.358. This outcome indicates a moderately concentrated structure where competition exists but is not fully. Finally, the average IQ is 0.596, showing a relatively high average institutional quality. This statistic indicates that GCC countries exhibit stable and effective institutions that promote good governance and reduce political risk.

Table 2. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Bstability	343	1.252	1.509	-4.099	4.183
ESG	343	0.280	0.224	0	0.778
GII	343	0.357	0.055	0.281	0.432
Bcomp	343	0.358	0.062	0.27	0.483
IQ	343	0.596	0.403	0	1
BS	343	9.251	1.491	5	15
Loans	343	0.025	0.013	-0.678	1.131
Cost	343	0.260	0.799	-8.067	0.753
Size	343	22.135	1.459	19.271	25.928
GDP	343	-0.099	4.406	-0.086	0.055
INF	343	-0.025	0.098	-0.259	0.162

Figure 2 illustrates the trends in Btsability and ESG, 2017–2023. Figures 3-5 illustrate the green innovation, bank competition, and institutional quality across country.

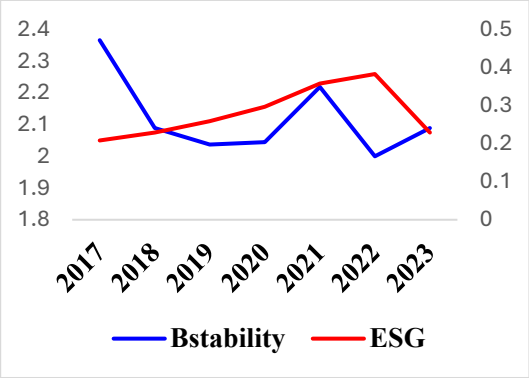

Figure 2. Trends in Btsability and ESG, 2017–2023.

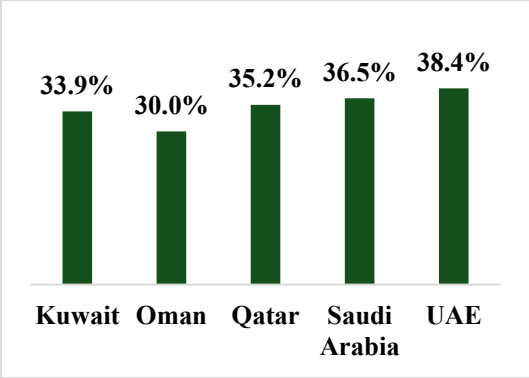

Figure 3. Trends in Green innovation (GII), by countries.

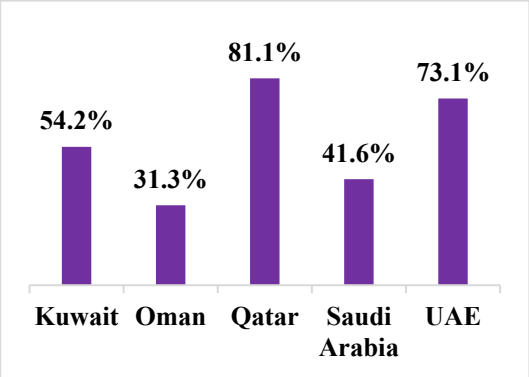

Figure 4. Trends in bank competition (Bcomp), by countries.

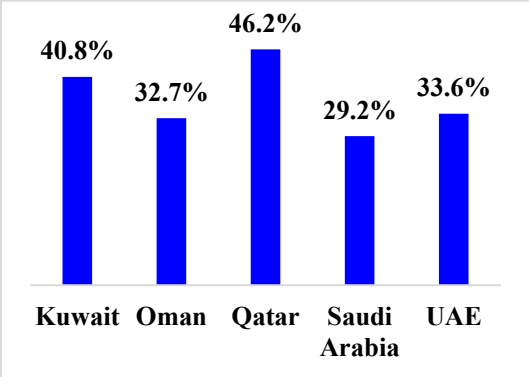

Figure 5. Trends in institutional quality (IQ), by countries.

Table 3 suggests that it is unlikely that the empirical models examined will be affected by multicollinearity problems. Indeed, the correlation coefficients measured between independent variables remain below the critical threshold of 0.80, indicating a weak correlation between these different variables (Gujarati, 2009). Moreover, the values obtained for the variance

inflation factor (VIF) are below 10, thus reinforcing the lack of multi-collinearity between the variables considered (table 4.

Table 3. Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Bstability	1.000										
(2) ESG	0.039*	1.000									
(3) GII	-0.029*	0.010	1.000								
(4) Bcomp	0.244*	0.159*	-0.126*	1.000							
(5) IQ	0.076*	0.033	0.640*	0.177*	1.000						
(6) BS	0.079	0.272*	-0.114*	0.007	-0.123*	1.000					
(7) Loans	-0.108*	0.003	0.053	-0.062	0.041	-0.151*	1.000				
(8) Cost	0.156*	0.222*	-0.104	-0.104	-0.110*	0.244*	0.107*	1.000			
(9) Size	-0.002	0.519*	0.055	-0.075	-0.058	0.294*	-0.099	0.325*	1.000		
(10) GDP	-0.026	0.119*	-0.329*	0.200*	-0.325*	0.306*	-0.146*	0.064	0.189*	1.000	
(11) INF	-0.116*	0.081	0.000	-0.046	-0.019	0.010	0.013	-0.045	0.036	0.050	1.000

Note: * represents significance at 5%.

Table 4. VIF correlation

Variable	VIF	1/VIF
IQ	2.03	0.492
GII	1.96	0.510
Size	1.63	0.615
ESG	1.52	0.659
GDP	1.38	0.727
Bcomp	1.31	0.764
BS	1.26	0.791
Cost	1.22	0.817
Loans	1.08	0.927
INF	1.02	0.980
Mean VIF	1.44	

4.2. Main outcomes

Table 5 summarizes the different results of DPTR (equations 5, 6, and 7). The outcomes of the bootstrap linearity test from Seo and Shin's (2016) show that there is a nonlinear relationship between ESG performance and bank stability in GCC countries validating Hypothesis 1. More precisely, these outcomes show that there is a threshold effect of three transition variables (Model 1, Model 2, and Model 3) on ESG-Bstability nexus.

4.2.1. ESG and threshold effect of green innovation

For Model 1, the bootstrap test confirms a statistically significant threshold effect at the 1% level, validating Hypothesis 2. The estimated threshold value for GII is 0.250, splitting the sample into a lower GII regime (37% of observations) and an upper GII regime (63%). The lagged variable coefficients (ESG_{t-1}) exhibit contrasting signs in different regimes (negative in the lower regime and positive in the upper regime). Also, they are highly significant at the 1%

level. These outcomes imply that the current ESG is lower than the previous ESG, indicating a lack of faster sustainable performance, and vice versa. A finding consistent with Khémiri & Alsulami (2023).

Using GII as transition variable, the results show a distinct nonlinear pattern. In the lower regime (GII < 0.334), the coefficient on the ESG is significantly negative. More precisely, a 10.0% increase in ESG causes a 9.7% loss in Bstability. This outcome supports Hypothesis 2 (a), aligning with the agency theory perspective. In fact, the high initial costs inherent in their adoption constitute a significant obstacle. These investments, often considered unproductive in the short term, tend to reduce profitability and intensify divergences between shareholders and managers, the latter being generally oriented towards maximizing immediate value. This result consists of Bruno et al. (2024) and Salim et al. (2023), showing that high ESG scores can be correlated with a higher level of non-performing loans, due to governance issues and controversies and observe that ESG investments can increase banking risk.

On the contrary, in the upper regime (GII ≥ 0.344), the coefficient on ESG becomes significantly positive, lending support to Hypothesis 2(b) and the prediction of stakeholder theory. This outcome is in line with Gehrig et al. (2024), who indicate that that ESG strategies mitigate systemic risks by improving the resilience of financial institutions.

4.2.2. ESG and threshold effect of bank competition

Regarding Model 2, the bootstrap test approves a statistically significant threshold effect at the 1% level, confirming Hypothesis 3. The estimated threshold value for Bcomp is 0.360, splitting the sample into a lower Bcomp regime (54% of observations) and an upper Bcomp regime (46%). The lagged variable coefficients (ESG_{t-1}) also reveal opposing signs in different regimes.

Employing Bcomp as transition variable, the outcomes also exhibit a nonlinear nexus between ESG and Bstability, revealing two regimes. In the lower regime (high competition), the coefficient on the ESG is significantly positive. More precisely, a 10.0% rise in ESG causes a 0.95% increase in Bstability. This result proves Hypothesis 3 (a), and the stakeholder theory predictions. More precisely, ESG performance strengthens banking stability by consolidating the trust of key stakeholders, limiting reputational risks, and improving resilience to economic shocks. However, in the upper regime (low competition), the coefficient on ESG becomes significantly negative, contributing support to Hypothesis 3(b) and the prediction of agency theory. This outcome is in line with Choi et al. (2024).

4.2.3. ESG and threshold effect of institutional quality

About Model 3, the bootstrap test allows a statistically significant threshold effect at the 1% level, enhancing Hypothesis 4. The estimated threshold value for IQ is 0.360, splitting the sample into a lower IQ regime (25% of observations) and an upper IQ regime (46%). The lagged variable coefficients (ESG_{t-1}) also reveal opposing signs in different regimes as for Model 1.

Utilizing IQ as transition variable, the conclusions also display a nonlinear association between ESG and Bstability, also revealing two regimes. In the lower regime (low IQ), the coefficient on the ESG is significantly negative. More precisely, a 10.0% rise in ESG causes a 0.95% increase in Bstability. This result proves Hypothesis 4 (a), and the agency theory predictions. Conversely, in the upper regime (high IQ), the coefficient on ESG becomes significantly positive, contributing support to Hypothesis 4(b) and the prediction of stakeholder theory. This outcome is in line with Gehrig et al. (2024).

4.2.4. Control variables result

Turning now to control variables. Board size (BS) demonstrates a dual effect (positive or negative) conditioned by the nature of the transition variable. For all Model, the impact of BS on Bstability should be explained by the fact that, when board size is small or moderate, an increase in members may lead to coordination problems, slower decision-making, and diluted accountability, which can undermine risk management and reduce stability. Conversely, in the upper regime, a larger board may enhance oversight, diversify expertise, and strengthen governance, thereby improving stability (Khémiri & Alsulami, 2023).

Loans also exhibit a dual effect on Bstability depending on nature of transition variable. These results should be explained by the fact that higher loan volumes may increase credit risk and exposure to non-performing assets, thereby weakening stability, and vice versa (Khémiri et al., 2024).

Cost also has a negative and positive effect on Bstability (Model 1, 2, and 3). This outcome can be explained by the higher risk-taking behavior, which means that a bank faces more volatility and uncertainty in its performance, and vice versa (Khémiri et al., 2024).

The same statement was proven by the Size variable (Model 1, 2, and 3). Greater size can give economies of scale, improved diversification, and stronger capacity to absorb shocks, thereby enhancing Bstability, and vice versa (Khémiri et al., 2024).

Macroeconomic variables also show a dual impact on Bstability depending on nature of transition variables. GDP rapid economic expansion may encourage excessive lending and risk-

taking, increasing credit risk and potentially undermining stability, and vice versa (Khémiri et al., 2024). Rising inflation can erode the real value of assets, increase uncertainty, and elevate credit risk, thereby weakening stability, and vice versa.

Table 5. Main outcomes.

	Model 1 (Equation 5)			Model 2 (Equation 6)			Model 3 (Equation 7)		
VARIABLES	Lower GII regime	Upper GII regime	Difference ($\delta=\lambda-\beta$)	Lower Bcomp regime	Upper Bcomp regime	Difference ($\delta=\lambda-\beta$)	Lower IQ regime	Upper IQ regime	Difference ($\delta=\lambda-\beta$)
$Bstability_{t-1}$	-0.994***	0.740***	1.734***	-0.391***	0.386***	0.777***	-0.099**	-0.239***	-0.114***
	(0.077)	(0.078)	(0.001)	(0.027)	(0.059)	(0.032)	(0.042)	(0.057)	(0.015)
ESG	-0.133***	0.134***	0.267***	0.095***	-0.198**	-0.293***	-0.133**	0.190***	0.323***
	(0.043)	(0.044)	(0.001)	(0.031)	(0.092)	(0.061)	(0.063)	(0.066)	(0.003)
BS	-0.720**	0.735**	1.455***	0.181***	0.837**	0.656***	0.150***	-0.139***	-0.289***
	(0.312)	(0.313)	(0.001)	(0.013)	(0.035)	(0.022)	(0.042)	(0.048)	(0.006)
Loans	-0.335**	0.328*	0.663***	-0.046	-0.244***	0.198***	-0.567	0.486	1.053***
	(0.167)	(0.169)	(0.002)	(0.094)	(0.032)	(0.062)	(0.593)	(0.592)	(0.001)
Cost	0.202***	-0.200***	-0.402***	-0.125***	0.095***	0.220***	-0.350***	0.353**	0.703***
	(0.018)	(0.019)	(0.001)	(0.019)	(0.002)	(0.017)	(0.013)	(0.015)	(0.002)
Size	-0.643***	0.445***	1.088***	-0.784***	0.258*	1.042***	0.188***	-0.248***	-0.436***
	(0.093)	(0.094)	(0.001)	(0.048)	(0.135)	(0.087)	(0.015)	(0.016)	(0.001)
GDPG	-0.579***	0.598***	1.177***	-0.081	0.394*	0.475***	0.117**	-0.121**	-0.238***
	(0.143)	(0.145)	(0.002)	(0.126)	(0.215)	(0.089)	(0.048)	(0.050)	(0.002)
INF	0.214***	-0.224***	-0.438***	0.047***	-0.154**	-0.201***	0.111***	-0.125***	-0.236***
	(0.014)	(0.015)	(0.001)	(0.007)	(0.015)	(0.008)	(0.010)	(0.011)	(0.001)
constant			-0.328***			-0.468*			0.122***
			(0.018)			(0.279)			(0.035)
Threshold value ($\hat{\gamma}$)	0.334*** [0.276, 0.388]			0.360*** [0.363, 0.370]			0.250*** [0.247, 0.293]		
Percentage (%)	37%	63%		54%	46%		25%	75%	
Bootstrap (p-value)		0.000			0.000			0.000	
Observations			343			343			343
Number of banks			49			49			49

Notes: *** displays level of significance at 1%, 5%, and 10%. Values in bracket illustrate standard error.

4.3. Robustness checks

To guarantee the reliability of main results, several sets of robustness checks are employed. These included: (i) utilizing an alternative measure of dependent, independent and transition variables, and (ii) re-running the model utilizing alternative econometric techniques. Across both strategies, our results remain consistent with the main model, reinforcing the validity of the observed threshold effect and the conditional effect of ESG on bank stability.

4.3.1. Alternative dependent variable

The first tests the sensitivity of the main outcomes to the operationalization of bank stability. Following Khémiri et al. (2023, 2024), the study employs alternative measure of ZSCORE based on Return on equity (ROE): $ZROE = \frac{ROE + EQUITY}{\sigma(ROE)}$.

The results (Table 6) are like those obtained from the main outcomes (Table 5), displaying that there is a threshold effect of GII, Bcomp, and IQ on ESG-Bstability nexus. This result also supports hypotheses 1, 2, 3 and 4.

Table 6. Changing dependent variable

VARIABLES	Lower GII regime	Upper GII regime	Difference ($\delta=\lambda-\beta$)	Lower Bcomp regime	Upper Bcomp regime	Difference ($\delta=\lambda-\beta$)	Lower IQ regime	Upper IQ regime	Difference ($\delta=\lambda-\beta$)
$ZROE_{t-1}$	-0.463***	0.145*	0.608***	-0.645***	0.763***	1.408***	-0.430***	-0.108***	0.322***
	(0.078)	(0.079)	(0.001)	(0.048)	(0.052)	(0.004)	(0.110)	(0.013)	(0.001)
ESG	-0.165***	0.104**	0.269***	0.041***	-0.087**	0.128***	-0.069***	0.117***	0.097***
	(0.046)	(0.042)	(0.004)	(0.014)	(0.034)	(0.020)	(0.022)	(0.019)	(0.003)
BS	-0.188	0.217*	0.405***	-0.254***	0.319*	0.573***	-0.797***	0.772***	1.569***
	(0.129)	(0.126)	(0.003)	(0.088)	(0.181)	(0.093)	(0.058)	(0.062)	(0.004)
Loans	0.029	0.020	-0.009	0.004	-0.354**	-0.358***	-0.206***	0.192***	0.389***
	(0.026)	(0.015)	(0.011)	(0.150)	(0.177)	(0.027)	(0.052)	(0.053)	(0.001)
Cost	0.829***	-0.794***	-1.623***	0.293*	-0.345	0.638**	0.179	-0.177	-0.356***
	(0.025)	(0.027)	(0.002)	(0.015)	(0.266)	(0.251)	(0.185)	(0.186)	(0.001)
Size	-0.299***	0.335***	0.634***	-0.038	0.226***	0.264*	0.234	-0.591**	0.825***
	(0.059)	(0.065)	(0.006)	(0.198)	(0.081)	(0.117)	(0.219)	(0.277)	(0.058)
GDP	0.342***	-0.450***	0.792***	-0.009	0.044	0.053	0.097	-0.107	-0.204***
	(0.115)	(0.107)	(0.008)	(0.065)	(0.157)	(0.092)	(0.061)	(0.076)	(0.015)
INF	-0.300***	0.195***	0.495***	-0.058	-0.157**	-0.099**	-0.100***	0.146***	0.246***
	(0.040)	(0.062)	(0.022)	(0.039)	(0.068)	(0.029)	(0.030)	(0.041)	(0.011)
constant			0.629***			-0.446**			0.184**
			(0.119)			(0.179)			(0.759)
Threshold value ($\hat{\gamma}$)	0.320*** [0.269, 0.370]			0.367*** [0.346, 0.387]			0.250*** [0.267, 0.293]		
Percentage (%)	35%	65%		55%	45%		25%	75%	
Bootstrap (p-value)		0.000			0.000			0.000	
Observations			343			343			343
Number of banks			49			49			49

Notes: *** displays level of significance at 1%, 5%, and 10%. Values in bracket illustrate standard error.

4.3.2. Alternative independent variable

The second test is changing the independent variable using the different pillars of ESG (Environmental, social, and governance). The results (Tables 7-9) are like those obtained from the main outcomes (Table 5), displaying that there is a threshold effect of GII, Bcomp, and IQ on ESG-Bstability nexus. This result also supports hypotheses 1, 2, 3 and 4.

Table 7. Environmental pillar and bank stability results

VARIABLES	Lower GII regime	Upper GII regime	Difference ($\delta=\lambda-\beta$)	Lower Bcomp regime	Upper Bcomp regime	Difference ($\delta=\lambda-\beta$)	Lower IQ regime	Upper IQ regime	Difference ($\delta=\lambda-\beta$)
$Bstability_{t-1}$	-0.162*	-0.235***	0.073***	-0.454***	0.772***	1.226***	-0.073***	-0.324**	0.251*
	(0.092)	(0.085)	(0.007)	(0.034)	(0.081)	(0.047)	(0.002)	(0.157)	(0.155)
ESGE	-0.166**	0.129**	0.295***	-0.173***	0.295***	0.468***	-0.224*	0.246**	0.470***
	(0.081)	(0.056)	(0.025)	(0.056)	(0.017)	(0.039)	(0.124)	(0.108)	(0.016)
BS	-0.866***	0.914***	1.780***	0.122	0.963***	0.841*	0.125**	-0.130***	-0.255***
	(0.303)	(0.255)	(0.048)	(0.526)	(0.021)	(0.505)	(0.054)	(0.037)	(0.017)
Loans	0.198	-0.257*	0.455***	-0.202	-0.247***	0.045	0.360	-0.402	-0.762***
	(0.157)	(0.156)	(0.001)	(0.467)	(0.030)	(0.437)	(0.355)	(0.292)	(0.063)
Cost	0.121*	-0.999*	-1.120***	0.863***	-0.377	-1.240***	-0.201**	0.187**	0.388**
	(0.668)	(0.572)	(0.096)	(0.299)	(0.689)	(0.390)	(0.090)	(0.084)	(0.006)
Size	0.178	-0.142	0.320	-0.382***	0.229	0.611***	0.470	-0.804	1.274***
	(0.344)	(0.105)	(0.239)	(0.060)	(0.79)	(0.019)	(1.475)	(1.293)	(0.182)
GDP	0.444***	-0.361**	-0.805***	0.097	0.747*	0.650**	0.514	-0.653	-1.167***
	(0.166)	(0.179)	(0.013)	(0.200)	(0.433)	(0.233)	(0.603)	(0.546)	(0.057)
INF	-0.271**	0.152**	0.423***	-0.392***	0.951***	1.243***	0.208	-0.317*	-0.525***
	(0.121)	(0.076)	(0.045)	(0.136)	(0.240)	(0.004)	(0.226)	(0.190)	(0.036)
constant			-0.459***			-0.147***			0.901***
			(0.032)			(0.042)			(0.315)
Threshold value ($\hat{\gamma}$)	0.357***[0.220, 0.494]			0.367*** [0.358, 0.375]			0.250*** [0.232, 0.261]		
Percentage (%)	38%	62%		55%	45%		25%	75%	
Bootstrap (p-value)		0.000			0.000			0.000	
Observations			343			343			343
Number of banks			49			49			49

Notes: *** displays level of significance at 1%, 5%, and 10%. Values in bracket illustrate standard error.

Table 8. Social Pillar and bank stability results

VARIABLES	Lower GII regime	Upper GII regime	Difference ($\delta=\lambda-\beta$)	Lower Bcomp regime	Upper Bcomp regime	Difference ($\delta=\lambda-\beta$)	Lower IQ regime	Upper IQ regime	Difference ($\delta=\lambda-\beta$)
$Bstability_{t-1}$	-0.278***	0.144*	0.422***	-0.138***	0.142	0.280***	0.195***	-0.699***	-0.894***
	(0.084)	(0.078)	(0.006)	(0.026)	(0.022)	(0.004)	(0.021)	(0.219)	(0.198)
ESG	0.174*	-0.230***	-0.404***	-0.019***	0.024**	0.043***	-0.057***	0.093***	0.150***
	(0.092)	(0.057)	(0.035)	(0.004)	(0.010)	(0.001)	(0.017)	(0.018)	(0.001)
BS	-0.197**	0.153	0.350***	0.303***	-0.440	-0.743***	-0.306*	0.555***	0.861***
	(0.079)	(0.107)	(0.028)	(0.103)	(0.333)	(0.230)	(0.184)	(0.208)	(0.024)
Loans	-0.153	0.175	0.328***	-0.011	-0.154***	-0.165***	-0.243	0.246	0.489***
	(0.145)	(0.132)	(0.007)	(0.059)	(0.053)	(0.006)	(0.187)	(0.186)	(0.001)
Cost	0.570	-0.108**	-0.462***	-0.071	0.140***	0.211**	0.685***	-0.793***	1.478***
	(0.539)	(0.477)	(0.062)	(0.116)	(0.035)	(0.081)	(0.177)	(0.158)	(0.019)
Size	-0.321*	0.367***	0.688***	-0.134**	-0.634*	0.500***	-0.407**	0.284	0.691***
	(0.166)	(0.099)	(0.067)	(0.058)	(0.371)	(0.313)	(0.206)	(0.216)	(0.010)
GDP	0.404	-0.719***	1.123***	-0.011	0.123*	0.133***	-0.462***	0.418***	0.880***
	(0.303)	(0.168)	(0.135)	(0.021)	(0.064)	(0.043)	(0.099)	(0.084)	(0.015)
INF	-0.021	0.007	0.028	-0.002	-0.070***	-0.068***	-0.036	0.022	0.058***
	(0.075)	(0.171)	(0.096)	(0.011)	(0.018)	(0.007)	(0.031)	(0.038)	(0.007)
constant			-0.750***			0.172*			-0.660***
			(0.262)			(0.101)			(0.051)
Threshold value ($\hat{\gamma}$)	0.357*** [0.286, 0.488]			0.367*** [0.349, 0.384]			0.250*** [0.243, 0.324]		
Percentage (%)	38%	62%		55%	45%		25%	75%	
Bootstrap (p-value)		0.000			0.000			0.000	
Observations			343			343			343
Number of banks			49			49			49

Notes: *** displays level of significance at 1%, 5%, and 10%. Values in bracket illustrate standard error.

Table 9. Governance Pillar and bank stability results

VARIABLES	Lower GII regime	Upper GII regime	Difference ($\delta=\lambda-\beta$)	Lower Bcomp regime	Upper Bcomp regime	Difference ($\delta=\lambda-\beta$)	Lower IQ regime	Upper IQ regime	Difference ($\delta=\lambda-\beta$)
$Bstability_{t-1}$	0.231	-0.695***	-0.926***	-0.153***	0.398***	0.551***	-0.577***	-0.071	0.506***
	(0.208)	(0.166)	(0.042)	(0.038)	(0.027)	(0.009)	(0.123)	(0.166)	(0.043)
ESG	-0.039***	0.054***	0.093***	0.012***	-0.025**	-0.037***	-0.056***	0.093***	0.149***
	(0.013)	(0.011)	(0.002)	(0.003)	(0.012)	(0.009)	(0.003)	(0.019)	(0.016)
BS	0.278	0.283	0.005	0.518**	0.236***	-0.282*	-0.267**	0.197**	0.464***
	(0.631)	(0.603)	(0.028)	(0.263)	(0.082)	(0.181)	(0.108)	(0.093)	(0.015)
Loans	-0.003	-0.009	-0.006**	-0.015	-0.370***	-0.355***	-0.153***	0.156***	0.309***
	(0.012)	(0.015)	(0.003)	(0.047)	(0.062)	(0.015)	(0.055)	(0.034)	(0.021)
Cost	0.448	-0.380	0.828***	-0.578	0.551***	1.129***	0.871**	-0.820***	1.691***
	(1.847)	(1.863)	(0.018)	(0.046)	(0.055)	(0.009)	(0.036)	(0.023)	(0.022)
Size	0.129	-0.936***	1.065***	-0.208***	0.201	0.409***	-0.390	0.327	0.717***
	(0.345)	(0.290)	(0.055)	(0.048)	(0.031)	(0.017)	(0.278)	(0.270)	(0.008)
GDP	-0.167***	0.241***	0.408***	-0.023**	0.062***	0.085***	-0.099	0.113	0.212***
	(0.063)	(0.052)	(0.011)	(0.011)	(0.007)	(0.004)	(0.083)	(0.081)	(0.002)
INF	-0.018	0.002	0.020*	0.021***	0.002	-0.019	-0.068**	0.050	0.118***
	(0.022)	(0.032)	(0.011)	(0.007)	(0.021)	(0.014)	(0.028)	(0.035)	(0.007)
constant			0.184***			-0.404***			0.130**
			(0.059)			(0.065)			(0.079)
Threshold value ($\hat{\gamma}$)	0.320*** [0.231, 0.408]			0.367*** [0.361, 0.373]			0.250*** [0.173, 0.287]		
Percentage (%)	35%	65%		55%	45%		25%	75%	
Bootstrap (p-value)		0.000			0.000			0.000	
Observations			343			343			343
Number of banks			49			49			49

Notes: *** displays level of significance at 1%, 5%, and 10%. Values in bracket illustrate standard error.

4.3.3. Alternative transition variables

The third test is changing the transition variable utilizing three alternative measures for transition variables: (i) R&D expenditure (%GDP) (R&D) for GII; (II) adjusted Lerner (ALER) for Bcomp, and average IQ (AIQ) for IQ. The outcomes (Table 10) are like those obtained from the main outcomes (Table 5), displaying that there is a threshold effect of R&D, ALER, and AIQ on ESG-Bstability nexus. This result also supports hypotheses 1, 2, 3 and 4.

Table 10. Changing in transition variables

VARIABLES	Lower R&D regime	Upper R&D regime	Difference ($\delta=\lambda-\beta$)	Lower ALER regime	Upper ALER regime	Difference ($\delta=\lambda-\beta$)	Lower AIQ regime	Upper AIQ regime	Difference ($\delta=\lambda-\beta$)
$Bstability_{t-1}$	-0.651***	0.510***	1.161***	-0.803***	0.606***	1.409***	0.098***	-0.326***	0.424***
	(0.093)	(0.049)	(0.044)	(0.175)	(0.154)	(0.021)	(0.023)	(0.011)	(0.012)
ESG	-0.354***	0.356***	0.710***	-0.111***	0.110***	0.221***	-0.023***	0.031***	-0.054***
	(0.119)	(0.135)	(0.001)	(0.027)	(0.022)	(0.008)	(0.001)	(0.008)	(0.007)
BS	0.268	-0.497	0.765***	0.503***	-0.455***	0.958***	0.109***	0.608*	0.499
	(0.698)	(0.898)	(0.200)	(0.194)	(0.191)	(0.003)	(0.039)	(0.362)	(0.323)
Loans	-0.109***	0.022	-0.121***	0.202	-0.379*	-0.581***	-0.029***	0.001	0.030***
	(0.033)	(0.028)	(0.005)	(0.214)	(0.202)	(0.012)	(0.007)	(0.008)	(0.001)
Cost	0.308**	0.318	0.626	0.662	0.649	-0.013	-0.131**	-0.378	0.509
	(0.147)	(0.381)	(0.234)	(0.815)	(0.857)	(0.042)	(0.059)	(0.471)	(0.402)
Size	-0.533	-0.177**	-0.356	0.096***	-0.108***	-0.204***	-0.296	-0.335**	-0.039
	(0.627)	(0.089)	(0.538)	(0.031)	(0.024)	(0.007)	(0.250)	(0.139)	(0.111)
GDP	-0.117	0.192	0.309***	0.209***	-0.199***	-0.408***	0.084	-0.094***	-0.178***
	(0.211)	(0.260)	(0.049)	(0.051)	(0.041)	(0.010)	(0.073)	(0.033)	(0.040)
INF	-0.136	0.230	0.366***	-0.563**	0.587**	1.150***	0.189***	-0.080*	0.269***
	(0.108)	(0.178)	(0.070)	(0.259)	(0.256)	(0.003)	(0.033)	(0.046)	(0.013)
constant			0.414*			0.241***			0.507***
			(0.213)			(0.058)			(0.056)
Threshold value ($\hat{\gamma}$)	0.167*** [0.142, 0.195]			0.313*** [0.237, 0.388]			0.458*** [0.396, 0.472]		
Percentage (%)									
Bootstrap (p-value)		0.000			0.000			0.000	
Observations			343			343			343
Number of banks			49			49			49

Notes: *** displays level of significance at 1%, 5%, and 10%. Values in bracket illustrate standard error.

4.3.4. Alternative econometric techniques

The study further tests the robustness of the main results by applying two alternative econometric approaches: (i) Static Panel Threshold Regression (PTR) by Seo and Shin (2016), and (ii) Dynamic PTR with a kink. The results (Tables 11-12) are like those obtained from the main results (Table 5), displaying that there is a threshold effect of GII, Bcomp, and IQ on ESG-Bstability nexus. This result also supports hypotheses 1, 2, 3 and 4.

Table 11. Static PTR model outcomes

VARIABLES	Lower GII regime	Upper GII regime	Difference ($\delta=\lambda-\beta$)	Lower Bcomp regime	Upper Bcomp regime	Difference ($\delta=\lambda-\beta$)	Lower IQ regime	Upper IQ regime	Difference ($\delta=\lambda-\beta$)
ESG	-0.068***	0.081***	0.149***	0.062***	-0.102	-0.164	-0.053***	0.043***	0.096***
	(0.019)	(0.011)	(0.008)	(0.014)	(0.157)	(0.143)	(0.015)	(0.013)	(0.002)
BS	0.127***	0.179	0.306***	0.149*	0.128**	-0.021	0.156	-0.092	-0.248***
	(0.009)	(0.011)	(0.002)	(0.086)	(0.065)	(0.021)	(0.125)	(0.119)	(0.006)
Loans	0.044***	-0.091**	-0.135***	-0.102**	-0.398**	-0.296	0.988***	-0.106***	-1.094***
	(0.005)	(0.035)	(0.030)	(0.040)	(0.181)	(0.141)	(0.018)	(0.017)	(0.001)
Cost	-0.238***	0.217***	0.445***	0.150	-0.239	-0.359**	-0.889**	0.945**	1.834***
	(0.024)	(0.023)	(0.001)	(0.206)	(0.308)	(0.102)	(0.404)	(0.405)	(0.001)
Size	0.623***	-0.133***	-0.736***	-0.195***	0.238	0.433*	0.980**	-0.134***	-1.114***
	(0.041)	(0.022)	(0.019)	(0.023)	(0.304)	(0.281)	(0.041)	(0.037)	(0.004)
GDP	0.161***	-0.136**	-0.297***	0.076**	0.133***	0.057***	0.369***	-0.376***	0.745***
	(0.054)	(0.053)	(0.001)	(0.038)	(0.034)	(0.004)	(0.059)	(0.060)	(0.001)
INF	-0.007	-0.200***	-0.207***	-0.063***	-0.071	-0.009	0.082***	-0.086***	-0.168***
	(0.010)	(0.019)	(0.009)	(0.016)	(0.088)	(0.072)	(0.027)	(0.022)	(0.005)
constant						-0.443***			-0.169**
						(0.066)			(0.083)
Threshold value ($\hat{\gamma}$)	0.320*** [0.203, 0.436]			0.378*** [0.361, 0.415]			0.250*** [0.203, 0.297]		
Percentage (%)	35%	65%		58%	42%		25%	75%	
Bootstrap (p-value)		0.000			0.000			0.000	
Observations			343			343			343
Number of banks			49			49			49

Notes: *** displays level of significance at 1%, 5%, and 10%. Values in bracket illustrate standard error.

Table 12. DPTR model with a kink

VARIABLES	GII	Bcomp	IQ
$Bstability_{t-1}$	-0.309***	-0.252***	-0.334***
	(0.012)	(0.009)	(0.011)
ESG	0.075***	0.038***	0.038***
	(0.011)	(0.007)	(0.012)
BS	0.131***	0.406	0.220***
	(0.043)	(0.260)	(0.036)
Loans	-0.124***	-0.019***	-0.120***
	(0.009)	(0.006)	(0.007)
Cost	1.393	0.445	0.104***
	(0.915)	(0.428)	(0.006)
Size	-0.019	-0.942***	-0.073
	(0.174)	(0.160)	(0.215)
GDP	-0.216***	-0.005	-0.321***
	(0.057)	(0.029)	(0.060)
INF	0.073***	-0.072***	-0.006
	(0.016)	(0.014)	(0.015)
Threshold value ($\hat{\gamma}$)	0.357***	0.377***	0.250***
	[0.203, 0.436]	[0.319, 0.429]	[0.142, 0.257]
kink_slope	-644.731***	145.180***	253.531***
	(147.855)	(17.804)	(39.198)
Bootstrap (p-value)	0.000	0.000	0.000
Observations	343	343	343
Number of banks	49	49	49

Notes: *** displays level of significance at 1%, 5%, and 10%. Values in bracket illustrate standard error.

5. Conclusion and implications

5.1. Conclusion

This study set out to explore whether and how sustainable performance affects banking stability under varying conditions of GII, Bcomp, and IQ, using a sample of 49 banks across five GCC countries between 2017 and 2023. Supporting the agency and stakeholder theories, we employed a Dynamic Panel Threshold Regression (DPTR) model to capture nonlinear dealings and threshold effects of GII, Bcomp, and IQ. The outcomes reveal a statistically significant green innovation threshold at 0.334 (33.4%), below which ESG exerts a negative effect on bank stability. Above this threshold, it begins to improve bank stability. In addition, the results show that there is a threshold effect of bank competition on this nexus. The threshold value estimated at 0.360, beyond which (low competition) ESG weakens bank stability. Finally, the outcomes indicate the existence of a threshold effect (estimated at 0.250) of institutional quality. More precisely, in case of high institutional quality (beyond the 0.250), ESG performance enhances the GCC bank stability.

5.2. Implications

As for the results of the threshold effect of GII and ESG-Bstability, they provide several policy implications. To achieve the maximum possible benefits from green innovation, policy makers can come up with a strategy that will enable banks to go beyond this critical threshold through comprehensive and large-scale initiatives rather than fragmented actions. For example, small symbolic measures like going paperless may increase compliance costs without increasing ESG resilience, while huge investments in renewable energy financing or green infrastructure would increase stability as well as attract socially responsible investors. The government should provide targeted incentives such as tax breaks or preferential funding for banks that are willing to undertake large-scale green projects in line with ESG goals. Regulatory frameworks will also need to ensure credible ESG reporting by mandating transparent disclosure of information on how companies are integrating green innovation into their risk management practices so as not to fall prey to greenwashing. Finally, coordination among the GCC countries at the regional level can help harmonize sustainability standards and thus create an environment of competition whereby innovation in the green sector is taken up strategically for enhanced financial stability and growth over the long term.

The threshold effect in the bank competition and ESG-bank stability nexus for GCC countries denotes that competition below and above the threshold value of 0.342 has a consistent positive effect. This implies that competitive banking environments can serve as a catalyst for sustainability. Hence, policymakers may seek to promote fair and healthy competition through regulatory measures aimed at preventing excessive market concentration and encouraging entry by ESG-oriented financial institutions. For instance, deregulating access to fintech and green finance players may spur innovation and compel traditional banks to adopt ESG practices if they are to maintain their competitive edge. Regulators also need to ensure transparency in pricing and lending practices to avoid anti-competitive behaviors that would undermine trust and ESG objectives. Incentive schemes like preferential licensing for banks offering sustainable products will further reinforce this trend. Finally, regional coordination among GCC countries toward harmonizing competition laws with ESG standards would create a *level playing field* where competition is not only about profitability but also about long-term financial stability as well as responsible banking. In this case, GCC policymakers can implement a strict competition policy, ensuring a *level playing field* among banks.

Finally, the threshold effect in the relationship between institutional quality and ESG-bank stability in GCC countries indicates that institutional quality below 0.25 is detrimental to stability while values above this level are beneficial. This finding should be very useful to

policymakers since it makes very clear what is necessary to achieve ESG resilience. They can improve governance frameworks by creating laws that are transparent and by having common standards for compliance with ESG. Improving the rule of law and anti-corruption will help build investor confidence and reduce reputational risks. For instance, mandatory ESG reporting with independent audits as per UAE implementation should be the benchmark for other GCC countries. Also, institutional capacity investment through specialized training for regulators on ESG risk assessment will ensure effective monitoring and enforcement. Incentive mechanisms like tax benefits or preferential lending conditions for banks that meet the ESG benchmarks can help speed up adoption. Lastly, harmonization of regional ESG standards across all GCC countries will avoid regulatory fragmentation and promote a unified sustainability agenda. These measures turn institutional quality from just an element of compliance into a strategic driver of financial stability and competitiveness.

5.3. Limitations and future research

This study has some limitations that must be recognized, even as it sheds light on the threshold effects of green innovation, institutional quality, and bank competition in relation to ESG-bank stability within GCC countries. First, it should be noted that secondary data were used for the analysis from WDI and other sources, thus this may not fully capture qualitative aspects regarding the practices of ESG or dynamics regarding institutions. Second, since this study is limited only to specific countries within the GCC region, therefore, findings cannot be generalized for other regions with different regulatory and cultural contexts. Thirdly, measurements related to stability could be improved by more details such as exposure to climate risks or metrics related to social impacts—currently these are not available in the dataset used herein. Lastly, institutional quality and ESG performance may be endogenous; however, it was controlled by some econometric techniques—not completely ruling out residual bias.

Future research can broaden this study by looking at comparisons between countries outside the GCC to see if similar threshold effects are present in emerging or developed markets. Firm-level data combined with qualitative case studies would give better insights into how the mechanisms driving ESG resilience work. Researchers may also want to consider digital transformation and fintech innovation as mediating factors that play a role in green innovation and bank stability. Finally, an examination of the interaction between ESG regulations and market competition under different institutional settings could lead to a more comprehensive understanding of sustainability within the banking sector.

Appendixes

Table A1. Lerner index across countries

Year	Kuwait	Oman	Qatar	Saudia Arabia	UAE
2017	0.406	0.335	0.452	0.270	0.275
2018	0.407	0.332	0.457	0.273	0.328
2019	0.408	0.331	0.461	0.277	0.334
2020	0.406	0.321	0.462	0.292	0.359
2021	0.410	0.320	0.462	0.315	0.364
2022	0.411	0.319	0.483	0.346	0.361
2023	0.406	0.335	0.452	0.270	0.275
Mean	0.408	0.327	0.461	0.292	0.328

Table A2. Translog cost function results using panel stochastic frontier model regression

Variables	lncost
ln(q)	-0.428*
	(0.130)
1/2 ln(q^2)	0.151***
	(0.0419)
ln(W_1)	0.419***
	(0.023)
ln(W_2)	-0.225
	(0.205)
ln(W_3)	0.421***
	(0.073)
ln(q) × ln(W_1)	-0.152**
	(0.048)
ln(q) × ln(W_2)	-0.024
	(0.032)
ln(q) × ln(W_3)	-0.054
	(0.029)
ln(W_1) × ln(W_2)	0.039
	(0.031)
ln(W_1) × ln(W_3)	0.103
	(0.098)
ln(W_2) × ln(W_3)	-0.034
	(0.051)
1/2 ln(W_1^2)	0.672**
	(0.251)
1/2 ln(W_2^2)	-0.014
	(0.017)
1/2 ln(W_3^2)	0.458**
	(0.236)
Constant	0.268***
	(0.017)
Observations	343

Number of banks	49

Notes: *** displays level of significance at 1%, 5%, and 10%. Values in bracket illustrate standard error.

Table A3. Results PCA and Applicability tests

Panel A: PCA outcomes				
Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	4.12744	2.64415	0.6879	0.6879
Comp2	1.48329	1.23001	0.2472	0.9351
Comp3	.253282	.175983	0.0422	0.9773
Comp4	.0772989	.0403994	0.0129	0.9902
Comp5	.0368994	.015107	0.0061	0.9964
Comp6	.0217924	.	0.0036	1.0000
Panel B: Applicability tests				
	Bartlett Sphericity Test			KMO
	Chi-square	Degrees of freedom	p-value	
	288.203	15	0.000	0.656

References

Acheampong, A.O., Said, R., 2024. Financial inclusion and the global net-zero emissions agenda: Does governance quality matter? Energy Economics 137, 107785.

Alghafes, R., Karim, S., Aliani, K., Qureishi, N., Alkayed, L., 2024. Influence of key ESG factors on Islamic banks' financial performance: Evidence from GCC countries. International Review of Economics & Finance 96, 103629.

Anginer, D., Demirguc-Kunt, A., & Zhu, M. (2014). How does deposit insurance affect bank risk? Evidence from the recent crisis. *Journal of Banking & Finance*, *48*, 312–321.

Antwi, F., Kong, Y., Gyimah, K.N., 2024. Financial inclusion, competition and financial stability: New evidence from developing economies. Heliyon 10.

Arnone, M., Leogrande, A., Costantiello, A., Laureti, L., 2024. Banking Stability in the ESG Framework Across Italian Regions.

Barnea, A., Rubin, A., 2010. Corporate Social Responsibility as a Conflict Between Shareholders. J Bus Ethics 97, 71–86.

Bebbington, J., Kirk, E. A., & Larrinaga, C. (2012). The production of normativity: A comparison of reporting regimes in Spain and the UK. *Accounting, Organizations and Society*, *37*(2), 78–94.

Beck, T. (2013). Bank Financing for SMEs – Lessons from the Literature. *National Institute Economic Review*, *225*, R23–R38. https://doi.org/10.1177/002795011322500105

Bermpei, T., Kalyvas, A., & Nguyen, T. C. (2018). Does institutional quality condition the effect of bank regulations and supervision on bank stability? Evidence from emerging and developing economies. *International Review of Financial Analysis*, *59*, 255–275.

Bhatter, H.K., Chhatoi, B.P., 2023. Financial inclusion and financial performance: evaluating the moderating effect of mandatory corporate social responsibility. JFEP 15, 208–225.

Boyd, J. H., & De Nicoló, G. (2005). The Theory of Bank Risk Taking and Competition Revisited. *The Journal of Finance*, *60*(3), 1329–1343. https://doi.org/10.1111/j.1540-6261.2005.00763.x

Bruno, E., Iacoviello, G., Giannetti, C., 2024. Bank credit loss and ESG performance. Finance Research Letters 59, 104719.

Cantero-Saiz, M., Polizzi, S., Scannella, E., 2024. ESG and asset quality in the banking industry: The moderating role of financial performance. Research in International Business and Finance 69, 102221.

Cao, Q., Zhu, T., Yu, W., 2024. ESG investment and bank efficiency: Evidence from China. Energy Economics 133, 107516.

Carletti, E., Hartmann, P., & Spagnolo, G. (2002). Implications of the bank merger wave for competition and stability. *Risk Measurement and Systemic Risk, Proceedings of the Third Joint Central Bank Research Conference*, 38–50. https://www.bri.org/cgfs/conf/mar02.pdf#page=44

Chen, Q., & Shen, C. (2024). How FinTech Affects Bank Systemic Risk: Evidence from China. *Journal of Financial Services Research*, *65*(1), 77–101. https://doi.org/10.1007/s10693-023-00421-7

Chiaramonte, L., Dreassi, A., Girardone, C., Piserà, S., 2022. Do ESG strategies enhance bank stability during financial turmoil? Evidence from Europe. The European Journal of Finance 28, 1173–1211.

Choi, S.Y., Ryu, D., You, W., 2024. ESG activities and financial stability: The case of Korean financial firms. Borsa Istanbul Review.

Claudio, L., & Gallo, S. (2025). An empirical analysis of how national culture influences banks' sustainability via ESG criteria. *Culture and Organization*, *31*(5), 375–400. https://doi.org/10.1080/14759551.2024.2443422

Cornell, B., Shapiro, A.C., 2021. Corporate stakeholders, corporate valuation and ESG. Euro Fin Management 27, 196–207.

Curcio, D., Gianfrancesco, I., Onorato, G., Vioto, D., 2024. Do ESG scores affect financial systemic risk? Evidence from European banks and insurers. Research in International Business and Finance 69, 102251.

Di Tommaso, C., & Thornton, J. (2020). Do ESG scores effect bank risk taking and value? Evidence from European banks. *Corporate Social Responsibility and Environmental Management*, *27*(5), 2286–2298. https://doi.org/10.1002/csr.1964

Dimaggio, P.J., Powell, W.W., 2004. The New Economic Sociology Chapter 4 The iron cage revisited: institutional isomorphism and collective rationality in organizational fields. In: Dobbin, F. (Ed.), A Reader.

Donaldson, T., Preston, L.E., 1995. The Stakeholder Theory of the Corporation: Concepts, Evidence, and Implications. The Academy of Management Review 20, 65.

Dumitru, I., & Dumitru, I. (2017). ENTREPRENEURSHIP DETERMINANTS IN CENTRAL AND EASTERN EUROPE. THE CASE OF ROMANIA. *Economic Computation & Economic Cybernetics Studies & Research*, *51*(1).

Dutta, K. D., & Saha, M. (2021). Do competition and efficiency lead to bank stability? Evidence from Bangladesh. *Future Business Journal*, *7*(1), 6. https://doi.org/10.1186/s43093-020-00047-4

Erhemjamts, O., Huang, K., Tehranian, H., 2024. Climate risk, ESG performance, and ESG sentiment in US commercial banks. Global Finance Journal 59, 100924.

Fang, Y., Hasan, I., & Marton, K. (2014). Institutional development and bank stability: Evidence from transition countries. *Journal of Banking & Finance*, *39*, 160–176.

Freeman, R. E. (1984). Strategic Management: A Stakeholder Approach. Boston : Pitman.

Friedman, M., 1970a. Social Responsibility of Business, the New York Times Magazine. September 13, 122–26.

Friedman, M., 1970b. Social Responsibility of Business, the New York Times Magazine. September 13, 122–26.

García-Sánchez, I.-M., Cuadrado-Ballesteros, B., & Frias-Aceituno, J.-V. (2016). Impact of the institutional macro context on the voluntary disclosure of CSR information. *Long Range Planning*, *49*(1), 15–35.

Gehrig, T., Iannino, M. C., & Unger, S. (2024). Social responsibility and bank resiliency. *Journal of Financial Stability*, *70*, 101191.

Ghosh, S., 2022. Financial inclusion and banking stability: Does interest rate repression matter? Finance Research Letters 50, 103205.

Gold, K. L., & Tregenna, F. (2025). Financial development, green innovation, green tax, industrialisation, and environmental performance in South Africa: The mediating role of institutions. *Journal of Environmental Management*, *393*, 126942.

González, L. O., Razia, A., Búa, M. V., & Sestayo, R. L. (2017). Competition, concentration and risk taking in Banking sector of MENA countries. *Research in International Business and Finance*, *42*, 591–604.

Gupta, J., Kashiramka, S., 2024. Examining the impact of liquidity creation on bank stability in the Asia Pacific region: Do ESG disclosures play a moderating role? Journal of International Financial Markets, Institutions and Money 91, 101955.

Hellmann, T. F., Murdock, K. C., & Stiglitz, J. E. (2000). Liberalization, moral hazard in banking, and prudential regulation: Are capital requirements enough? *American Economic Review*, *91*(1), 147–165.

Hofstede, G. (1984). *Culture's consequences: International differences in work-related values* (Vol. 5). sage.

Hua, X., Bi, J., Shi, H., 2023. The appropriate level of financial inclusion: The perspective of financial stability. China Economic Quarterly International 3, 167–178.

Jensen, M.C., 1986. Agency costs of free cash flow, corporate finance and takeovers. American Economic Review.

Jensen, M.C., Meckling, W.H., 1979. Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure, in: Brunner, K. (Ed.), Economics Social Institutions, Rochester Studies in Economics and Policy Issues. Springer Netherlands, Dordrecht, pp. 163–231.

Jiang, K., Zhang, J., Zhou, M., & Chen, Z. (2025). ESG disagreement and corporate debt maturity: Evidence from China. *Financial Innovation*, *11*(1), 32. https://doi.org/10.1186/s40854-024-00724-1

Jones, T.M., 1995. Instrumental Stakeholder Theory: A Synthesis of Ethics and Economics. The Academy of Management Review 20, 404.

Keeley, M. C. (1990). Deposit insurance, risk, and market power in banking. *The American Economic Review*, 1183–1200.

Khalid, F., Irfan, M. and Srivastava, M. (2024), "The impact of digital inclusive finance on ESG disputes: Evidence from Chinese non-financial listed companies", *Technological Forecasting and Social Change*, Elsevier, Vol. 204, p. 123415.

Khémiri, W., Alsulami, F., 2023. Corporate social responsibility disclosure and Islamic bank stability in GCC countries: Do governance practices matter? Cogent Business & Management 10, 2260559.

Khémiri, W., Chafai, A., & Alsulami, F. (2023). Financial Inclusion and Sustainable Growth in North African Firms: A Dynamic-Panel-Threshold Approach. *Risks*, *11*(7), Article 7.

Khémiri, W., Chafai, A., Attia, E.F., Tobar, R., Farid Fouad, H., 2024. Trade-off between financial inclusion and Islamic bank stability in five GCC countries: the moderating effect of CSR. Cogent Business & Management 11, 2300524.

Kurniawati, A.D., Purwaningsih, A., 2024. The Impact of Financial Stability and Audit Firm Affiliation on the Level of Disclosure of Sustainable Green Banking. Media Ekonomi dan Manajemen 39, 419–432.

Li, W., Shi, C., Xiao, Z. and Zhang, X. (2024), "Bridging the Green Gap: How Digital Financial Inclusion Affects Corporate ESG Greenwashing", *Finance Research Letters*, Elsevier, p. 106018.

Liaqat, I., Floerani, J., & Naseer, M. M. (2025). ESG Performance and Bank stability: The Role of National Culture and Formal Institutions. *Research in International Business and Finance*, 103214.

Lind, J.T., Mehlum, H., 2010. With or Without U? The Appropriate Test for a U-Shaped Relationship*: Practitioners' Corner. Oxford Bulletin of Economics and Statistics 72, 109–118.

Liu, J., & Xie, J. (2024). The effect of ESG performance on bank liquidity risk. *Sustainability*, *16*(12), 4927.

Lu, H. and Cheng, Z. (2024), "Digital inclusive finance and corporate ESG performance: The moderating role of executives with financial backgrounds", *Finance Research Letters*, Elsevier, Vol. 60, p. 104858.

Luh, P. K., Arthur, M., Fiador, V., & Kusi, B. A. A. (2024). Gender of firm leadership and environmental, social and governance (ESG) reporting: Evidence from banks listed on Ghana Stock Exchange. *Gender in Management: An International Journal*, *39*(6), 778–795.

Mallek, R.S., Albaity, M., Ur-Rehman, I., Thangavelu, S., 2024. The puzzle of convex/concave ESG returns and large banks in MENA region countries. Borsa Istanbul Review 24, 618–633.

Moudud-Ul-Huq, S. (2021). Does bank competition matter for performance and risk-taking? Empirical evidence from BRICS countries. *International Journal of Emerging Markets*, *16*(3), 409–447.

Nchofoung, T. N., Edoh, O. M., & Monkam, N. (2024). Green finance, green innovation, and industrial development in Africa. *Energy Reports*, *12*, 2801–2811.

Nicolò, G., Zanellato, G., Esposito, B., & Tiron-Tudor, A. (2024). Cultural dimensions and sustainability disclosure in the banking sector: Insights from a qualitative comparative analysis approach. *Business Strategy and the Environment*, *33*(8), 8086–8101. https://doi.org/10.1002/bse.3911

Nkoa, B. E., & Song, J. S. (2020). Does institutional quality affect financial inclusion in Africa? A panel data analysis. *Economic Systems*, *44*(4), 100836.

North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge university press.

Oanh, T.T.K., Dinh, L.Q., 2024. Digital financial inclusion, financial stability, and sustainable development: Evidence from a quantile-on-quantile regression and wavelet coherence. Sustainable Development 32, 6324–6338.

Peng, L.S., Isa, M., 2020. Environmental, social and governance (ESG) practices and performance in Shariah firms: agency or stakeholder theory? Asian Academy of Management Journal of Accounting & Finance 16.

Pizzi, S., Principale, S., Fasiello, R., & Imperiale, F. (2023). The institutionalisation of social and environmental accounting practices in Europe. *Journal of Applied Accounting Research*, *24*(5), 816–838. https://doi.org/10.1108/JAAR-07-2022-0190

Posadas, S. C., Ruiz-Blanco, S., Fernandez-Feijoo, B., & Tarquinio, L. (2023a). Institutional isomorphism under the test of Non-financial Reporting Directive. Evidence from Italy and Spain. *Meditari Accountancy Research*, *31*(7), 26–48.

Posadas, S. C., Ruiz-Blanco, S., Fernandez-Feijoo, B., & Tarquinio, L. (2023b). Institutional isomorphism under the test of Non-financial Reporting Directive. Evidence from Italy and Spain. *Meditari Accountancy Research*, *31*(7), 26–48.

Saadaoui, A., Ben Salah, O., 2023. The moderating effect of financial stability on the CSR and bank performance. EuroMed Journal of Business 18, 621–642.

Salah, H., & Chafai, A. (2022). Monetary policy market power and Risk Shifting does bailout matter in Tunisian banking sector.pdf. World Bank Publications. https://thedocs.worldbank.org/en/doc/ff41970598964fdbedb7cf627d9be94c-0280032021/monetary-policy-market-power-and-risk-shifting-does-bailout-matter-in-tunisian-banking-sector-pdf?fbclid=IwAR0N3R-NRA8b-NXHvJSmo6MYePJBq_hi5mqDcO_Q2QrOmynDsyTPDV29o3I

Saif-Alyousfi, A.Y., Saha, A., Alshammari, T.R., 2023. Bank diversification and ESG activities: A global perspective. Economic Systems 47, 101094.

Sang, Y., Xie, M., Bai, X. and Guo, F. (2024), "Does natural resource dependence influence the impact of financial technologies on corporate ESG and digital governance in China's listed enterprises?", *Resources Policy*, Elsevier, Vol. 91, p. 104948.

Sari, T. K., Cahaya, F. R., & Joseph, C. (2021). Coercive pressures and anti-corruption reporting: The case of ASEAN countries. *Journal of Business Ethics*, 495–511.

Scott, W. R. (2008). *Institutions and organizations: Ideas and interests*. Sage Publications.

Setianto, R. H., Azman-Saini, W. N. W., Law, S. H., Ahmad, A. H., & Daud, S. N. M. (2025a). Does financial inclusion affect bank market power? International evidence. *Finance Research Letters*, 108302.

Setianto, R. H., Azman-Saini, W. N. W., Law, S. H., Ahmad, A. H., & Daud, S. N. M. (2025b). Does financial inclusion affect bank market power? International evidence. *Finance Research Letters*, 108302.

Shabir, M., Jiang, P., Bakhsh, S., & Zhao, Z. (2021). Economic policy uncertainty and bank stability: Threshold effect of institutional quality and competition. *Pacific-Basin Finance Journal*, *68*, 101610.

Shin, J., Moon, J. J., & Kang, J. (2023). Where does ESG pay? The role of national culture in moderating the relationship between ESG performance and financial performance. *International Business Review*, *32*(3), 102071.

Soana, M.-G. (2011). The Relationship Between Corporate Social Performance and Corporate Financial Performance in the Banking Sector. *Journal of Business Ethics*, *104*(1), 133–148. https://doi.org/10.1007/s10551-011-0894-x

Suo, W., & Qiao, P. (2025). Patient capital, green innovation bubble, and corporate ESG performance. *Finance Research Letters*, 108803.

Uddin, A., Chowdhury, M. A. F., Sajib, S. D., & Masih, M. (2020). Revisiting the impact of institutional quality on post-GFC bank risk-taking: Evidence from emerging countries. *Emerging Markets Review*, *42*, 100659.

Van Duuren, T., De Haan, J., & Van Kerkhoff, H. (2020). Does institutional quality condition the impact of financial stability transparency on financial stability? *Applied Economics Letters*, *27*(20), 1635–1638. https://doi.org/10.1080/13504851.2019.1707762

Vives, X. (2016). *Competition and Stability in Banking: The Role of Regulation and Competition Policy*. Princeton University Press. https://doi.org/10.1515/9781400880904

Vuković, D.B., Hassan, M.K., Kwakye, B., Febtinugraini, A., Shakib, M., 2024. Does fintech matter for financial inclusion and financial stability in BRICS markets? Emerging Markets Review 61, 101164.

Wang, H., Jiao, S., Ma, C., 2024. The impact of ESG responsibility performance on corporate resilience. International Review of Economics & Finance 93, 1115–1129.

Wu, M., Shen, L., Wu, T., & Shao, Y. (2025). Does strategic cooperation between banks and fintech companies increase bank risk-taking? Evidence from China. *Applied Economics*, 1–16. https://doi.org/10.1080/00036846.2025.2536881

Xing, T., Li, X., Feng, N., 2024. Is bank competition conducive to corporate ESG performance? International Review of Financial Analysis 95, 103509.

Xing, X., Ouyang, W., Deng, J., & Lin, Z. (2025). The Impact of Climate Change Factors on Financial Markets: Evidence from China. *Emerging Markets Finance and Trade*, *61*(4), 858–874. https://doi.org/10.1080/1540496X.2024.2399540

Xu, L., Lu, X., Zhang, Z., & Shu, H. (2025). Green Innovation, Financialization, and ESG Performance. *International Review of Economics & Finance*, 104404.

Yu, L., & Jin, P. (2026). Green innovation under multiple pressures: Examining financial constraints, ESG performance, and environmental regulations. *Journal of Innovation & Knowledge*, *12*, 100876.