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Green Finance's Impact on Economic Resilience – The Moderating Role of Market Integration

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Abstract

This study examines whether and how green finance enhances economic resilience in emerging economies and evaluates the moderating role of market integration in this relationship. Using the System Generalized Method of Moments (SGMM) estimation to address issues of endogeneity and lagged dependent variables, the empirical results indicate that green finance exerts a positive and statistically significant influence on economic resilience. Furthermore, a high level of market integration enhances the effectiveness of green finance in strengthening a country's ability to withstand and recover from economic, social, and environmental shocks. Based on these findings, the study recommends that emerging economies promote the development of green finance by establishing clear policy frameworks, advancing sustainable financial instruments, and encouraging the flow of green capital into the real economy. Simultaneously, efforts should be made to deepen market integration through trade liberalization, regional financial cooperation, and improvements in the investment climate, to fully leverage the spillover benefits of globalization and reinforce the foundation for economic recovery amid increasing global uncertainties.

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Introduction

Recent years have witnessed an increasing frequency of economic, environmental, and geopolitical shocks, making economic resilience a central policy priority for emerging and advanced economies alike. At the same time, the global expansion of green finance instruments such as green bonds, sustainable lending, and low-carbon investment initiatives continues to reshape financial systems and development strategies. Existing studies provide evidence that green finance contributes to sustainable growth, reduces transition risks, and supports environmental quality (Wang et al. 2022; Wei 2024). However, much less attention has been given to its role in strengthening economic resilience, especially within emerging markets where climate vulnerabilities, structural rigidities, and financial constraints are more pronounced.

While several strands of the literature examine the drivers of economic resilience, the interaction between green finance and market integration remains understudied. Market integration through trade openness, cross-border investment, and capital mobility can amplify positive spillovers from green finance by facilitating technology diffusion, deepening green capital flows, and enhancing access to external resources. Conversely, high integration may also expose economies to synchronized shocks and global volatility. Despite these theoretical ambiguities, empirical evidence explaining whether and how market integration moderates the resilience-enhancing role of green finance is still sparse.

Most existing studies also focus on advanced economies or regional case studies; few account for the dynamic nature of resilience or the potential endogeneity between green finance and macroeconomic outcomes. This creates two important research gaps: (i) limited empirical evidence on the interaction between green finance and market integration in shaping economic resilience within emerging markets; and (ii) insufficient use of econometric approaches capable of handling endogeneity and dynamic adjustment processes, which are inherent in resilience analysis.

The objectives of this study are twofold:

1. To examine the effect of green finance on economic resilience across 32 emerging economies from 2014 to 2023.
2. To assess the moderating role of market integration in this relationship.

To address dynamic endogeneity and country-specific heterogeneity, the study employs the System Generalized Method of Moments (SGMM) estimator (Arellano–Bover/Blundell–Bond). By doing so, the study contributes new empirical evidence on the joint role of green financial development and market integration in strengthening resilience in emerging markets – an area where current global discussions are still evolving.

The rest of the paper is organized as follows. Section 2 reviews the theoretical framework and empirical evidence. Section 3 presents the data and methodology. Section 4 discusses the empirical results, and Section 5 concludes with policy implications.

Theoretical framework and Literature review

Theoretical framework

To provide a theoretical foundation for analyzing the effects of green finance and market integration, as well as the moderating role of market integration on the relationship between green finance and economic resilience, this study is grounded in two key economic theories: (1) the theory of comparative advantage, which explains how economies can benefit from specialization and resource efficiency through openness and financial development; and (2) the real business cycle theory, which highlights the role of external shocks and structural factors such as green finance in shaping the dynamics of economic fluctuations and recovery.

First, the Real Business Cycle (RBC) theory developed by Kydland and Prescott (1982) posits that economic cycles are not primarily driven by fluctuations in aggregate demand or monetary policy. Instead, they represent natural responses of the economy to supply-side shocks, particularly changes in labor productivity, technological progress, and production conditions. According to this theory, shifts in technology, access to production resources, and external factors such as climate change or environmental policy adjustments can generate fluctuations in GDP, employment, and investment.

Empirical studies by Long Jr. and Plosser (1983) and Hansen (1999) have shown that the RBC model can partially explain economic volatility based on how firms and investors respond to such shocks. Applying the RBC theory to green finance, it becomes evident that investments in cleaning technology and sustainable development can play a crucial role in enhancing productivity and mitigating risks associated with economic shocks caused by environmental degradation. When supply-side shocks such as energy crises, natural disasters, or the depletion of natural resources impact the economy, a transition toward green production models and sustainable investments can help minimize adverse effects, sustain employment, and promote long-term economic growth. Recent studies by Yang, Zheng, and Wang (2023) and Wei (2024) reinforce this view by showing that green finance has a positive impact on maintaining economic stability and fostering sustainable development, especially amid global uncertainties. Similarly, Shen, Ma, and Chen (2024) argue that green finance initiatives not only drive sustainable growth but also enhance the economy's resilience against environmental challenges. Accordingly, this study proposes the following hypothesis:

Hypothesis 1: Green finance has a positive impact on economic resilience in emerging economies.

Second, the Comparative Advantage Theory, developed by David Ricardo in 1891, suggests that a country should focus on producing goods for which it has a lower opportunity cost compared to other nations, thereby optimizing international trade efficiency (Ricardo 2001). This theory argues that even when a country holds an absolute advantage in all industries, it can still benefit from trade by specializing in sectors where it holds a higher comparative advantage. The theory has been further reinforced and expanded by studies from Dornbusch, Fischer, and Samuelson (1977) and Krugman (1980), showing that comparative advantage is influenced not only by technology

and labor productivity but also by transportation costs, trade policies, and technological advancements. According to Ricardo, when countries expand trade and integrate into global markets, they can maximize their comparative advantages, optimize production structures, improve productivity, and increase exports. This not only fosters economic growth but also enables countries to recover more quickly from economic shocks. Participation in global value chains opens access to large markets, attracts investment, and provides momentum for sustainable recovery.

At the same time, the RBC theory shows that countries can adapt more effectively to economic shocks when they diversify resources, optimize supply chains, and enhance productivity. By integrating into global markets, nations can access technologies, capital, and human resources from other countries, thereby mitigating the adverse effects of shocks such as financial crises or climate change. Furthermore, RBC theory serves as a foundation for the expectation that market integration positively influences a country's economic resilience. Economic agents can better adapt to shocks by diversifying resources, improving productivity, and optimizing supply chains. As countries further integrate into global markets, they can leverage advanced technologies, capital, and human resources from abroad, helping reduce the negative impacts of economic shocks and accelerating the recovery process. Based on these arguments and previous studies, this thesis proposes the following hypothesis regarding the positive impact of market integration on the economic resilience of the countries in the sample:

Hypothesis 2: Market integration has a positive impact on the economic resilience of emerging economies.

Moreover, market integration is also considered a key factor in enhancing the relationship between green finance and economic resilience. As countries increasingly integrate into the global market, they not only leverage comparative advantages in production but also gain opportunities to exchange knowledge and experiences in developing green finance, particularly in sustainable sectors such as renewable energy, clean technology, and natural resource conservation.

According to the theory of comparative advantage, expanded market integration enables economies to access advanced technologies, capital, and human resources from other nations, thereby mitigating the negative effects of external shocks. In this context, green finance plays a pivotal role in promoting environmental protection initiatives and sustainable development, while simultaneously contributing to the construction of a resilient economic foundation. The synergy between green finance and market integration not only reduces environmental risks but also creates pathways for long-term development and rapid economic recovery. Wang et al. (2022) highlight that the interaction between green finance and market integration generates a synergistic effect that strengthens resilience to economic shocks and supports sustainable recovery. In addition, Wei (2024) emphasizes that market integration facilitates the transfer of green technology and expertise, allowing countries to effectively adopt advanced solutions that enhance economic resilience while addressing environmental challenges. Based on the theoretical and empirical foundations discussed above, this study hypothesizes that market integration positively moderates the relationship between green finance and economic resilience in emerging economies.

Hypothesis H3: Market integration positively moderates the relationship between green finance and economic resilience in emerging economies.

Literature review

Green Finance and Economic Resilience

The concept of economic resilience has been widely debated across economics, regional science, and development studies. Foundational reviews highlight that resilience encompasses absorption capacity, recovery speed, adaptive efficiency, and long-term transformative ability (Rose 2007; Bristow and Healy 2014). The measurement of resilience also remains contentious: while some studies use GDP volatility, others construct multidimensional indices that combine exposure, sensitivity, and adaptive capacity (Martin 2012). These differences imply that empirical results may vary depending on how resilience is operationalized.

Recent studies have clarified the role of green finance in promoting economic recovery and sustainable growth, particularly in the post-COVID-19 context and the transition toward a low-carbon economy. Overall, green finance is identified as an effective policy tool that helps direct capital flows into environmentally friendly sectors, enhances resource efficiency, and mitigates systemic risks through market-based mechanisms.

An important branch of the literature focuses on the relationship between green finance and economic resilience. Wei (2024) shows that green finance positively influences regional economic recovery in China, and this effect is amplified by market integration. Similarly, Tengfei and Ullah (2024) highlight the role of green finance especially green credit and tax incentives – in stabilizing energy prices and reducing reliance on fossil fuels, thereby supporting medium-term economic recovery. Additionally, Nenavath and Mishra (2023) and Zhang (2023) expand the analysis to South Asia and India, affirming that both green finance and financial technology (FinTech) promote sustainable growth by improving environmental performance and increasing access to green capital. Saydaliev and Chin (2023) show that a 1% increase in the green finance index leads to a 0.321% reduction in environmental pollution, thereby promoting sustainable economic recovery. In addition, the study highlights the role of green energy transition policies in improving environmental quality and proposes climate finance measures to ensure long-term growth.

Several studies investigate the specific mechanisms of green finance, such as green credit, green bonds, and green technology investment. Using a difference-in-differences (DID) approach, Li et al. (2024) find that green credit policies in China have encouraged high-pollution industries to boost green investments, thereby reducing emissions and improving resource efficiency. Guan and Zhao (2024) take a technological perspective, emphasizing that green financial investment in resource innovation can simultaneously ensure growth and environmental protection. Green bonds, in particular, are highlighted as key instruments during times of crisis: Fatica and Panzica (2024) find that investors were more likely to retain green bonds than conventional ones during the COVID crisis, helping reduce sell-off pressure and stabilize the market.

Similarly, Ning et al. (2023) underscore the role of green bonds and green banks in financing energy-efficient projects and supporting post-pandemic green recovery.

Some studies also examine supporting factors and interaction conditions that enhance the effectiveness of green finance. Tengfei and Ullah (2024) and Wei (2024) both argue that the success of green economic recovery depends on the level of market integration and the coordination of fiscal, monetary, and environmental policies. Ning et al. (2023) further analyze political, governance, technical, and market-related factors, suggesting that a transparent institutional environment and effective regulatory frameworks are prerequisites for scaling up the green finance market. In a global context, Wang et al. (2022) extend the analysis to the international level, emphasizing the importance of green investment, green FDI inflows, and technological innovation in fostering sustainable economic recovery and realizing the Sustainable Development Goals (SDGs).

In summary, the literature consistently agrees that green finance serves not only as a financial tool for post-crisis recovery but also as a long-term driver of sustainable growth. However, maximizing its impact requires careful policy design, effective cross-sectoral coordination, and broader access through financial technology.

Market Integration and Economic Resilience

Market integration is similarly multidimensional. Trade openness, cross-border investment flows, and capital account liberalization can increase diversification benefits and accelerate the diffusion of green technologies, potentially enhancing resilience. Several studies argue that integrated markets are more capable of reallocating resources efficiently during downturns (Eichengreen, Park, and Shin 2024). However, other scholars caution that highly integrated economies may be more exposed to external shocks, contagion, and synchronized crises (Rodrik 1998). Many studies find a mixed relationship between integration and resilience. While integration can enhance resilience by increasing flexibility, diversifying resources, and expanding access to capital/technology, it also opens additional channels of risk contagion when there is a global shock. Thus, the results depend on the nature of integration and national institutions (Eichengreen, Park, and Shin 2024).

Using the evaluation index developed by Zhou et al. (2023) for agricultural economic resilience and rural industrial integration, this paper employs panel data from 30 Chinese provinces (2000–2020) to examine the impact of rural industrial integration on agricultural economic resilience. Using panel data from 241 prefecture-level and above cities in China between 2010 and 2019, Feng, Lee, and Peng (2023) treat urban agglomeration planning as a quasi-natural experiment to assess the impact of regional integration on economic resilience through a difference-in-differences (DID) approach. The study finds strong evidence that regional integration significantly enhances economic resilience, with the results holding robust across multiple checks. Importantly, the effect of regional integration is not uniform; it varies across periods, regions, and urban structures, suggesting that the depth and form of integration play a crucial role in shaping the capacity of local economies to withstand and recover from external shocks.

Yang (2023) assessed the impact of market integration on economic growth from 2010 to 2019 in the Pearl River Delta urban cluster, which includes 27 cities in China. The study applied a threshold model and analyzed the non-linear relationship. Results showed that commodity market integration had a positive impact on economic recovery, while capital market integration had a negative initial impact but gradually decreased as the level of integration increased. Labor market integration had no significant impact, suggesting the need for additional measures to improve efficiency. In addition, the degree of economic openness and consumption promotion were identified as important factors in economic recovery. The study recommended investment in transport infrastructure and technology, optimization of inter-regional financial institutions, and strengthening of consumption support policies and economic openness to ensure sustainable recovery.

Lyu et al. (2023) evaluate the impact of market integration on economic growth in nine cities in the Pearl River Delta urban cluster, China, during the period 2010–2019. Through spatial autocorrelation analysis and spatial econometric models, including the Spatial Autoregressive Model (SAR), the Spatial Error Model (SEM), and the Spatial Durbin Model (SDM), the study measures the degree of market integration using indicators such as the relative price index, wage volatility, and the coefficient of variation. The SAR model captures spatial dependence in the dependent variable, the SEM model accounts for spatial correlation in the error term, while the SDM model incorporates spatial lags of both the dependent and independent variables to better reflect spatial spillover effects. The study shows that market integration has a negative impact on economic growth as well as regional economic recovery. However, this has a negligible impact on neighboring regions. The main reasons come from domestic trade barriers and local protectionism, which reduce the efficiency of resource allocation and hinder economic recovery.

Oprea and Stoica (2018) examine the impact of capital market integration on economic growth in 28 European Union (EU) countries from 2004 to 2016, using research methods such as the Autoregressive Distributed Lag (ARDL) model, Granger causality analysis, and Johansen cointegration. The results show that capital market integration has a positive impact on sustainable economic growth and recovery through increasing stock market capitalization, improving capital mobility, increasing transaction value, developing stock indexes, and encouraging foreign portfolio investment.

Lester and Nguyen (2016) indicate that a higher level of economic integration, measured by occupational diversity among immigrants across U.S. metropolitan areas, can contribute to enhanced regional economic resilience. The findings suggest that regions with more broadly distributed immigrant populations across occupations tended to maintain stronger real wage growth and better control of unemployment rates during the 2008–2010 economic crisis. This implies that deeper economic integration may serve as a reinforcing factor for economic resilience in the face of external shocks.

Research method

Model

Based on the research of Zhang (2023) and Wei (2024), to test the proposed hypotheses, we sequentially construct two models, specifically as follows:

Model 1 is used to test hypotheses 1 and 2:

$$\mathrm{ER}_{i,t} = \alpha_0 + \beta_0 \mathrm{ER}_{i,t-1} + \beta_1 \mathrm{GF}_{i,t} + \beta_2 \mathrm{MI}_{i,t} + \beta_3 X_{i,t} + \varepsilon_{i,t}. \tag{1}$$

Model 2 is used to test hypothesis 3:

$$\mathrm{ER}_{i,t} = \alpha_0 + \beta_0 \mathrm{ER}_{i,t-1} + \beta_1 \mathrm{GF}_{i,t} + \beta_2 \mathrm{MI}_{i,t} + \beta_3 \mathrm{GF\_MI}_{i,t} + \beta_4 X_{i,t} + \varepsilon_{i,t}, \tag{2}$$

where:
$\mathrm{ER}_{i,t}$ is economic resilience, proxied by the inverse of the five-year rolling standard deviation of GDP growth. $\mathrm{ER}_{i,t-1}$ is the lagged dependent variable used to capture persistence in resilience and justifies the use of dynamic SGMM estimation;
GF denotes green finance, a composite measure derived from green bonds, government environmental spending, and low-carbon trade;
MI represents market integration, calculated as the ratio of total inward and outward investment to GDP;
GF_MI is the interaction term between green finance and market integration;
X denotes a vector of control variables;
i and *t* denote the country and year indices, respectively;
α_0 is the constant term, and $\varepsilon_{i,t}$ represents the idiosyncratic error term.

The vector of control variables, $X_{i,t}$, includes the logarithm of Gross Domestic Product (GDP), the logarithm of GDP per capita (GDPC), the number of listed companies (Listed), the share of the tertiary sector as a percentage of GDP (Tertiary), and government health expenditure as a percentage of GDP (HE). To construct the green index (GFI), the study uses an improved entropy weighting method. Suppose z_{ij} denotes the *j*-th index of the *i*-th country. The following matrix, *Z*, serves as a basic index of the level of green finance development.

$$Z = (z_{\mathrm{ij}})_{\mathrm{mn}} = \begin{pmatrix} z_{11} z_{n1} \\ z_{m1} z_{\mathrm{mn}} \end{pmatrix}_{\mathrm{mn}}, \tag{3}$$

where:
z_{ij} denotes the original value of indicator *j* for country (or region) *i*;
m denotes the number of observations (countries/regions);
n denotes the number of indicators used in the evaluation system.

Since the indices have different units of measurement, equations (3) are normalized with equation (4):

$$\mathrm{r_{ij}} = \begin{cases} \frac{\mathrm{z_{ij}} - \min \mathrm{z_{ij}}}{\max \mathrm{z_{ij}} - \min \mathrm{z_{ij}}} & \mathrm{if z_{ij}\ \ is\ a\ positive\ index} \\ \frac{\max \mathrm{z_{ij}} - \mathrm{z_{ij}}}{\max \mathrm{z_{ij}} - \min \mathrm{z_{ij}}} & \mathrm{if z_{ij}\ \ is\ a\ negative\ index} \end{cases} \tag{4}$$

where:
r_{ij} represents the normalized value of indicator j for country i after the normalization process.

Matrix Normalization:

$$\mathrm{r_{ij}} = \begin{cases} \frac{\mathrm{z_{ij}}}{\sqrt{\sum_{\mathrm{i=1}}^{\mathrm{m}} \mathrm{z_{ij}}^2}} & \mathrm{ifz_{ij}\ \ is\ a\ positive\ index} \\ \frac{\frac{1}{\mathrm{z_{ij}}}}{\sqrt{\sum_{\mathrm{i=1}}^{\mathrm{m}} \left(\frac{1}{\mathrm{z_{ij}}}\right)^2}} & \mathrm{ifz_{ij}\ \ is\ a\ negative\ index} \end{cases} \tag{5}$$

Adjust the normalization matrix as follows:

$$b_{\mathrm{ij}} = r_{\mathrm{ij}} + 0.0001, \tag{6}$$

$$P_{\mathrm{ij}} = \frac{b_{\mathrm{ij}}}{\sum_1^m b_{\mathrm{ij}}}, \tag{7}$$

where:
b_{ij} is the adjusted normalized value obtained by adding a small constant (0.0001) to avoid the logarithm of zero;
P_{ij} denotes the proportion of the ith observation under the jth indicator in the normalized matrix.

The entropy index H_j and the difference coefficients G_j are then calculated as follows:

$$H_j = -\frac{1}{\ln(m)} \sum_{i=1}^{m} P_{\mathrm{ij}} \ln P_{\mathrm{ij}}, j = 1, 2, 3 \ldots . n, \tag{8}$$

$$G_j = 1 - H_j j = 1, 2, 3 \ldots . n, \tag{9}$$

where:
H_j represents the entropy value of indicator j, reflecting the amount of information provided by that indicator;
G_j denotes the difference coefficient of indicator j, which measures the degree of variation among observations.

Determine the Improved Entropy Weighting Factor:

$$w_j = \frac{G_j + 0.1\sum_{j=1}^{n} G_j}{\sum_{j=1}^{n}\left(G_j + 0.1\sum_{j=1}^{n} G_j\right)} = \frac{1 - H_j + 0.1\sum_{j=1}^{n}(1 - H_j)}{\sum_{j=1}^{n}\left(1 - H_j + 0.1\sum_{j=1}^{n}(1 - H_j)\right)}. \tag{10}$$

Normalization matrix:

$$V = (v_{\mathrm{ij}})_{\mathrm{mn}} = \begin{pmatrix} w_1\gamma_{11} \ldots . w_n\gamma_{1n} \\ w_1\gamma_{m1} \ldots . w_n\gamma_{\mathrm{mn}} \end{pmatrix}_{\mathrm{mn}}. \tag{11}$$

The positive ideal solution v_j^+ and the negative ideal solution v_j^- for the j-th index can be expressed as follows:

$$v_j^+ = \max\{v_{\mathrm{ij}} | i = 1, 2, 3, \ldots . m\}, \tag{12}$$

$$v_j^- = \min\{v_{ij} | i = 1, 2, 3, \ldots . m\}. \tag{13}$$

The Euclidean distances of the positive and negative ideal solutions are calculated as s_i^+ and s_i^-, respectively, as follows:

$$s_i^+ = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^+\right)^2} i = 1, 2, 3, \ldots, m, \tag{14}$$

$$s_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^-\right)^2} i = 1, 2, 3, \ldots, m, \tag{15}$$

where:
v_j^+ represents the positive ideal solution for indicator j;
v_j^- represents the negative ideal solution for indicator j;
w_j represents the entropy weight assigned to indicator j;
v_{ij} denotes the weighted normalized value of indicator j for observation i;
s_i^+ represents the Euclidean distance to the positive ideal solution, where a smaller value indicates a more desirable alternative;
s_i^- denotes the distance to the negative ideal solution, where a larger value is preferred.

GFI_i is calculated based on the Euclidean distance between a country's positive and negative ideal solutions. Higher (lower) *GFI* values indicate higher (lower) levels of green financial development.

$$\mathrm{GFI}_i = \frac{s_i^-}{s_i^+ - s_i^-} i = 1, 2, 3, \ldots, m. \tag{16}$$

This indicator reflects the ability to access external capital and technology, as well as the level of connectivity with the global economy. Countries with high market integration typically take better advantage of development opportunities, attract investment, foster technological innovation, and enhance competitiveness. Studies by Feng, Lee, and Peng (2023) and Yang and Deng (2025) show that high market integration supports rapid economic growth, strong resilience, and sustainable development.

Data

The sample consists of 32 economies (see Appendix) selected according to three main criteria. First, the countries provide consistent and comparable information for all components of the green finance index and the market integration indicator over the period 2014–2023. Second, they are classified as emerging markets by the IMF or the World Bank, which makes them particularly suitable for examining resilience in economies that are highly exposed to external shocks while experiencing rapid financial and environmental transformation. Third, the selection ensures geographic and institutional diversity, covering Asia, Latin America, Eastern Europe, and Africa, thereby improving the external validity of the analysis.

Several countries were removed from the initial pool due to substantial data gaps or inconsistencies in key variables related to green finance. For observations with minor missing values (one or two consecutive years), linear interpolation was applied to maintain continuity. After this

screening and cleaning process, the final dataset constitutes a balanced panel of 32 countries with 320 country–year observations.

Empirical Strategy (Step-by-Step)

Step 1: Data construction. Panel data covering 32 emerging economies from 2014 to 2023 were assembled using the World Bank, IMF, Climate Bonds Initiative, WTO, and national statistical sources. Missing values were screened, and harmonization procedures were applied where necessary to ensure consistency across countries and years.

Step 2: Variable measurement.

- Economic resilience (ER) is measured as the inverse of GDP growth volatility. This transformation ensures that higher values correspond to stronger resilience.
- Green finance (GF) is constructed as a composite index combining green bond issuance, government environmental expenditure, and low-carbon trade, using entropy weighting.
- Market integration (MI) is proxied by the ratio of total cross-border investment flows to GDP and alternative measures for robustness.

Step 3: Model specification. Two dynamic models are estimated: (i) a baseline model assessing the effect of GF on ER; and (ii) an interaction model including GF × MI to capture moderation. Lagged ER is included to reflect dynamic adjustment processes. Controlling variables capture macroeconomic, institutional, and energy-related characteristics.

Step 4: Addressing endogeneity. Since lagged ER and the main regressors may be endogenous, the System GMM estimator (Arellano–Bover/Blundell–Bond) is applied. Internal instruments are constructed using second- and higher-order lags. Serial correlation and over-identification are checked using AR (1)/AR (2) tests and Hansen/Sargan tests.

Step 5: Robustness checks. To verify the stability of the baseline results, the composite green finance (GF) index is replaced with an alternative proxy measured by renewable energy investment. This substitution allows us to examine whether the estimated relationship remains consistent when a different representation of green financial development is employed.

Step 6: Interpretation and validation. Coefficient patterns are evaluated against theoretical expectations and previous empirical findings. Instrument validity, model diagnostics, and economic interpretation guide the discussion and policy implications.

Research results

Table 1 presents the descriptive statistics of the variables, including the number of observations, mean, standard deviation, minimum value, and maximum value.

Table 1. Descriptive statistics

Variable	Obs.	Mean	Std	Minimum	Maximum
ER	320	2.7072	1.8992	0.1073	8.6790
GF	320	0.097	0.081	0.017	0.553
MI	320	3.910	2.867	0.756	19.375
GF_MI	320	0.379	0.481	0.013	10.715
GDP	320	8.0860	1.4422	5.0254	12.0941
GDPC	320	9.3273	0.8046	7.3485	11.2852
Listed	320	650.1063	1709.8420	8	12730
Tertiary	320	56.5652	6.2238	39.8625	70.5563
HE	320	4.0803	1.6534	0.8600	8.1770

Source: Stata output.

The results from Table 1 show that the economic resilience variable (ER) ranges from 0.1073 to 8.6790, with an average of 2.7072 and a standard deviation of 1.8992, indicating a significant disparity among countries. Peru recorded the highest ER (8.6790 in 2023), while Indonesia had the lowest (0.1073 in 2019), highlighting differences in recovery capacity across nations. The green finance variable (GF) ranges from 0.017 to 0.553, with an average value of 0.097 and a standard deviation of 0.081. Hungary led with the highest GF in 2023, while Russia recorded no green finance activities during the last two years of the study period. The market integration variable (MI) shows significant volatility, ranging from 0.756 to 19.375, with an average of 3.910 and a standard deviation of 2.867. Both the highest and lowest values were observed in Hungary, suggesting that the integration process in some emerging economies remains unstable and is influenced by external economic and political factors.

Table 2. Results: Model 1 and Model 2

	Model 1	Model 2
L1.ER	0.9619***	0.9336***
GF	0.7159***	0.9667***
MI	0.0781***	0.0249***
GF*MI		0.0211***
GDP	−0.4411***	−0.4142***
GDPC	−2.8361***	−3.5223***
Listed	0.0002***	0.0002***
Tertiary	0.0180	0.0484

	Model 1	Model 2
Cons	0.8001***	0.8549***
AR (2)	0.275	0.243
Sargan test	0.342	0.335
Hansen test	0.183	0.165

Note: *** denotes statistical significance at the 1% levels.

Source: Stata output.

The SGMM regression results from Models 1 and 2 show that, except for the *Tertiary* variable, all independent and control variables in the model are statistically significant in explaining economic resilience, at the 1% significance level. Specifically:

First, regarding the green finance variable, the findings demonstrate that green finance significantly enhances economic resilience, aligning with prior studies showing that green financial instruments strengthen environmental and economic stability through improved resource allocation and reduced transition risk (Fatica and Panzica 2024; Wei 2024). For emerging markets, this result suggests that expanding green investment channels can help buffer economies against shocks by fostering cleaner and more efficient production structures. This finding is consistent with the Real Business Cycle (RBC) theory, which posits that external shocks such as climate change or environmental policies can affect national productivity and output, thereby influencing the business cycle. At the same time, the results reinforce the initial hypothesis and align with previous studies by Wang et al. (2022), Fatica and Panzica (2024), Guan and Zhao (2024), Li et al. (2024), Tengfei and Ullah (2024), and Wei (2024), which argue that green finance enhances an economy's resilience to environmental and energy-related shocks. In the context of increasing climate-related risks, green finance supports the transition to a low-carbon growth model, while also fostering innovation and improving growth quality (Nenavath and Mishra 2023; Ning et al. 2023; Saydaliev and Chin 2023). In practice, in Vietnam during the 2020–2025 period, over USD 10 billion was invested in renewable energy projects such as solar and wind power. These initiatives not only contribute to reducing carbon emissions but also strengthen economic resilience against global risks. Thus, green finance is not only a post-crisis recovery tool but also a driving force for sustainable development in emerging economies.

Second, regarding the market integration variable, market integration (MI) is found to have a positive impact on economic resilience (ER) in emerging economies, with statistical significance at the 1% level in both regression models. This finding suggests that a higher level of integration may enhance a country's capacity to cope with economic, environmental, and social shocks. In practice, market integration through trade liberalization, capital flow openness, and global financial connectivity helps improve resource allocation efficiency. It also facilitates access to investment capital, advanced technologies, and modern governance practices from abroad. These factors play a vital role in boosting productivity, accelerating structural economic transformation, and strengthening the adaptability of economies amidst increasingly complex global dynamics. Recent studies by Lester and Nguyen (2016), Oprea and Stoica (2018), Feng, Lee, and Peng

(2023), Lyu et al. (2023), and Yang and Deng (2025) also demonstrate that countries with higher levels of market integration tend to recover more quickly from crises, due to their ability to maintain capital inflows and stable trade activities. The cases of Singapore and South Korea provide clear evidence that these two countries have effectively leveraged market integration to build resilient financial systems and strengthen risk management capabilities, thereby mitigating the adverse effects of external shocks.

Moreover, market integration contributes to the diversification of external economic relations, which helps reduce the risks associated with overdependence on a single market or region. This also enhances flexibility and adaptability in the face of increasing global economic uncertainty. This finding aligns with Ricardo (2001) theory of comparative advantage, which posits that market integration allows countries to specialize in production based on their relative strengths, thereby optimizing resource use and improving economic efficiency. Simultaneously, the results are consistent with Kydland and Prescott's (1982) Real Business Cycle (RBC) theory, which emphasizes that market integration enables countries to diversify production resources, optimize supply chains, and access modern technology, thus minimizing the economic losses caused by shocks.

Third, the moderating role of market integration provides additional insights. The positive and significant interaction term indicates that higher levels of integration amplify the resilience-enhancing effect of green finance. This is consistent with arguments that integrated markets facilitate technology diffusion, enable access to global green capital, and accelerate structural upgrading (Eichengreen and Leblang 2003). However, the effect appears stronger in countries with more stable institutional environments, suggesting that integration benefits are conditional rather than automatic, a point not sufficiently addressed in earlier studies.

The implication is that a higher level of market integration further strengthens the positive relationship between green finance and resilience. In the context of globalization, market integration serves as a crucial transmission channel that enables green capital flows to access advanced technologies, international standards, and strategic investors. This, in turn, enhances capital allocation efficiency and boosts the positive economic impact of green finance.

Moreover, integration promotes information transparency, strengthens governance, and improves institutional quality factors that facilitate the effectiveness of green finance in enhancing the economy's resilience and adaptability to complex and unpredictable shocks.

Next, regarding the control variables in the model. Both Gross Domestic Product (GDP) and Gross Domestic Product per capita (GDPC) exhibit a negative impact on economic resilience in emerging economies, with statistical significance at the 1% level across both models. This result contrasts with initial expectations and diverges from previous findings by Ilter (2017), Simonova (2019), Awan and Azam (2021), and Kaneva et al. (2022), which generally suggest that higher GDP and GDPC are associated with greater resilience. However, in the context of emerging economies, rapid growth is often accompanied by excessive resource exploitation, leading to environmental degradation and pollution (Acheampong and Opoku 2023), which can undermine long-term resilience. Additionally, the relationship between GDP, GDPC, and economic resilience may be influenced by various confounding factors, making the overall impact ambiguous.

The number of listed companies (Listed) shows a positive and statistically significant effect at the 1% level in both models, indicating that an increase in the number of listed firms contributes to enhanced economic resilience in emerging markets. This finding aligns with the research hypothesis and is consistent with the results of Hassan and Halbouni (2013), Bonfim, Custódio, and Raposo (2023), and Zhang (2023). The expansion of stock markets helps diversify capital mobilization channels, improve liquidity, and enhance shock resistance. Moreover, the development of financial markets fosters more efficient resource allocation and risk mitigation, thereby strengthening macroeconomic stability. Government expenditure on health (HE) has a positive and statistically significant impact at the 1% level in both models, underscoring the critical role of healthcare investment in bolstering economic resilience. This finding supports the research expectation and echoes earlier studies by Bedir (2016), Wang, Wang, and Huang (2016) and Chen and Zhang (2025). Increased spending on healthcare not only enhances the quality of health systems but also improves labor productivity and fosters sustainable growth. Particularly in emerging economies, health investment is a key factor in reinforcing crisis response capacity and promoting long-term economic recovery.

Taken together, this study provides new empirical evidence that the interaction between green finance and market integration is a key mechanism shaping economic resilience in emerging markets, and it employs a dynamic GMM approach that enhances identification accuracy. These insights offer valuable implications for policymakers aiming to design integrated strategies for green transformation and resilience building.

Robustness check

To test the reliability and consistency of the results, the study conducts a robustness check by using an alternative proxy for green finance. Specifically, instead of using a composite green finance index constructed from multiple components (including green bonds, government investment in the environment, and carbon trading), the study replaces it with the ratio of renewable energy investment to total energy investment, a specific indicator commonly used in previous studies (e.g., Zhan, Wang, and Zhong 2023; Chin et al. 2024; Yadav, Pathania, and Ramesh 2024; Jawadi, Pondie, and Cheffou 2025) and shown to be correlated with the original composite green finance variable. This alternative variable directly reflects the extent to which financial resources are mobilized for environmentally friendly projects and represents one of the clearest forms of green finance (Table 4). The use of this variable helps assess whether the model's conclusions depend on how green finance is measured.

Table 3 further confirms that the composite green finance index is positively and significantly correlated with the alternative measure of green finance at the 1% significance level.

Table 3. Correlation Matrix

	GF	GF_replace
GF	1.0000	
GF_ replace	0.2928*	1.0000

Note: * denotes statistical significance at the 10% level.

Source: Stata output.

The regression results using the alternative variable show that the positive and statistically significant relationship between green finance and economic resilience remains robust (Table 4). At the same time, the moderating effect of market integration in this relationship retains its sign and level of significance, indicating that the model's results are reliable. These findings suggest that the positive impact of green finance on economic resilience is consistent and not sensitive to changes in the measurement of the green finance variable.

Table 4. Results of Models 1 and 2 with GF_replace

	Model 1	Model 2
L1.ER	0.95609***	0.9614***
GF_replace	0.0056***	0.0221***
MI	0.0288***	0.1303***
GF_replace*MI		6.3638***
GDP	0.5522***	−0.5634***
GDPC	−0.2566***	−0.0273***
Listed	−0.0055***	−0.6768***
Tertiary	0.1082	0.0299
HE	0.0018	0.4490***
Cons	0.0967***	1.1614***
AR (2)	0.705	0.771
Sargan test	0.549	0.543
Hansen test	0.209	0.520

Note: *** denotes statistical significance at the 1% level.

Source: Stata output.

Conclusion

This study contributes to clarifying the role of green finance in enhancing economic resilience in emerging economies, while also emphasizing the importance of market integration as a key moderating factor. Using the SGMM method on a panel dataset of 32 economies over the period 2014–2023, the empirical results reveal that green finance has a positive and statistically significant impact on economic resilience. In addition, market integration plays a catalytic role by amplifying the effectiveness of green finance in strengthening resilience, highlighting the complementary interplay between institutional quality, financial development, and global integration in building a sustainable and resilient economy.

Based on the findings, it is evident that the development of green finance plays a pivotal role in enhancing economic resilience in emerging economies. Accordingly, it is essential to implement targeted policy measures tailored to each component of green finance to fully leverage their individual contributions. First, regarding green bonds, emerging economies should improve the legal

framework and enhance transparency in the issuance and supervision processes. Establishing unified standards and independent evaluation systems can strengthen investor confidence and channel capital into high-impact green projects, thereby supporting sustainable and resilient growth. Second, in terms of public environmental expenditure, governments should prioritize budget allocations for critical sectors such as pollution treatment, climate adaptation, and sustainable infrastructure development. In addition, mechanisms for evaluating the efficiency of public environmental investment should be put in place to ensure optimal use of resources and to strengthen long-term resilience. Third, with respect to low-carbon trade, it is important to create enabling conditions for enterprises to participate more deeply in global green supply chains. This includes upgrading technological capabilities, standardizing environmentally friendly production processes, and improving green trade infrastructure. Furthermore, implementing green trade agreements and effective carbon pricing mechanisms will incentivize the private sector's transition toward greener practices. Finally, strengthening market integration by advancing trade liberalization, financial linkage, and investment climate improvement are essential measures to enhance market integration. These steps not only facilitate the flow of capital and international technology but also broaden policy space to bolster resilience against external shocks.

Although this study provides empirical evidence on the positive impact of green finance on economic resilience, as well as clarifying the moderating role of market integration in this relationship, there remain several limitations that should be acknowledged. First, the measurement of green finance remains a major challenge due to the lack of a globally standardized index. Both the composite index and the alternative proxy used in this study reflect only certain aspects of green finance and may not capture the full scope of green financial activities. Second, the dataset primarily operates at a macro level, which may overlook important differences in the level of green finance development and market integration across country groups. Third, the study mainly focuses on assessing the role of market integration, while other relevant factors have not yet been taken into consideration. Furthermore, although the SGMM approach was applied to address potential endogeneity, the possibility of reverse causality or unobserved variable bias cannot be entirely ruled out. Therefore, future research could be extended in several directions: (i) adopting more comprehensive and standardized measures of green finance as data becomes available; (ii) conducting subgroup analyses by country characteristics (e.g., developed vs. developing economies, or different geographic regions); (iii) incorporating institutional quality, environmental policies, or governance capacity as additional moderating variables; and (iv) evaluating long-term effects to fully capture the impact of green finance strategies on economic resilience.

Competing interests

I declare that I have no significant competing financial, professional, or personal interests that might have influenced the performance or presentation of the work described in this manuscript.

Appendix: List of 32 countries that comprise the sample: Albania, Algeria, Argentina, Bangladesh, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Egypt, Estonia, Georgia, Guatemala, Honduras, India, Indonesia, Iran, Latvia, Lithuania, Malaysia, Mexico, Morocco, Nicaragua, Pakistan, Peru, Philippines, Poland, South Africa, Thailand, Turkey, Vietnam.

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Wpływ zielonych finansów na odporność gospodarczą – moderująca rola integracji rynkowej

Niniejszy artykuł odpowiada na pytania, czy i w jaki sposób zielone finanse zwiększają odporność gospodarczą w gospodarkach wschodzących, a także poddaje ocenie moderującą rolę integracji rynkowej w tym zakresie. Wyniki badań empirycznych, uzyskane z wykorzystaniem systemowej uogólnionej metody momentów (SGMM) w celu uwzględnienia problemów endogeniczności i opóźnionych zmiennych zależnych, wskazują, że zielone finanse wywierają pozytywny i statystycznie istotny wpływ na odporność gospodarczą. Ponadto wysoki poziom integracji rynkowej zwiększa skuteczność zielonych finansów w umacnianiu zdolności danego kraju do przetrwania wstrząsów gospodarczych, społecznych i środowiskowych oraz do odbudowy po nich. Na podstawie tych ustaleń rekomenduje się, aby gospodarki wschodzące promowały rozwój zielonych finansów poprzez ustanowienie jasnych ram politycznych, promowanie zrównoważonych instrumentów finansowych oraz zachęcanie do napływu zielonego kapitału do gospodarki realnej. Jednocześnie należy podjąć wysiłki na rzecz pogłębienia integracji rynkowej poprzez liberalizację handlu, regionalną współpracę finansową oraz poprawę klimatu inwestycyjnego, aby w pełni wykorzystać pożytki płynące z globalizacji i wzmocnić podstawy ożywienia gospodarczego w obliczu rosnącej niepewności na świecie.

Słowa kluczowe: zielone finanse, odporność gospodarcza, integracja rynkowa, gospodarki wschodzące