



Does good governance intensify the impact of energy finance on globalization? Evidence from BRICS nations

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ABSTRACT

In the context of globalization, good governance and energy financing are essential for sustainable and inclusive economic growth, particularly in emerging countries, as both are necessary for optimizing globalization. Existing research investigated the governance-energy-environment nexus; however, insufficient focus has been directed on the good governance-energy finance-globalization nexus in the BRICS countries. Hence, this study investigates the impact of energy finance and governance on globalization in BRICS countries, focusing on how energy finance, both fossil fuel and renewable, influences global integration. It examines the direct effect of governance on globalization and explores the moderating role of governance in strengthening the relationship between energy finance and globalization. Using advanced econometric models, including fully modified ordinary least square, augmented mean group, common correlated effects mean group, dynamic ordinary least square, two-stage least square, and generalized methods of the moment, the study provides empirical evidence on the significance of energy finance in driving globalization, with fossil fuel energy finance showing a negative impact and renewable energy finance a positive one. The results highlight the crucial role of good governance in enhancing the effectiveness of energy finance, suggesting that stronger governance frameworks can maximize the benefits of energy investments for globalization. This study provides novel insights by examining the moderating impacts of governance quality on the links between energy financing and globalization underpinning institutional theory within the BRICS nations. The findings highlight the necessity of improving governance frameworks to facilitate sustainable energy investments and globalization in BRICS states and other comparable countries, as effective governance and energy finance are both critical issues in the globalization discourse.

1. Introduction

The contemporary world contends with a multitude of interconnected difficulties arising from globalization, encompassing economic, environmental, and social dimensions (Castro-Cárdenas & Ibarra-Yunez, 2022; Thompson, 2023; Traore, 2023). Globalization has become a defining feature of the modern world, driving interconnectedness, trade expansion, and economic integration across borders. Energy finance, as a critical component of economic growth and sustainability, plays a significant role in fueling this integration (Ng & Tao, 2016; Plantinga & Scholtens, 2021). By ensuring the availability and sustainability of energy resources, energy finance enables countries to support industrialization, trade, and infrastructure development,

essential pillars of globalization (Traore, 2023; Wellum, 2020). However, the impact of energy finance on globalization varies widely depending on factors such as governance quality, regulatory stability, and the alignment of national policies with global standards. Understanding these dynamics is crucial as nations seek to harness energy finance for sustainable development in a globalized economy (Khaw & Ni, 2021; Kim & Lee, 2021). These globalized issues highlight the pressing necessity for new strategies and strong governance structures to enhance resilience, reduce risks, and promote equitable growth worldwide.

Governance fundamentally pertains to the systems and procedures by which society regulates its activities (Aransyah, 2023; Islam, 2019). Institutional Theory offers a valuable framework for analyzing the relationship between governance and globalization. This theory posits

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Nomenclature			
GDP	Gross domestic product	IPS	Im-Pesaran-Shin
AMG	Augmented mean group	BRICS	Brazil, Russia, India, China, and South Africa
2SLS	Two-stage least square	FMOLS	Fully modified ordinary least square
FDI	Foreign direct investment	DOLS	Dynamic ordinary least square
FDV	Financial development	CCEMG	Common correlated effects mean group
IFL	Inflation	FFIN	Fossil fuel energy finance
EGR	Economic growth	RFIN	Renewable energy finance
GLB	Globalization	CSD	Cross-sectional dependence
GGV	Good governance	LLC	Levin, Lin, and Chu
ECM	Error Correction Model	CIPS	Cross-sectional Augmented Im, Pesaran, and Shin
SE	Standard Error	CADF	Cross-sectional Augmented Dickey-Fuller
SD	Standard deviation	GMM	Generalized methods of moment
H	Hypothesis	EKC	Environmental Kuznets curve
		WDI	World development indicators
		D-H	Dumitrescu & Hurlin

that strong institutions and governance frameworks promote economic stability and accountability, which, in turn, influence a country’s capacity to participate in the global economy. In the context of BRICS nations, governance is instrumental in shaping both the availability of energy finance and its influence on globalization (Ortiz, 2023; Plantinga & Scholtens, 2021). High-quality governance frameworks can enhance regulatory stability, foster foreign investment, and align national energy finance strategies with global standards. Institutional Theory thus provides a theoretical basis for examining how governance can intensify the impact of energy finance on globalization (Xu & Gallagher, 2022; Xu et al., 2021; Zhang & Umair, 2023). Thus, understanding how governance influences the dynamics of energy finance and economic growth is critical for advancing sustainability agendas and fostering resilient economies, which is the main priority of the contemporary globalized world.

The old BRICS nations—“Brazil, Russia, India, China, and South Africa”—comprise a significant bloc in the global economy characterized by their substantial economic influence, demographic diversity, and strategic geopolitical positions (Fu et al., 2021). Collectively, these nations account for over 40 % of the world’s population and a substantial share of global GDP, making them pivotal players in shaping international trade, investment flows, and global governance frameworks (Baloch et al., 2022). BRICS nations share common developmental aspirations alongside distinct socio-economic challenges. For instance, Brazil and South Africa are notable for their rich biodiversity and reliance on natural resources, which presents both opportunities and challenges for sustainable development (Rahman & Islam, 2023).

Russia possesses vast reserves of natural gas and oil, underscoring its pivotal role in global energy markets. India, as one of the world’s fastest-growing economies, faces the dual challenge of meeting burgeoning energy demands while transitioning towards cleaner and more sustainable energy sources (Rahman & Halim, 2024). China has made significant strides in renewable energy adoption but continues to grapple with environmental degradation and energy security concerns. The relevance of BRICS in the context of global energy dynamics cannot be overstated. These nations are key drivers of global energy consumption patterns and investment trends, influencing market prices and resource allocations (Baloch et al., 2019). Their policy choices regarding energy finance—whether towards fossil fuel-intensive infrastructure or renewable energy technologies—have profound implications for global energy security, climate change mitigation efforts, and SDGs. Therefore, studying the relationships between energy finance and economic growth within the BRICS context is not only timely but also essential for understanding global energy transitions and shaping future policy agendas (Baloch et al., 2019; Chien et al., 2023; Denters et al., 2023; Fu et al., 2021). The BRICS nations hold a unique position in the global economy as emerging markets with substantial growth potential. Collectively representing a

large portion of the world’s population and GDP, BRICS countries are central to discussions on energy finance and globalization (Hope, 2005; Kassi et al., 2023; Khan et al., 2019; Lee & Yu, 2014). They face challenges such as energy security, regulatory alignment, and sustainable development, which are critical for their continued global integration (Mahi et al., 2019; Mayer et al., 2016; Pfenninger et al., 2014; Rahman & Islam, 2023). Studying BRICS nations is particularly relevant as they strive to balance energy finance and governance with their aspirations for deeper integration into the global economy.

Baajike et al. (2022) reveal that while trade liberalization and financial development initially harm environmental sustainability in West Africa, effective institutions can mitigate these effects and enhance environmental outcomes. In Ghana, Baidoo et al. (2023) observe that economic globalization has, paradoxically, reduced economic growth in both short and long runs, urging policymakers to address this unintended consequence. Conversely, Eltayeb Elfaki and Musa Ahmed (2024) show a positive link between globalization and Sudan’s economic growth, where increasing global market openness and capital accumulation drive economic benefits. Triatmanto et al. (2023) present findings from Southeast Asia, where foreign direct investment linked to globalization supports economic growth, although rising foreign debt may negatively impact GDP.

Existing studies have examined various dimensions of globalization and issues related to the environment and energy (Karim et al., 2023; Kwilinski et al., 2023; Luomi, 2020; Mayer et al., 2016; Omri & Mabrouk, 2020; Rahman & Halim, 2024; Simionescu et al., 2021; Baidoo et al., 2023). These studies have explored how energy policies and environmental sustainability intersect with globalization efforts, as well as the impact of governance quality on sustainable energy finance. However, this study takes a novel approach by exploring how governance quality specifically moderates the impact of energy finance on globalization within BRICS nations. This focus on the moderating role of governance in the energy finance-globalization relationship fills a critical gap in the literature and provides insights that are relevant for emerging markets aiming to optimize their globalization strategies.

The aim of this study is to investigate the role of governance and energy finance on globalization in BRICS nations. The specific objectives are threefold:

- (1) to analyze the relationship between energy finance and globalization,
- (2) to investigate the direct role of governance in globalization, and
- (3) to examine how governance quality moderates the impact of energy finance on globalization.

By addressing these objectives, the study seeks to fill a research gap by clarifying the ways governance can amplify the influence of energy finance on global integration, especially in the context of emerging economies.

The contributions of this study are multifaceted. First, it assesses the

impact of energy finance on globalization, providing empirical evidence of its importance for BRICS countries. Second, it investigates the direct influence of governance on globalization, offering insights into how governance quality affects global integration. This finding underscores the critical role of governance quality in shaping the economic outcomes of energy investments, providing a nuanced perspective on how institutional factors can influence sustainable development pathways in BRICS countries and other similar countries since the institutional factors' impact on the economy is a globalized issue. Third, it explores the moderating role of governance in the relationship between energy finance and globalization, showing how effective governance can amplify the benefits of energy finance. Lastly, the study contributes methodologically by employing various econometric models such as FMOLS, AMG, CCEMG, DOLS, 2SLS, and GMM to test the robustness of its findings. By utilizing these diverse approaches, the study enhances the reliability and validity of its results. This methodological rigor not only strengthens the empirical evidence but also provides a framework for future research to adopt similar approaches in examining energy-related issues across different countries. The findings have significant policy implications, suggesting that strengthening governance frameworks could maximize the effectiveness of energy finance in driving globalization, particularly for emerging markets.

The remainder of this paper is structured as follows. [Section 2](#) underpins institutional theory, and [section 3](#) reviews the related literature. [Section 4](#) outlines the methodology, and [section 5](#) presents the results. Finally, [section 6](#) discusses the findings and [section 7](#) concludes the research.

2. Theoretical Background

The “institutional theory of development” posits that the quality of institutions is a crucial determinant of economic growth, with governance issues integrated into the technological, institutional, political, and financial options employed at local, national, and global scales (Lele et al., 2013). The “law and finance” theory posits that financial market development transpires in countries where the legal structure upholds private ownership rights, binding contracts, and the safeguarding of investors' legal rights, all of which are essential for fostering economic growth (Demetriades & Hook Law, 2006; Hope, 2005).

Institutional Theory emphasizes the role of formal and informal institutions in shaping human behavior and organizational practices within a given environment (Grob & Benn, 2014; Lawrence & Shadnam, 2008). It posits that institutions—such as laws, norms, regulations, and organizational structures—provide the framework within which individuals and organizations operate (Grob & Benn, 2014). These institutions not only guide behavior but also influence the efficiency and effectiveness of economic and social outcomes. The theory highlights how institutions evolve over time and how they are shaped by historical, cultural, and societal factors. In the context of globalization, Institutional Theory helps explain how different countries' institutional frameworks—ranging from legal systems to governance structures—affect their integration into the global economy (Ebrahimi & Koh, 2021; Willmott, 2011). As such, institutions are seen as key drivers or barriers to globalization, affecting the flow of goods, services, and investments.

In the relationship between globalization and energy finance, Institutional Theory provides insight into how institutional frameworks influence both the access to and the allocation of energy finance (Lawrence & Shadnam, 2008; Willmott, 2011). As globalization increases cross-border financial flows, countries with robust institutions—such as stable legal systems, transparent financial regulations, and effective governance structures—are better able to attract investment, particularly in energy sectors. In contrast, nations with weaker institutions may face difficulties in mobilizing energy finance, especially for large-scale renewable energy projects, due to challenges such as corruption, political instability, or inadequate regulatory frameworks.

Good governance, in this context, plays a critical role in ensuring that energy finance is efficiently mobilized and directed towards sustainable energy initiatives. Strong institutional frameworks ensure that energy finance is managed effectively, with transparent policies that foster investor confidence and align energy finance goals with broader economic and environmental objectives (Gauthier, 2013; Glover et al., 2014). Therefore, Institutional Theory highlights the pivotal role of governance structures in shaping how energy finance impacts globalization, suggesting that robust institutions can help countries better harness globalization's benefits while navigating the complexities of energy transition.

3. Review of related literature

As the world confronts the urgent impacts of climate change, the shift from fossil fuels to renewable energy has become essential. This transition, however, presents not only environmental challenges but also significant financial and geopolitical ones, demanding coordinated global action. A key element of this shift is the immense funding required to reduce dependency on fossil fuels. Thompson (2023) highlights that a comprehensive move toward a climate-neutral economy calls for robust global financing mechanisms and subsidies to support the development of renewable energy systems. Achieving this requires policies and regulations that foster green economic growth and work to reverse the ecological damage caused by fossil fuels. In this context, multilateral development banks play an important role by increasing investments in renewable energy projects, particularly in developing nations, to support global renewable energy (Kim & Lee, 2021). This financial assistance is critical for reducing greenhouse gas emissions and advancing sustainable development.

The historical context of fossil fuel finance reveals a longstanding trend of wealth accumulation benefiting the global North, often to the detriment of the global South. Ortiz (2023) points out that the oil price surges of the 1970s led to a “petrodollar recycling” process that fueled financial growth in the North, while simultaneously intensifying debt crises across the South. This pattern continues today, with profits from fossil fuel investments still favoring the capitalist elite, even as the climate crisis escalates. Wellum (2020) highlights how energy market financialization, particularly through futures markets, has become essential in managing energy crises, further embedding fossil fuel dependency within global financial systems. Moreover, the economic impact of fossil fuel divestment is profound. According to Plantinga and Scholtens (2021), divesting from fossil fuels can drive up the cost of exploiting these resources, thereby making renewable alternatives more economically attractive. This supports Khaw and Ni's (2021) recommendation to reallocate subsidies toward renewable energy, enhancing its competitiveness as fossil fuels become costlier due to resource scarcity. These financial strategies are crucial for promoting a sustainable energy future that prioritizes environmental integrity over short-term economic gain.

The global energy landscape is heavily influenced by the policies of major economies, especially China, which has become a major player in financing energy projects around the world. According to Jansen (2022), China's Development Bank and Export-Import Bank have funded extensive energy projects globally, underscoring China's substantial role in the international energy finance arena. However, much of this investment still supports fossil fuel projects, complicating the transition to renewable energy and underscoring the need for global collaboration on energy finance reform. Yang, Jahanger, and Awan (2024) explore the impact of China's carbon emissions trading scheme on small- and medium-sized enterprises, revealing a “double dividend” effect: a reduction in sulfur dioxide emissions by 2–3 % and an increase in employment by 6–7 %, especially among non-state and foreign-owned firms in heavily polluted industries. This suggests that market-based tools can simultaneously drive pollution abatement and job creation.

The intersection of renewable energy finance and globalization has

become increasingly critical as countries work toward reducing fossil fuel reliance in favor of sustainable energy sources. This shift is driven by both environmental concerns and the pursuit of economic resilience and energy security. Innovative financing mechanisms, such as green bonds and project financing, are essential in supporting renewable energy projects, especially in developing nations where conventional funding sources are often insufficient. A key player in renewable energy finance is the development finance institution, which helps to address systemic obstacles hindering renewable projects, such as the entrenched interests of fossil fuel industries and inadequate renewable infrastructure (Xu & Gallagher, 2022). DFIs provide vital capital and risk mitigation strategies, drawing in private investment to support renewable initiatives that typically have high upfront costs (Ng & Tao, 2016). Notably, project financing models like Build-Operate-Transfer have demonstrated success in channeling funds into renewable infrastructure (Lyu & Shi, 2018). These models enable effective allocation of financial risks, enhancing project bankability and making investments more attractive to private financiers. Through these mechanisms, renewable energy finance is becoming a powerful tool for advancing sustainable energy projects within a globalized economy.

The rise of green bonds has significantly reshaped renewable energy financing by providing dedicated funding for projects with positive environmental impacts, gaining popularity across both developed and emerging economies (Zhang & Umair, 2023). Green financing frameworks, like those in Indonesia, emphasize the importance of structured financial systems that enhance access to capital for renewable energy initiatives (Aransyah, 2023). These frameworks help streamline funding processes and ensure efficient allocation of resources to projects aligned with sustainability goals, maximizing the impact of investments. The globalization of renewable energy finance is also evident in the growing involvement of international investors in local markets. For instance, large-scale renewable projects in Kenya have benefited from foreign investments, supported by liberalized energy markets and favorable international climate policies (Klagge & Nweke-Eze, 2020). This trend underscores the interconnected nature of global financial markets and the role of international cooperation in meeting renewable energy targets. However, significant challenges persist, especially in emerging economies where financial intermediaries often lack the capacity to manage complex renewable energy projects (Castro-Cárdenas & Ibarra-Yunez, 2022). Overcoming these obstacles will require adaptable financing solutions that harness global capital flows while addressing specific local needs.

Jahanger, Ozturk, et al. (2023) explore the impacts of technology and renewable energy in the top manufacturing countries, finding both to be crucial in achieving carbon neutrality, especially by improving energy efficiency in manufacturing sectors, which counters emission growth. Another study by Jahanger, Zaman, et al. (2023) highlights the potential of nuclear energy and ICT to reduce CO₂ emissions, supporting the EKC hypothesis by demonstrating that increased nuclear energy use and ICT advancements correlate with lower emissions. Kocoglu et al. (2024) extend this view, revealing that expanding forests can play a complementary role to renewable energy in curbing CO₂ emissions, positioning forestation as a viable solution alongside energy efficiency.

Good governance within the context of globalization is a multifaceted issue involving economic, political, and social dimensions. The relationship between globalization and governance is intricate, as globalization can simultaneously strengthen and challenge governance structures across nations. Globalization has notably impacted economic growth, particularly in Asian economies, where a positive correlation exists between the Globalization Index and GDP growth (Xu et al., 2021). This connection is shaped by various governance factors that can either facilitate or impede economic performance. Empirical evidence suggests that effective governance is essential for fully leveraging the benefits of globalization, as it contributes to enhanced institutional quality and stronger economic outcomes (Islam, 2019). Consequently, good governance serves not merely as an outcome of globalization but as

a foundational requirement for its favorable effects on economic development.

Globalization calls for a reevaluation of governance structures at both national and international levels. The World Trade Organization, for example, plays a crucial role in regulating global trade while promoting principles like transparency and non-discrimination, which are fundamental for ensuring good governance (Traore, 2023). This regulatory framework helps mitigate the risks associated with globalization, such as corruption and poor governance, by setting standards that member countries are expected to uphold. The relationship between global governance institutions and national governance frameworks is key, as it influences how countries navigate global economic challenges and opportunities (Ababakr, 2022). Moreover, the democratization of global governance is increasingly seen as vital for effective governance in a globalized world. The establishment of a public sphere that connects decision-making processes with transnational constituencies enhances transparency and accountability in international organizations (Nanz & Steffek, 2004). This participatory model enables civil society to play a critical role in global governance, ensuring that a wide range of perspectives is integrated into policy-making processes, thereby strengthening the legitimacy and inclusivity of global decision-making.

The rise of transnational public-private partnerships highlights a significant shift in governance dynamics, where non-state actors collaborate with state entities to address collective goods (Schäferhoff et al., 2009). This hybrid governance model reflects the growing complexity of global governance, as traditional state-centric approaches may no longer be sufficient to tackle pressing global challenges, such as climate change and public health (Andonova et al., 2009). The success of such partnerships relies on their ability to integrate diverse stakeholder interests and deliver equitable outcomes. As globalization continues to evolve, the need for adaptive governance structures that can effectively address emerging challenges and capitalize on new opportunities becomes increasingly essential. Many studies have analyzed the roles of energy consumption and financial development (Akhtaruzzaman, 2022; Baloch et al., 2019; Hofbauer et al., 2022; Kwilinski et al., 2023; Mahi et al., 2019; Ngoma & Yang, 2024; Omri & Mabrouk, 2020; Vo et al., 2022). Nevertheless, most of these researches do not offer additional insights into the moderating impacts of governance quality on energy financing and economic growth nexus. Limited research has examined the threshold implications of effective governance (Giotitsas et al., 2022; Mahran, 2023; Simionescu et al., 2021). Numerous empirical studies have overlooked the multifaceted dimensions of energy financing concerning economic growth.

The prospects for effective governance are contingent upon institutional frameworks and the economic resources allocated for governance assurance (Afrin & Rahman, 2023; Akhtaruzzaman, 2022; Deb et al., 2024; Gómez & Rodríguez, 2019; Karim et al., 2023; Lowitzsch et al., 2020; Mombeuil & Diunugala, 2021). International energy markets evidently need enough governance (Baloch et al., 2019; Fu et al., 2021). Appropriate budget allocation and use are possible in a restrained financial system, particularly in one with good governance (Butler et al., 2018; Dantama et al., 2012). Therefore, the following hypothesis is developed:

- H1. There is a negative relationship between fossil fuel energy finance and globalization.*
- H2. There is a positive association between renewable energy finance and globalization.*
- H3. There is a positive impact of good governance on globalization.*
- H4. Good governance strengthens the fossil fuel energy finance-globalization relationship.*
- H5. Good governance strengthens the renewable energy finance-globalization relationship.*

Based on the related studies and theoretical support, Fig. 1 is constructed as a conceptual model of this study.

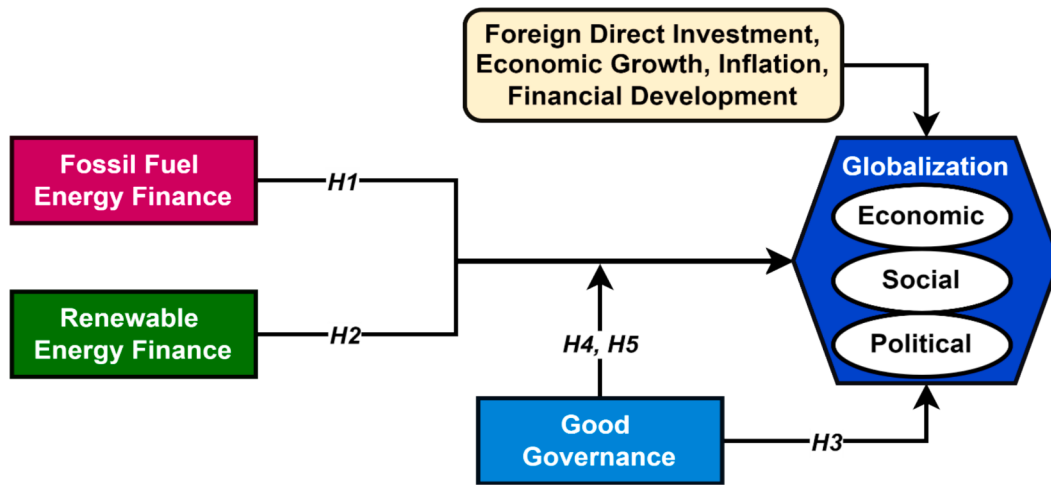


Fig. 1. The conceptual model.

Source: Developed by the authors

Table 1

Definition, measure, and sources of data.

Sign	Definition	Measure	Source
EGR	Economic Growth	GDP growth (annual %)	WDI
GLB	Globalization	The KOF Globalisation Index measures the economic, social, and political dimensions of globalization.	KOF
FFIN	Fossil Fuel Energy Finance	Fossil fuel energy finance (% of total energy finance)	WDI
RFIN	Renewable Energy Finance	Renewable energy finance (% of total energy finance)	WDI
GGV	Good Governance	Government Effectiveness: Percentile Rank	WDI
FDI	Foreign Direct Investment	Net inflows (% of GDP)	WDI
FDV	Financial Development	Domestic credit to private sector (% of GDP)	WDI
IFL	Inflation	Inflation, consumer prices (annual %)	WDI

4. Data and methods

4.1. Data

This study utilizes secondary data from the World Bank's World Development Indicators and the KOF Globalisation Index to examine the relationship between energy finance, globalization, and governance in BRICS countries over the period from 2000 to 2023 (see Table 1). The BRICS nations—Brazil, Russia, India, China, and South Africa—were selected due to their significant roles in the global economy, their diverse energy systems, and their varied approaches to governance and globalization (Ahmed, 2017; Baloch et al., 2022; Baloch et al., 2019; Rahman & Halim, 2024). These countries represent both emerging and developed economies, providing a comprehensive perspective on how energy finance and governance structures intersect in the context of globalization.

The data includes key indicators that capture the dimensions of globalization, economic growth, energy finance, and governance. Economic growth is measured by annual GDP growth rates (%), sourced from the WDI. Globalization is assessed through the KOF Globalisation Index, which captures the economic, social, and political aspects of globalization. Fossil fuel energy finance is measured as the percentage of total energy finance allocated to fossil fuels, while renewable energy finance is similarly measured as the percentage of total energy finance directed toward renewable sources, both sourced from the WDI. Good governance is represented by the Government Effectiveness percentile rank from the WDI, which measures the quality of governance in each country. Additional variables, such as FDI, FDV, and IFL, are also included to control for other factors that might influence the relationships under study. These indicators are collected annually for the period from 2000 to 2023 to provide a robust dataset for analysis.

4.2. Specified model

Equation (1) depicts a general formulation of the model where globalization depends on fossil fuel energy finance, renewable energy finance, good governance, foreign direct investment, financial development, economic growth, and inflation (Rahman & Halim, 2024). The specific equations (2) to (7) offer detailed variations that include interaction terms to explore the moderating effects of good governance on the relationships between energy finance (both fossil fuel and renewable) and globalization.

Basic Model:

$$GLB = f(FFIN, RFIN, GGV, FDI, FDV, EGR, IFL) \quad (1)$$

Specific models

$$\text{Model1: } GLB_{it} = C_{it} + \beta_1(FFIN_{it}) + \beta_2(GGV_{it}) + \sum_{c=1}^c \beta_c Y_{it}^c + \varepsilon_{it}, \quad (2)$$

$$\begin{aligned} \text{Model2: } GLB_{it} &= C_{it} + \beta_1(FFIN_{it}) + \beta_2(FFIN_{it} * GGV_{it}) \\ &+ \beta_3(GGV_{it}) + \sum_{c=1}^c \beta_c Y_{it}^c + \varepsilon_{it}, \end{aligned} \quad (3)$$

$$\text{Model3: } GLB_{it} = C_{it} + \beta_1(RFIN_{it}) + \beta_2(GGV_{it}) + \sum_{c=1}^c \beta_c Y_{it}^c + \varepsilon_{it}, \quad (4)$$

$$\begin{aligned} \text{Model4: } GLB_{it} &= C_{it} + \beta_1(RFIN_{it}) + \beta_2(RFIN_{it} * GGV_{it}) + \beta_3(GGV_{it}) \\ &+ \sum_{c=1}^c \beta_c Y_{it}^c + \varepsilon_{it}, \end{aligned} \quad (5)$$

Model5 : GLB_{it}

$$= C_{it} + \beta_1(FFIN_{it}) + \beta_2(RFIN_{it}) + \beta_3(GGV_{it}) + \sum_{c=1}^c \beta_c Y_{it}^c + \varepsilon_{it}, \quad (6)$$

Model6(FinalCombinedModel) : $GLB_{it} = C_{it} + \beta_1(FFIN_{it}) + \beta_2(RFIN_{it})$

$$+ \beta_3(FFIN_{it} * GGV_{it}) \\ + \beta_4(RFIN_{it} * GGV_{it}) \\ + \beta_5(GGV_{it}) + \sum_{c=1}^c \beta_c Y_{it}^c + \varepsilon_{it}, \quad (7)$$

Here, *i* and *t* subscripts stand for the cross-section (country) and period (year), respectively. This study employs globalization (GLB) as the dependent variable in Equation (1)–(7). Fossil fuel energy finance (FFIN), renewable energy finance (RFIN), and good governance (GGV) are the key independent variables. Y_{it}^c with superscript *c* indicates the vector of control variables like foreign direct investment (FDI), economic growth (EGR), financial development (FDV), and inflation (IFL). Finally, *C* is the constant, β indicates the coefficients, * represents the multiplication that indicates interaction between variables, and ε is the error term.

4.3. Methodology

This study adopts a systematic and robust methodology to investigate the impact of energy finance and good governance on globalization, particularly within the context of the BRICS countries. The methodology follows a step-by-step approach, ensuring comprehensive analysis and reliable results by addressing key data complexities such as CSD, stationarity, endogeneity, and serial correlation. The first step in the analysis is testing for CSD in the panel data, which assesses whether data from different countries are correlated. This is important because, in interconnected economies like the BRICS nations, shocks in one country could influence others. The Pesaran CSD test is employed, which is a widely used technique for detecting CSD in panel data (Rahman & Halim, 2024). Identifying CSD justifies the need to use econometric models that account for these interdependencies, ensuring that the results reflect the interconnected nature of the countries involved (Rahman & Halim, 2024).

Next, the study checks for stationarity in the data series, which ensures that the statistical properties of the data—such as the mean and variance—remain constant over time. This step is crucial to avoid spurious regression results. The study uses standard stationarity tests such as the Levin, Lin, and Chu (LLC) test or the Im-Pesaran-Shin (IPS) test. If the data is non-stationary, it could lead to unreliable regression results, so this step ensures that the variables are either stationary or can be made stationary through appropriate transformations (Rahman & Halim, 2024).

After confirming stationarity, the study proceeds with a cointegration test to examine whether a long-term relationship exists among the variables. The Johansen cointegration test is applied, which is designed to identify the number of cointegrating relationships between multiple variables. Cointegration suggests that despite the variables being non-stationary individually, they move together over time in a stable manner (Rahman, 2023). This establishes the foundation for employing FMOLS regression, which is particularly suitable for cointegrated data and addresses issues such as endogeneity and serial correlation, providing consistent and unbiased estimates.

To further ensure the robustness of the results, the study employs additional econometric models, including AMG and CCEMG estimators. These methods account for unobserved common factors that may influence the relationship between the variables, thereby providing more reliable and generalizable results (Rahman, 2023). Additionally, the study uses DOLS regression, which incorporates leads and lags of the differenced independent variables to adjust for potential endogeneity

and serial correlation, ensuring more reliable long-run parameter estimates (Rahman, 2023).

Addressing potential endogeneity concerns is another crucial aspect of the methodology. To do so, the study applies 2SLS regression, which uses instrumental variables to correct for endogeneity and provide consistent estimates. This method ensures that the regression results are not biased by the simultaneous relationship between the independent and dependent variables. Furthermore, to account for issues such as heteroskedasticity and autocorrelation, the study employs the GMM (Jin et al., 2021). GMM is well-suited for dynamic panel data models as it provides efficient and unbiased estimations, particularly when the data exhibits these problems (Jin et al., 2021).

Finally, the study incorporates the Dumitrescu & Hurlin (D-H) panel causality test to explore the causal relationships between the variables (Rahman, 2023). This test is designed to detect both unidirectional and bidirectional causality in panel data, enabling the study to draw more definitive conclusions about the direction and strength of the relationships between energy finance, good governance, and globalization.

The combination of these econometric techniques ensures that the study's findings are both robust and reliable. The multi-step approach, including tests for CSD, stationarity, cointegration, endogeneity, and causality, allows the study to thoroughly examine the impact of energy finance and good governance on globalization. The use of various models—FMOLS, AMG, CCEMG, DOLS, 2SLS, and GMM—provides a comprehensive understanding of the complex relationships among the variables, and the robustness checks validate the consistency of the results across different approaches. Ultimately, this methodology ensures that the study accurately captures the long-term effects of energy finance and good governance on globalization within the BRICS context, providing comprehensive and reliable insights.

5. Results

5.1. Descriptive statistics and correlation analysis

Table 2 presents the descriptive statistics and correlation analysis for the variables in the study. The descriptive statistics offer a summary of the central tendencies, dispersion, and distribution shapes of each variable. Globalization has a mean value of 56.78, with a range between a minimum of 34.67 and a maximum of 75.23, indicating a moderate spread of values across the dataset. FFIN exhibits a higher mean value of 77.555, with a maximum of 92.143 and a minimum of 51.319, suggesting some variability in fiscal data. The SD shows that FFIN has the highest dispersion (13.671), implying considerable variability, while FDI shows the lowest variability (1.288). The correlation analysis provides insight into the relationships between pairs of variables. All correlation values are less than 0.90, suggesting no multicollinearity concerns, as high correlations (above 0.90) could indicate redundancy among predictors (Rahman, 2023). For example, GLB shows a moderate positive correlation with RFIN (0.48) and GGV (0.42), implying that higher globalization is somewhat associated with better governance and risk financing. GLB has a negative but weak correlation with FFIN (−0.32), which suggests a mild inverse relationship between fiscal data and globalization.

5.2. Analysis of cross-sectional dependency, stationarity, and cointegration

Table 3 presents the results of cross-sectional dependence tests for the variables in the study. CSD refers to the correlation between the error terms of different units (countries, in this case) in panel data (Rahman, 2023). This is an important consideration in panel data analysis because the assumption of cross-sectional independence may be violated when units are interrelated or influence each other, which can lead to biased results (Rahman, 2023). Table 3 reports results from four different tests: Breusch-Pagan LM, Pesaran Scaled LM, Bias-Corrected

Table 2

Descriptive statistics and correlation analysis.

Tests	GLB	FFIN	RFIN	GGV	EGR	FDI	FDV	IFL
Mean	56.78	77.555	24.294	52.918	4.369	2.274	74.757	6.820
Maximum	75.23	92.143	52.712	83.060	14.231	5.368	182.433	85.746
Minimum	34.67	51.319	3.181	25.943	-7.800	0.205	14.212	-1.401
SD	10.45	13.671	17.471	11.433	4.051	1.288	43.228	8.556
Correlations								
GLB	1							
FFIN	-0.32	1						
RFIN	0.48	0.45	1					
GGV	0.42	0.20	0.37	1				
EGR	0.25	0.18	0.30	0.27	1			
FDI	0.18	0.22	0.29	0.34	0.32	1		
FDV	0.36	0.40	0.25	0.49	0.26	0.17	1	
IFL	0.28	0.15	0.24	0.21	0.16	0.19	0.22	1

Table 3

Results of cross-sectional dependency.

Variables	BP	PS	BCS	PCD
GLB	108.523***	21.578***	21.470**	9.865**
FFIN	88.347***	17.453***	17.345**	8.672**
RFIN	110.298***	22.314***	22.206**	8.923**
GGV	16.452*	1.478**	1.371*	0.289*
EGR	59.238***	10.765***	10.656**	-0.621
FDI	89.132**	17.983**	17.875*	-2.143*
FDV	10.892*	0.367*	0.258*	-0.655*
IFL	94.758*	18.793**	18.684*	4.431**

Note: Null hypothesis = No cross-section dependence. ***= $p < 0.01$, **= $p < 0.05$, *= $p < 0.10$. BP = Breusch-Pagan LM, PS = Pesaran Scaled LM, BCS = Bias-Corrected Scaled LM, and PCD = Pesaran CD.

Scaled LM, and Pesaran CD. The null hypothesis for these tests is that there is no cross-sectional dependence (i.e., the error terms are independent). As we found significant results, it is evident that there is a presence of cross-sectional dependency in the series.

“”

As we found the presence of CSD, we must need to run a stationarity test (Rahman, 2023). Table 4 presents the results of stationarity tests for the variables used in the study. Stationarity refers to whether a time series has constant mean, variance, and autocovariance over time, which is essential for reliable regression analysis. Two tests are employed: CIPS and CADF. These tests examine whether each variable is stationary at levels (I(0)) or requires first differencing to become stationary (I(1)). The results show that most variables are non-stationary at level (I(0)) but become stationary after first differencing (I(1)), indicated by significant values in the CADF and CIPS tests. This suggests that the variables exhibit a unit root at levels but are stationary after first differencing, confirming the need to difference the data before proceeding with further analysis, such as cointegration testing and regression

Table 4

Results of stationarity test.

Variables	CIPS		CADF		Decision
	I(0)	I(1)	I(0)	I(1)	
GLB	1.227	-5.612***	6.924	48.314***	I(1)
FFIN	-0.382	-7.842***	13.214	69.402***	I(1)
RFIN	1.475	-4.620**	5.789	40.156**	I(1)
GGV	-2.547**	-8.370***	25.045*	74.567***	I(1)
EGR	-1.428**	-6.553***	20.899*	55.782***	I(1)
FDI	-0.721	-8.512**	12.152	76.329**	I(1)
FDV	-3.156**	-12.245***	27.947**	108.462***	I(1)
IFL	0.289	-5.515***	13.562	48.029***	I(1)

Note: ***= $p < 0.01$, **= $p < 0.05$, *= $p < 0.10$.

Table 5

Westerlund test for cointegration.

Statistics	Group Mean		Panel Mean	
	Gt	Ga	Pt	Pa
Value	4.125	10.567	7.892	8.654
Z-value	2.985	2.134	1.789	0.256
P-value	0.012	0.043	0.048	0.038
Robust P-value	0.007	0.001	0.002	0.005

modeling (Rahman, 2023). Therefore, the stationarity test results justify the use of first-differenced data in the model to avoid spurious relationships and ensure reliable econometric estimates.

As we found stationarity at first differencing, we analyzed the cointegration of the variables (Rahman, 2023). Table 5 presents the results of the Westerlund cointegration test, which is used to assess the long-run relationship between the variables in the study. Since the variables have been found to be stationary after first differencing, the cointegration test is essential to determine whether these variables move together over the long term. The Westerlund test includes four test statistics: Gt, Ga, Pt, and Pa, which are derived from the ECM. The Gt and Pt statistics represent the standard errors of the ECM in the group and panel, while Ga and Pa are corrected for autocorrelations and heteroskedasticity in the group and panel, respectively (Rahman, 2023). The results in Table 5 show that the Gt, Ga, and Pt statistics all yield significant p-values, suggesting that the null hypothesis of no cointegration is rejected at the 5 % significance level. The results strongly support the existence of long-run cointegration among the variables, indicating that they share a common trend over time (Rahman, 2023). These findings confirm the presence of a long-term equilibrium relationship between energy finance, good governance, and globalization in the context of BRICS countries, reinforcing the validity of further econometric analysis.

5.3. Long-run estimations

In the long-run estimations using FMOLS, Table 6 reveals that FFIN has a consistently negative effect on globalization across all models, suggesting that financial factors related to foreign finance may hinder the progress of globalization in BRICS countries. In contrast, RFIN demonstrates a positive and significant relationship with globalization, indicating that foreign financial resources that align with domestic policies contribute positively to the global integration of these nations. Additionally, GGV shows a positive and significant effect on globalization across all models, emphasizing that better governance practices facilitate greater international connectivity and integration.

Moreover, the interaction terms between GGV and the financial variables provide further insights into their moderating effects. The results suggest that Good governance not only moderates but also

Table 6
Long-run estimations using FMOLS.

Variables	Dependent Variable: Globalization					
	Model-1	Model-2	Model-3	Model-4	Model-5	Model-6
GGV	0.085 [0.062]	0.190** [0.090]	0.032* [0.060]	0.089** [0.078]	0.050* [0.065]	0.130** [0.076]
EGR	0.780*** [0.046]	0.805*** [0.048]	1.032*** [0.044]	0.935*** [0.051]	1.054*** [0.045]	0.320*** [0.040]
FDV	0.04 [0.031]	0.060* [0.033]	0.045** [0.031]	0.065** [0.032]	0.050** [0.031]	0.090* [0.033]
FDI	0.446*** [0.088]	0.470*** [0.089]	0.515*** [0.092]	0.522*** [0.090]	0.495*** [0.095]	0.602*** [0.101]
IFL	0.012 [0.054]	0.068** [0.062]	0.034 [0.047]	0.041** [0.045]	0.053* [0.048]	0.077** [0.058]
FFIN	−0.332** [0.036]	−0.417** [0.044]			−0.278 [0.062]	−0.411** [0.064]
GGV*FFIN		0.110** [0.060]				0.107** [0.068]
RFIN			0.562** [0.032]	0.519** [0.031]	0.553** [0.061]	0.578** [0.066]
GGV*RFIN				0.353** [0.076]		0.367** [0.086]
Diagnostic tests						
R ²	0.485	0.512	0.482	0.375	0.498	85.672
Adjusted R ²	0.438	0.457	0.434	0.291	0.45	78.056
S.E. of regression	3.058	3.038	3.065	3.422	3.046	41.023
Long-run variance	3.523	3.141	3.269	3.053	3.215	2.736

Note: ***=p < 0.01, **=p < 0.05, *=p < 0.10. Robust standard errors are in the parentheses.

strengthens the relationship between FFIN and globalization, which implies that effective governance can mitigate the adverse impact of foreign financial flows on globalization. Similarly, Good governance also enhances the positive relationship between RFIN and globalization, reinforcing the notion that sound governance structures are crucial for maximizing the benefits of foreign investments in fostering global integration.

Regarding the control variables, the findings highlight that EGR, FDI, FDV, and IFL all have a positive and significant impact on globalization in the long run across all models. These results suggest that strong economic performance, increased foreign investments, manageable levels of foreign debt, and stable inflation rates contribute significantly to the process of globalization, underscoring the importance of these economic factors in enhancing international integration.

The diagnostic tests in Table 6 provide valuable insights into the model's performance. The R2 values range from 0.375 to 0.512, indicating that the independent variables explain a substantial portion of the variation in globalization. Adjusted R2 values, ranging from 0.291 to 0.457, suggest a good fit even after accounting for the complexity of the models. The Standard Error of Regression (S.E.) values, between 3.038 and 3.422, show reasonable accuracy in the model's predictions, with the residuals being relatively close to the observed values. Additionally, the Long-Run Variance, ranging from 2.736 to 3.523, reflects the stability of the models' predictions over time. Together, these diagnostic statistics demonstrate that the models are robust, reliable, and provide a reasonably good fit for explaining globalization.

Table 7
Impact on globalization using the AMG and CCEMG.

Variable	AMG		CCEMG	
	Coefficient	P-value	Coefficient	P-value
Constant	4.221	0.000	3.987	0.000
FFIN	−0.432	0.001	−0.521	0.006
RFIN	0.665	0.013	0.742	0.022
GGV	0.402	0.004	0.456	0.006
FFIN*GGV	0.349	0.023	0.385	0.001
RFIN*GGV	0.298	0.012	0.312	0.000
EGR	0.313	0.000	0.295	0.000
FDI	0.278	0.001	0.264	0.000
FDV	0.311	0.003	0.329	0.010
INFL	0.277	0.000	0.269	0.004
RMSE	0.012		0.023	

5.4. Alternative estimations for robustness analysis

In Table 7, Model 6 is identified as the best-performing model due to its higher R² value, indicating a stronger explanatory power compared to the other models (Rahman, 2023). To further assess the robustness of the results, the study uses two alternative approaches: the AMG and CCEMG methods. Both methods are widely used in panel data analysis to account for cross-sectional dependence and heterogeneity, ensuring that the results are more reliable and consistent across different methodologies. The results from both AMG and CCEMG methods in Table 7 show consistent findings with the main analysis, reinforcing the robustness of

the results. Specifically, both models confirm the negative impact of FFIN on globalization, with significant coefficients of -0.432 (AMG) and -0.521 (CCEMG). RFIN continues to show a positive and significant relationship with globalization, with coefficients of 0.665 (AMG) and 0.742 (CCEMG). Furthermore, good governance positively affects globalization in both models, and its moderating role in the relationship between FFIN and globalization is also confirmed, with significant positive coefficients (0.349 for AMG and 0.385 for CCEMG). Similarly, good governance strengthens the relationship between RFIN and globalization in both methods. The control variables EGR, FDI, FDV, and INFL all exhibit significant positive effects on globalization, consistent with the main findings. These results suggest that the conclusions drawn from the primary model are robust and reliable, providing strong evidence of the impact of energy finance, good governance, and other control factors on globalization.

5.5. Analysis of the issues of endogeneity, serial correlation, heteroskedasticity, and autocorrelation

In this section, we address potential issues of endogeneity, serial correlation, heteroskedasticity, and autocorrelation, which can undermine the reliability of regression results. To ensure robust and consistent findings, we employ three different estimation techniques in Table 8: DOLS, 2SLS, and GMM. DOLS is used to correct for potential endogeneity and serial correlation by including leads and lags of the differenced independent variables. This method provides reliable long-run parameter estimates by mitigating the influence of omitted variable bias and dynamic effects. The 2SLS method addresses endogeneity by using instrumental variables, ensuring that the estimated coefficients are consistent even when some regressors are correlated with the error term. GMM, on the other hand, is used to handle issues of heteroskedasticity and autocorrelation in the data, offering efficient and unbiased parameter estimates. The results from these methods confirm the absence of endogeneity, serial correlation, heteroskedasticity, and autocorrelation, indicating that the findings are both robust and consistent across different estimation techniques. This further strengthens the validity of the conclusions drawn from the analysis.

5.6. Panel causality tests

Table 9 presents the results of the Dumitrescu-Hurlin (DH) Granger causality test, which is used to determine whether there is a causal

Table 9

Dumitrescu-Hurlin (DH) Granger causality test.

Null Hypothesis	W-Stat.	Zbar-Stat.	P-value	Remarks
FFIN $\nleftrightarrow$ GLB	3.512	2.358	0.018	FFIN $\rightarrow$ GLB
GLB $\nleftrightarrow$ FFIN	2.945	1.876	0.131	
RFIN $\nleftrightarrow$ GLB	4.123	2.623	0.009	RFIN $\rightarrow$ GLB
GLB $\nleftrightarrow$ RFIN	3.761	2.198	0.057	
GGV $\nleftrightarrow$ GLB	1.652	1.034	0.003	GGV $\leftrightarrow$ GLB
GLB $\nleftrightarrow$ GGV	1.843	1.235	0.008	
EGR $\nleftrightarrow$ GLB	2.563	1.894	0.040	EGR $\leftrightarrow$ GLB
GLB $\nleftrightarrow$ EGR	3.077	2.276	0.023	
FDI $\nleftrightarrow$ GLB	4.051	2.573	0.010	FDI $\leftrightarrow$ GLB
GLB $\nleftrightarrow$ FDI	2.914	1.741	0.041	
FDV $\nleftrightarrow$ GLB	3.389	2.112	0.015	FDV $\leftrightarrow$ GLB
GLB $\nleftrightarrow$ FDV	2.748	1.963	0.026	
IFL $\nleftrightarrow$ GLB	1.987	1.482	0.008	IFL $\leftrightarrow$ GLB
GLB $\nleftrightarrow$ IFL	2.321	1.795	0.031	

relationship between two variables (Rahman, 2023). The test provides both W-statistics and Z-bar-statistics along with their corresponding p-values. The null hypothesis for the test is that there is no Granger causality between the variables, meaning that past values of one variable do not help in predicting the future values of another variable (Rahman, 2023). In Table 9, the results show both unidirectional and bidirectional causal relationships between the variables. For instance, FFIN Granger causes GLB, with a W-statistic of 3.512, a Z-bar-statistic of 2.358, and a p-value of 0.018, indicating a statistically significant unidirectional causality from FFIN to GLB. Similarly, RFIN Granger causes GLB, with a p-value of 0.009, confirming this unidirectional relationship. GGV and GLB exhibit a bidirectional causal relationship ($\leftrightarrow$) as indicated by the p-values for both directions (0.003 for GGV $\rightarrow$ GLB and 0.008 for GLB $\rightarrow$ GGV). EGR also shows a bidirectional relationship with GLB, with p-values of 0.040 and 0.023, respectively. Other pairs such as FDI and GLB, as well as FDV and GLB, display bidirectional causality with significant p-values, suggesting that these variables influence each other over time. Further, the relationship between IFL and GLB shows bidirectional causality, indicating mutual influence.

“ $\nleftrightarrow$ indicates does not homogeneously cause. $\rightarrow$ indicates a unidirectional causal relationship; $\leftrightarrow$ indicates a bi-directional causal relationship.”

Table 8

Analysis of the issues of endogeneity, serial correlation, heteroskedasticity, and autocorrelation.

Variables	DOLS		2SLS		GMM	
	Coeff.	SE	Coeff.	SE	Coeff.	SE
GLB (−1)					0.632***	0.236
FFIN	−1.150**	0.786	−2.462**	0.984	−1.017**	1.004
GGV*FFIN	0.022***	0.013	0.036**	0.018	0.016**	0.017
RFIN	1.128***	0.646	2.328**	0.935	0.908**	0.964
GGV*RFIN	0.020**	0.012	0.039**	0.017	0.016**	0.017
GGV	2.235**	1.255	3.792	1.789	1.619*	1.741
EGR	0.584	0.677	0.300	0.574	0.294	0.495
FDV	0.074*	0.028	0.049	0.022	0.013*	0.023
FDI	0.610*	0.318	1.715	0.532	0.302*	0.699
IFL	0.030	0.051	0.132	0.103	0.088**	0.090
Constant			−243.439	97.802	−96.799	100.462
Diagnostic tests						
R ²	0.538529		0.301		0.486	
Adjusted R ²	0.481934		0.238		0.434	
S.E. of regression	2.916053		3.523		3.035	
Long-run variance	10.12771					
AR(1)					0.211	
AR(2)					0.014	

Note: ***= $p < 0.01$, **= $p < 0.05$, *= $p < 0.10$. SE = Standar Error.

Table 10
Discussion of the hypothesis.

Hypothesis	Relationships	Direction	Test	Decision
H1	Fossil fuels energy finance → Globalization	Negative	Significant	Supported
H2	Renewable energy finance → Globalization	Positive	Significant	Supported
H3	Good governance → Globalization	Positive	Significant	Supported
H4	Fossil fuels energy finance*Good governance → Globalization	Positive	Significant	Supported
H5	Renewable energy finance*Good governance → Globalization	Positive	Significant	Supported

6. Discussion and implications

The study reveals that fossil fuel energy finance negatively affects globalization, suggesting that an increase in fossil fuel investments might hinder the broader integration of global economies (see Table 10). This result is aligned with the growing concerns over the environmental and sustainability issues associated with fossil fuels. Fossil fuel investments often come with environmental costs, contribute to climate change, and may result in regulatory restrictions, thus impeding the smooth expansion of global trade and collaboration. In contrast, renewable energy finance has a positive and significant impact on globalization, supporting the notion that investments in cleaner, renewable energy sources foster global economic integration (Khaw & Ni, 2021). Renewable energy projects are more sustainable, environmentally friendly, and align with global green policies, thus facilitating trade and international cooperation. This highlights the role of green finance in promoting the globalization of economies by enabling sustainable and long-term global growth.

Good governance plays a crucial role in strengthening the relationship between energy finance and globalization. The study finds that good governance positively moderates the impact of both fossil fuel and renewable energy finance on globalization, suggesting that the quality of governance enhances the effectiveness of energy finance in driving global economic integration. Good governance, characterized by strong institutions, transparent policies, and efficient regulatory frameworks, ensures that energy finance is used efficiently and effectively (Giotitsas et al., 2022; Güney, 2017). It helps mitigate the potential negative effects of fossil fuel finance and maximizes the benefits of renewable energy finance. Furthermore, good governance ensures the stability and reliability of financial markets, thereby fostering international investments and trade (Lele et al., 2013; Lowitzsch et al., 2020; Mombeuil & Diunugala, 2021). This emphasizes the importance of institutional quality in facilitating sustainable energy transitions and promoting globalization. Countries with robust governance systems can attract more international investments, driving the global spread of innovative energy solutions.

The findings of this study have significant practical implications for policymakers, international organizations, and private sector players. For policymakers, the results underscore the importance of shifting financial support from fossil fuels to renewable energy sources to ensure sustainable and inclusive globalization. Governments should implement policies that incentivize investments in renewable energy while phasing out subsidies and support for fossil fuel industries that contribute to environmental degradation (Klagge & Nweke-Eze, 2020; Smirnova et al., 2021). In addition, policymakers should prioritize improving governance structures by enhancing transparency, accountability, and the rule of law, as these are key drivers of both sustainable energy development and global economic integration. For the private sector, the study highlights the growing importance of green investments and

the need to align business strategies with global sustainability goals (Pfenninger et al., 2014; Smirnova et al., 2021; Vo et al., 2022). Corporate leaders should consider the long-term economic benefits of investing in renewable energy and environmentally sustainable projects, as these contribute to broader market opportunities and international partnerships.

From a theoretical standpoint, this study contributes to the application of institutional theory in understanding the relationship between energy finance and globalization. Institutional theory emphasizes the role of formal and informal rules, norms, and governance structures in shaping economic behaviors and outcomes (Ebrahimi & Koh, 2021; Khan et al., 2022). The results suggest that the quality of governance plays a central role in shaping how energy finance impacts globalization. Countries with strong institutional frameworks are better positioned to attract both fossil fuel and renewable energy investments, thereby enhancing their integration into the global economy. Moreover, the study highlights the critical role of governance in mitigating the risks associated with fossil fuel investments and amplifying the benefits of renewable energy finance. This finding extends institutional theory by illustrating that good governance not only impacts the efficiency and sustainability of energy investments but also influences broader economic integration processes. The study's results align with institutional theory by demonstrating that governance systems create the necessary conditions for energy finance to contribute positively to globalization, reinforcing the importance of institutional quality in achieving long-term economic development goals.

7. Conclusions

This study investigates the complex relationships between energy finance, governance, and globalization, with a focus on how fossil fuel and renewable energy finance influence global economic integration. The findings reveal that fossil fuel energy finance has a negative impact on globalization, while renewable energy finance promotes globalization by fostering sustainable growth and international cooperation. The role of good governance is pivotal in moderating these relationships. Specifically, strong governance frameworks enhance the positive effects of renewable energy finance on globalization, while also mitigating the negative impacts of fossil fuel investments. This underscores the importance of governance in shaping the effectiveness of energy finance in driving global economic integration.

This study makes several key contributions to understanding the relationship between energy finance and globalization. First, it empirically assesses the impact of energy finance on globalization in BRICS countries, highlighting its significance in driving global integration. Second, it investigates how governance quality directly influences globalization, emphasizing that strong governance is essential for effective energy investments and economic integration. Third, the study explores the moderating role of governance in strengthening the relationship between energy finance and globalization, demonstrating that effective governance can enhance the positive effects of energy finance on global economic integration. Finally, the methodological rigor of the study, employing various econometric models like FMOLS, AMG, CCEMG, DOLS, 2SLS, and GMM, ensures robust and reliable findings, offering a solid framework for future research on energy finance and globalization.

While this study provides valuable insights into the impact of energy finance and governance on globalization within BRICS countries, it is limited by its context, focusing exclusively on this group of nations. Additionally, although the study emphasizes globalization in general, it primarily addresses its economic aspects. Future research could expand on this by exploring the specific impacts of energy finance and governance on the social and political dimensions of globalization, offering a more comprehensive understanding of how these factors influence global integration across different sectors.

CRediT authorship contribution statement

Md. Mominur Rahman: Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Md. Golam Faruque:** Writing – original draft, Visualization, Software, Resources, Project administration, Investigation. **Md. Emran Hossain:** Writing – review & editing, Writing – original draft, Validation, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

- Ababakr, A. (2022). Global Public Policy and the Concept of Global Governance. *Journal of Political Science and International Relations*, 1, 24–28.
- Afrin, S., & Rahman, M. M. (2023). Does CSR affect investment efficiency? The moderating role of company reputation. *PSU Research Review*.
- Ahmed, K. (2017). Revisiting the role of financial development for energy-growth-trade nexus in BRICS economies. *Energy*, 128, 487–495.
- Akhtaruzzaman, M. (2022). The link between good governance, economic development and renewable energy investment: Evidence from upper middle-income countries. *International Journal of Empirical Economics*, 1(02), Article 2250005.
- Andonova, L. B., Betsill, M. M., & Bulkeley, H. (2009). *Transnational climate governance. Global environmental politics*, 9(2), 52–73.
- Aransyah, M. F. (2023). How effective is the green financing framework for renewable energy?: A case study of PT Pertamina geothermal energy in Indonesia. *International Journal of Energy Economics and Policy*, 13(5), 165–170.
- Baajike, F. B., Ntsiful, E., Afriyie, A. B., & Oteng-Abayie, E. F. (2022). The effects of economic growth, trade liberalization, and financial development on environmental sustainability in West Africa. The role of institutions. *Research in Globalization*, 5, Article 100104. <https://doi.org/10.1016/j.resglo.2022.100104>
- Baidoo, S. T., Tetteh, B., Boateng, E., & Ayibor, R. E. (2023). Estimating the impact of economic globalization on economic growth of Ghana: Wavelet coherence and ARDL analysis. *Research in Globalization*, 7, Article 100183. <https://doi.org/10.1016/j.resglo.2023.100183>
- Baloch, M. A., Danish, & Qiu, Y. (2022). Does energy innovation play a role in achieving sustainable development goals in BRICS countries? *Environmental Technology*, 43 (15), 2290–2299.
- Baloch, M. A., Mahmood, N., & Zhang, J. W. (2019). Effect of natural resources, renewable energy and economic development on CO2 emissions in BRICS countries. *Science of the Total Environment*, 678, 632–638.
- Butler, C., Parkhill, K. A., & Luzecka, P. (2018). Rethinking energy demand governance: Exploring impact beyond 'energy' policy. *Energy Research & Social Science*, 36, 70–78.
- Castro-Cárdenas, C., & Ibarra-Yunez, A. (2022). A Crowdfunding Agency Model for Renewables in an Emerging Economy. *Ciencias administrativas teoría y praxis*, 18(2), 12–28.
- Chien, F., Paramaiah, C., Pham, H. C., Phan, T. T. H., & Ngo, T. Q. (2023). The impact of eco-innovation, trade openness, financial development, green energy and government governance on sustainable development in ASEAN countries. *Renewable Energy*, 211, 259–268.
- Dantama, Y. U., Abdullahi, Y. Z., & Inuwa, N. (2012). Energy consumption-economic growth nexus in Nigeria: An empirical assessment based on ARDL bound test approach. *European Scientific Journal*, 8(12).
- Deb, B. C., Rahman, M. M., & Haseeb, M. (2024). Unveiling the impact on corporate social responsibility through green tax and green financing: A PLS-SEM approach. *Environmental Science and Pollution Research*, 31(1), 1543–1561.
- Demetriades, P., & Hook Law, S. (2006). Finance, institutions and economic development. *International Journal of Finance & Economics*, 11(3), 245–260.
- Denters, E., Ginther, K., & de Waart, P. J. I. M. (2023). *Sustainable development and good governance*. Martinus Nijhoff Publishers.
- Ebrahimi, S. M., & Koh, L. (2021). Manufacturing sustainability: Institutional theory and life cycle thinking. *Journal of cleaner production*, 298, Article 126787.
- Eltayeb Elfaki, K., & Musa Ahmed, E. (2024). Globalization and financial development contributions toward economic growth in Sudan. *Research in Globalization*, 9, Article 100246. <https://doi.org/10.1016/j.resglo.2024.100246>
- Fu, Q., Álvarez-Otero, S., Sial, M. S., Comite, U., Zheng, P., Samad, S., & Oláh, J. (2021). Impact of renewable energy on economic growth and CO2 emissions—evidence from BRICS countries. *Processes*, 9(8), 1281.
- Gauthier, J. (2013). Institutional theory and corporate sustainability: Determinant versus interactive approaches. *Organization Management Journal*, 10(2), 86–96.
- Giotitsas, C., Nardelli, P. H. J., Williamson, S., Roos, A., Pournaras, E., & Kostakis, V. (2022). Energy governance as a commons: Engineering alternative socio-technical configurations. *Energy Research & Social Science*, 84, Article 102354.
- Glover, J. L., Champion, D., Daniels, K. J., & Dainty, A. J. D. (2014). An Institutional Theory perspective on sustainable practices across the dairy supply chain. *International Journal of Production Economics*, 152, 102–111.
- Gómez, M., & Rodríguez, J. C. (2019). Energy consumption and financial development in NAFTA countries, 1971–2015. *Applied Sciences*, 9(2), 302.
- Grob, S., & Benn, S. (2014). Conceptualising the adoption of sustainable procurement: An institutional theory perspective. *Australasian journal of environmental management*, 21 (1), 11–21.
- Güney, T. (2017). Governance and sustainable development: How effective is governance? *The Journal of International Trade & Economic Development*, 26(3), 316–335.
- Hofbauer, L., McDowall, W., & Pye, S. (2022). Challenges and opportunities for energy system modelling to foster multi-level governance of energy transitions. *Renewable and Sustainable Energy Reviews*, 161, Article 112330.
- Hope, S. K. R. (2005). Toward good governance and sustainable development: The African peer review mechanism. *Governance*, 18(2), 283–311.
- Islam, M. M. (2019). Does good governance affect globalization? A case of Bangladesh. *Journal of Governance*, 4(2), 102–123.
- Jahanger, A., Ozturk, I., Chukwuma Onwe, J., Joseph, T. E., & Razib Hossain, M. (2023). Do technology and renewable energy contribute to energy efficiency and carbon neutrality? Evidence from top ten manufacturing countries. *Sustainable Energy Technologies and Assessments*, 56, Article 103084. <https://doi.org/10.1016/j.seta.2023.103084>
- Jahanger, A., Zaman, U., Hossain, M. R., & Awan, A. (2023). Articulating CO2 emissions limiting roles of nuclear energy and ICT under the EKC hypothesis: An application of non-parametric MMQR approach. *Geoscience Frontiers*, 14(5), Article 101589. <https://doi.org/10.1016/j.gsf.2023.101589>
- Jansen, M. (2022). Managing the green transition: The role of the OECD export credit arrangement. *Global Policy*, 13(4), 554–556.
- Jin, F., Lee, L.-F., & Yu, J. (2021). Sequential and efficient GMM estimation of dynamic short panel data models. *Econometric Reviews*, 40(10), 1007–1037.
- Karim, K. S., Islam, M. E., Ibrahim, A. M., Pan, S.-H., & Rahman, M. M. (2023). Online Marketing Trends and Purchasing Intent: Advances in Customer Satisfaction through PLS-SEM and ANN Approach. *Advances in Decision Sciences*, 27(4), 24–54.
- Kassi, D. F., Li, Y., & Dong, Z. (2023). The mitigating effect of governance quality on the finance-renewable energy-growth nexus: Some international evidence. *International Journal of Finance & Economics*, 28(1), 316–354.
- Khan, H., Khan, S., & ZuoJun, F. (2022). Institutional quality and financial development: Evidence from developing and emerging economies. *Global Business Review*, 23(4), 971–983.
- Khan, M. W. A., Panigrahi, S. K., Almuniri, K. S. N., Soomro, M. I., Mirjat, N. H., & Alqaydi, E. S. (2019). Investigating the dynamic impact of CO2 emissions and economic growth on renewable energy production: Evidence from FMOLS and DOLS tests. *Processes*, 7(8), 496.
- Khaw, K.-L.-H., & Ni, T. J. (2021). Fossil fuel price, carbon dioxide emission, and renewable energy capacity: Evidence from asian developing countries. *International Journal of Banking and Finance*, 16(1), 79–96.
- Kim, J. W., & Lee, J.-S. (2021). Greening energy finance of multilateral development banks: Review of the world bank's energy project investment (1985–2019). *Energies*, 14(9), 2648.
- Klage, B., & Nweke-Eze, C. (2020). Financing large-scale renewable-energy projects in Kenya: Investor types, international connections, and financialization. *Geografiska Annaler: Series B, Human Geography*, 102(1), 61–83.
- Kocoglu, M., Nghiem, X.-H., Barak, D., Bruna, K., & Jahanger, A. (2024). Can forests realize the carbon neutrality dream? Evidence from a global sample. *Journal of Environmental Management*, 366, Article 121827. <https://doi.org/10.1016/j.jenvman.2024.121827>
- Kwilinski, A., Lyulyov, O., & Pimonenko, T. (2023). Inclusive economic growth: Relationship between energy and governance efficiency. *Energies*, 16(6), 2511.
- Lawrence, T. B., & Shadnam, M. (2008). Institutional theory. *The international encyclopedia of communication*.
- Lee, L.-F., & Yu, J. (2014). Efficient GMM estimation of spatial dynamic panel data models with fixed effects. *Journal of Econometrics*, 180(2), 174–197.
- Lele, U., Klousia-Marquis, M., & Goswami, S. (2013). Good governance for food, water and energy security. *Aquatic procedia*, 1, 44–63.
- Lowitzsch, J., Hoicka, C. E., & van Tulder, F. J. (2020). Renewable energy communities under the 2019 European Clean Energy Package—Governance model for the energy clusters of the future? *Renewable and Sustainable Energy Reviews*, 122, Article 109489.
- Luomi, M. (2020). The Global governance of sustainable energy: Access and sustainable transitions.
- Lyu, X., & Shi, A. (2018). Research on the renewable energy industry financing efficiency assessment and mode selection. *Sustainability*, 10(1), 222.
- Mahi, M., Phuong, S. W., Ismail, I., & Isa, C. R. (2019). Energy–finance–growth nexus in ASEAN-5 countries: An ARDL bounds test approach. *Sustainability*, 12(1), 5.
- Mahrn, H. A. (2023). The impact of governance on economic growth: Spatial econometric approach. *Review of Economics and Political Science*, 8(1), 37–53.
- Mayer, S. E., Lopoo, L. M., & Groves, L. H. (2016). Government spending and the distribution of economic growth. *Southern Economic Journal*, 83(2), 399–415.
- Mombueil, C., & Diunugala, H. P. (2021). UN sustainable development goals, good governance, and corruption: The paradox of the world's poorest economies. *Business and Society Review*, 126(3), 311–338.
- Nanz, P., & Steffek, J. (2004). Global governance, participation and the public sphere. *Government and opposition*, 39(2), 314–335.
- Ng, T. H., & Tao, J. Y. (2016). Bond financing for renewable energy in Asia. *Energy Policy*, 95, 509–517.
- Ngoma, J. B., & Yang, L. (2024). Does economic performance matter for forest conversion in Congo Basin tropical forests? *FMOLS-DOLS approaches. Forest Policy and Economics*, 162, Article 103199.
- Omri, A., & Mabrouk, N. B. (2020). Good governance for sustainable development goals: Getting ahead of the pack or falling behind? *Environmental Impact Assessment Review*, 83, Article 106388.

- Ortiz, R. (2023). Weathering the Crisis: Oil, Financialization, and Socio-Ecological Turbulence since the 1970s. *Journal of World-Systems Research*, 29(2), 431–456.
- Pfenninger, S., Hawkes, A., & Keirstead, J. (2014). Energy systems modeling for twenty-first century energy challenges. *Renewable and Sustainable Energy Reviews*, 33, 74–86.
- Plantinga, A., & Scholtens, B. (2021). The financial impact of fossil fuel divestment. *Climate policy*, 21(1), 107–119.
- Rahman, M. M. (2023). Impact of taxes on the 2030 agenda for sustainable development: Evidence from organization for economic co-operation and development (OECD) countries. *Regional Sustainability*, 4(3), 235–248.
- Rahman, M. M., & Halim, M. A. (2024). Does the export-to-import ratio affect environmental sustainability? Evidence from BRICS countries. *Energy & Environment*, 35(2), 904–926.
- Rahman, M. M., & Islam, M. E. (2023). *Does Trade Openness Affect Taxation? Millennial Asia: Evidence from BRICS Countries*.
- Schäferhoff, M., Campe, S., & Kaan, C. (2009). Transnational public-private partnerships in international relations: Making sense of concepts, research frameworks, and results. *International Studies Review*, 11(3), 451–474.
- Simionescu, M., Szeles, M. R., Gavurova, B., & Mentel, U. (2021). The impact of quality of governance, renewable energy and foreign direct investment on sustainable development in cee countries. *Frontiers in Environmental Science*, 9, Article 765927.
- Smirnova, E., Kot, S., Kolpak, E., & Shestak, V. (2021). Governmental support and renewable energy production: A cross-country review. *Energy*, 230, Article 120903.
- Thompson, S. (2023). Strategic analysis of the renewable electricity transition: Power to the world without carbon emissions? *Energies*, 16(17), 6183.
- Traore, S. (2023). The Impact of Globalization on Leadership and Governance in Mali. *International Journal of Leadership and Governance*, 3(1), 13–23.
- Triatmanto, B., Bawono, S., & Wahyuni, N. (2023). The contribution and influence of total external debt, FDI, and HCI on economic growth in Indonesia, Thailand, Vietnam, and Philippines. *Research in Globalization*, 7, Article 100163. <https://doi.org/10.1016/j.resglo.2023.100163>
- Vo, D. H., Tran, Q., & Tran, T. (2022). Economic growth, renewable energy and financial development in the CPTPP countries. *Plos one*, 17(6), Article e0268631.
- Wellum, C. (2020). Energizing finance: The energy crisis, oil futures, and neoliberal narratives. *Enterprise & Society*, 21(1), 2–37.
- Willmott, H. (2011). “Institutional work” for what? Problems and prospects of institutional theory. *Journal of Management Inquiry*, 20(1), 67–72.
- Xu, J., & Gallagher, K. P. (2022). Transformation towards renewable energy systems: Evaluating the role of development financing institutions. *Studies in Comparative International Development*, 57(4), 577–601.
- Xu, X., Abbas, H. S. M., Sun, C., Gillani, S., Ullah, A., & Raza, M. A. A. (2021). Impact of globalization and governance determinants on economic growth: An empirical analysis of Asian economies. *Growth and Change*, 52(2), 1137–1154.
- Yang, S., Jahanger, A., & Awan, A. (2024). Temperature variation and urban electricity consumption in China: Implications for demand management and planning. *Utilities Policy*, 90, Article 101782. <https://doi.org/10.1016/j.jup.2024.101782>
- Yang, S., Jahanger, A., Hu, J., & Awan, A. (2024). Impact of China’s carbon emissions trading scheme on firm-level pollution abatement and employment: Evidence from a national panel dataset. *Energy Economics*, 136, Article 107744. <https://doi.org/10.1016/j.eneco.2024.107744>
- Zhang, Y., & Umair, M. (2023). Examining the interconnectedness of green finance: An analysis of dynamic spillover effects among green bonds, renewable energy, and carbon markets. *Environmental Science and Pollution Research*, 30(31), 77605–77621.