



Impact of Financial Institution efficiency, Financial Market efficiency, Fiscal Policy, and Institutional Quality on Inclusive Green Growth in Bangladesh

ABSTRACT

Md. Amzad Hossain

Department of Economics &
Banking, Bangladesh

Corresponding author e-mail:
amzad@iiuc.ac.bd

This study examines the effects of financial efficiency, institutional quality, fiscal policy, and natural resources on inclusive green growth in Bangladesh during 1990–2025. Unlike previous studies that primarily focus on the direct effects of financial development, this study distinguishes between the efficiency of financial institutions and financial markets to provide a more comprehensive understanding of their contributions to sustainable development. The study employs the Kernel based Regularized Least Squares (KRLS) approach, estimating both average marginal effects and pointwise KRLS average marginal effects to identify nonlinear and heterogeneous relationships across observations. The empirical findings show that financial institution efficiency plays a significant role in promoting inclusive green growth by improving the allocation of financial resources toward productive and environmentally sustainable activities. In contrast, financial market efficiency has a negative effect, suggesting that efficient financial markets may continue financing environmentally intensive investments in the absence of adequate green finance incentives. Institutional quality and fiscal policy have significant positive effects, highlighting the importance of good governance and effective public expenditure in achieving sustainable and inclusive development. Natural resources also contribute positively, indicating that responsible and sustainable resource management can support long term development. The findings emphasize the need to strengthen financial institutions, improve governance, implement green fiscal policies, and manage natural resources sustainably. Fiscal policy should prioritize green public investment, climate-resilient infrastructure, and environmentally sustainable initiatives. Stronger monitoring, conservation, and community participation are also essential for responsible resource management. Together, these measures can help Bangladesh achieve economic growth while advancing social inclusion and environmental sustainability.

Keywords: Bangladesh; Financial Institution Efficiency; Financial Market Efficiency; Inclusive Green Growth

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INTRODUCTION

Inclusive green growth is one of the most pressing policy challenges for developing economies. Countries are increasingly expected to sustain economic growth while protecting environmental quality and ensuring that the benefits of development are

distributed more equitably. The financial system is an important component of this transition because it determines how savings and capital are mobilized and allocated across economic activities. A well-functioning banking system can support green growth by improving the allocation of financial resources, financing productive investment, and facilitating the adoption of renewable energy and cleaner technologies. Financial inclusion can further expand access to financial services, allowing a broader segment of the population to participate in sustainable economic activities. The rapid development of digital finance has reinforced this process by improving financial accessibility, expanding the scope of financial services, and accelerating digitalization, thereby contributing to more inclusive green development (Song et al., 2022).

However, the relationship between finance and green growth is not necessarily linear or uniformly positive. For example, green credit policies may negatively affect green innovation among some non-state-owned firms by restricting their access to credit (Yin et al., 2023). This suggests that relying on a single financing mechanism may be insufficient and that diversified financial channels are necessary to ensure effective financial intermediation toward environmental objectives (Yin et al., 2023). The effectiveness of financial interventions also depends on institutional and structural conditions, including human capital, marketization, and environmental regulation (Song et al., 2022; Wu et al., 2025). Human capital, for instance, generates greater benefits when combined with digital inclusive finance than when operating independently (Song et al., 2022). These findings indicate that inclusive green growth depends not only on financial development itself but also on how different financial mechanisms interact with broader macroeconomic and institutional policies. Sustainable financial intermediation and effective fiscal policy can therefore play complementary roles in promoting economic growth that is socially inclusive and environmentally sustainable, particularly by reducing barriers faced by disadvantaged groups in accessing green development opportunities (Batool et al., 2023).

These challenges are particularly relevant to Bangladesh, where economic development and environmental vulnerability are closely interconnected. Bangladesh is among the countries highly exposed to sea-level rise and the adverse effects of climate change (Nicholls et al., 2018; Karim et al., 2019; Molla, 2016). In addition to climate-related risks, the country faces natural resource depletion, environmentally damaging activities such as brick-kiln operations and brackish-water shrimp farming, inadequate waste-management facilities, limited industrial ecological capacity, rapid population growth, and persistent poverty. These structural challenges complicate efforts to reconcile export-oriented economic growth with environmental sustainability (Nicholls et al., 2018). The country's ability to respond to these challenges is strongly influenced by institutional and policy capacity. Institutional quality is therefore increasingly recognized as an important determinant of green development, particularly through its influence on environmental regulation, policy implementation, transparency, accountability, and regulatory enforcement (Ahmed, 2026; Toufique, 2024). Institutional rigidity, bureaucratic inefficiencies, and limited inclusiveness can constrain Bangladesh's capacity to respond effectively to climate-related challenges (Rahman & Hickey, 2019), while

dependence on short-term donor funding may also limit the ability of NGOs to undertake long-term resilience-building initiatives (Hossain & Huq, 2013). Collectively, these conditions highlight the importance of stronger institutions, effective environmental regulation, cleaner energy systems, and sustainable resource management for green development in Bangladesh (Ahmed, 2026; Karim et al., 2019; Toufique, 2024).

Although financial development, institutional quality, and fiscal policy have been identified as important determinants of green growth, the existing literature remains fragmented. Institutional quality (Ahmed, 2026; Toufique, 2024), fiscal expenditure (Putri et al., 2024), and financial development have generally been examined separately, providing limited evidence on how these factors jointly shape inclusive green growth. Most existing studies also treat financial development as a broad and homogeneous concept, without sufficiently distinguishing between financial institutions and financial markets. This distinction is particularly important in Bangladesh because the country's financial system is strongly bank-dominated. The banking sector accounted for approximately 88% of total financial sector assets in June 2024, while the capital market remained relatively shallow. More recent evidence indicates that the banking sector accounts for about 90% of total financial sector assets, underscoring the central role of banks in financial intermediation and resource allocation in Bangladesh.

This bank-dominated structure provides a specific theoretical and contextual rationale for distinguishing Financial Institution Efficiency (FIE) from Financial Market Efficiency (FME). FIE captures the ability of banks and other financial intermediaries to mobilize savings, allocate credit, manage financial resources, and provide financial services efficiently. In contrast, FME reflects the capacity of market-based mechanisms to allocate capital through securities and other market instruments. These two financial channels perform different economic functions and may therefore generate different effects on inclusive green growth. In Bangladesh, where banks constitute the dominant component of the financial system, improvements in FIE may have a particularly direct effect on credit allocation, investment financing, financial inclusion, and the capacity of firms to adopt sustainable technologies. At the same time, FME remains relevant because capital-market mechanisms can mobilize longer-term financing and influence the allocation of investment across sectors. The relatively smaller role of market-based finance does not make FME irrelevant; rather, it creates an important empirical question regarding whether market efficiency produces effects that differ from those generated by bank-based financial intermediation.

The distinction is particularly important because greater financial efficiency does not automatically imply greater environmental sustainability. Efficient banks may improve the allocation of credit toward productive and green activities when appropriate environmental standards and incentives are in place. Conversely, more efficient financial markets may facilitate the rapid movement of capital toward sectors offering high financial returns but generating substantial environmental pressures when environmental risks are not adequately incorporated into investment decisions. Therefore, combining FIE and FME into a single measure of financial development could mask heterogeneous or even opposing effects on inclusive green growth. This issue is

especially relevant for Bangladesh, where the dominance of bank-based finance coexists with efforts to deepen capital markets and mobilize private investment for long-term development. The World Bank has emphasized both the importance of strengthening the banking sector and the need to expand financial-sector capacity to support investment, resilience, and sustainable development in Bangladesh.

This distinction also addresses an important policy issue. Bangladesh's banking sector faces substantial structural challenges, including weak corporate governance, regulatory deficiencies, related-party lending, and high levels of non-performing loans, which can reduce the efficiency of financial intermediation. Consequently, improving FIE in Bangladesh is not simply a matter of expanding the volume of financial resources; it requires improving the quality and efficiency of financial resource allocation. At the same time, developing market-based finance can provide alternative channels for mobilizing long-term capital. Examining FIE and FME separately therefore enables policymakers to determine whether strengthening bank-based intermediation, developing market-based financing, or combining both is more conducive to inclusive green growth. It also allows the environmental consequences of financial efficiency to be evaluated rather than assuming that greater financial efficiency is inherently beneficial for sustainable development.

Despite these considerations, empirical research that simultaneously examines FIE, FME, fiscal policy, institutional quality, and natural resources within a single framework for Bangladesh remains limited. Existing studies have predominantly employed time-series approaches to institutional quality (Toufique, 2024) or qualitative approaches to renewable energy and environmental policy (Karim et al., 2019), while regional studies have focused primarily on environmental processes and governance rather than the financial, fiscal, and institutional linkages underlying inclusive green growth (Nicholls et al., 2018). Furthermore, the literature provides limited evidence on whether financial institution efficiency and financial market efficiency have similar, heterogeneous, or opposing effects in a bank-dominated developing economy. The absence of such evidence makes it difficult to determine how financial policies should be designed under different institutional and fiscal conditions.

To address this gap, the present study develops an integrated empirical framework to examine the effects of Financial Institution Efficiency, Financial Market Efficiency, fiscal policy, institutional quality, and natural resources on inclusive green growth in Bangladesh. The study makes three main contributions. First, it disaggregates financial efficiency into institution-based and market-based components, providing a more context-specific assessment of financial mechanisms in Bangladesh's bank-dominated financial system. Second, it integrates financial efficiency with fiscal policy, institutional quality, and natural resources, thereby moving beyond the fragmented treatment of these determinants in previous studies. Third, the study employs the Kernel-based Regularized Least Squares (KRLS) approach to capture nonlinear and heterogeneous relationships that may not be detected by conventional linear estimation techniques. This framework provides a more nuanced understanding of how different financial

channels and broader policy conditions jointly shape Bangladesh's transition toward inclusive and environmentally sustainable growth.

LITERATURE REVIEW

The conceptual framework of this study is built on the Sustainable Finance theory, Institutional economics, and the Natural Resource Curse hypothesis, which can explain the impact of financial efficiency, fiscal policy, institutional quality, and natural resource together on inclusive green growth (IGG) in Bangladesh. According to Sustainable Finance Theory, well-functioning financial systems enhance the allocation of resources to productive and environmentally friendly investments, and thus help to stimulate economic growth without increasing environmental burden (Schoenmaker & Schramade, 2018). According to Sustainable Finance Theory, well-functioning financial systems enhance the allocation of resources to productive and environmentally friendly investments, and thus help to stimulate economic growth without increasing environmental burden. These enhancements foster innovation, resource efficient production and wider economic engagement which boost inclusive green growth.

Institutional Economics also indicates that the performance of financial systems and public policies will be contingent on the formal institutional setting (North, 1990). Improved institutional quality (INQ) increases regulatory effectiveness, strengthens property rights, improves government accountability and reduces rent seeking. This means that financial resources and fiscal interventions can promote environmentally sustainable infrastructure, social inclusion and long-term productivity more easily than these that are inefficient or politically motivated. Fiscal policy (FIS) is also at the heart of the matter, as it helps to channel public investments towards renewable energy, human capital, environmental protection and the development of green infrastructure, thus supporting sustainable and inclusive development (Stiglitz, 1998).

The Natural Resource Curse hypothesis offers an alternative view as to why the presence of NTR is not always associated with sustainable development (Sachs & Warner, 2001). Poor governance and inefficient resource management can result in environmental degradation, institutional decay and unequal income distribution. But, with effective financial systems, good fiscal policy and strong institutions, natural resource wealth can fund economic diversification, environmental conservation, and inclusive development. Therefore, integrated framework suggests that FIE, FME, FIS and INQ positively impact inclusive green growth, and the impact of NTR relies on the institutional and financial context in which resources are used.

Hypothesis Development

Financial Institution Efficiency and Inclusive Green Growth

In the current sustainable development literature, efficient financial institutions and inclusive green growth stand as a central topic. Financial institutions that are more efficient tend to facilitate inclusive green growth and sustainable development by

reducing financing frictions, better allocating resources, and channeling financial resources towards cleaner technologies and firms (Wang et al., 2022; Yıldırım et al., 2025; Zhao et al., 2024). Efficiency and financial growth, which tend to expand credit without green safeguards or policy coordination, can worsen environmental effects (Anu et al., 2023; Yang & Ni, 2022). This heterogeneous pattern means that institutional design and policy context is as important as efficiency.

Through credit screening efficiency improves green outcomes. Transfers of capital from polluting activities into cleaner production, banks can reallocate investments energy-saving sectors (Liu et al., 2022; Wang et al., 2022; Yang & Masron, 2022). In China, by credit constraints on high polluting companies, financial inclusion drives green economic efficiency (Liu et al., 2022; Wang et al., 2022). Digital transformation and digital finance ensure better operational efficiency, costs reduction, faster matching of financial services to enterprise needs, and help technological upgrading and energy efficiency (Mavlutova et al., 2023; Yang & Masron, 2022). The channels reflect that green growth not only achieved through efficiency scale but also through strategic reallocation of capital resources.

In some studies, financial development including broadness financial efficiency measures, has been found to be negatively correlated with the green-development efficiency, particularly in Belt and Road countries, indicating that scale does not necessarily lead to sustainability (Yang & Ni, 2022). Financial inclusion may also increase ecological footprints or emissions if there are poor policy synergies, especially in environments with higher ecological footprints (Anu et al., 2023; Liu et al., 2022; Shashwat et al., 2025).

Financial institutions contributes to inclusive green growth and sustainable development by helping lowering financial frictions and directing capital to green innovation, energy efficiency and less polluting firms (Nenavath & Mishra, 2023; Shashwat et al., 2025; Xu et al., 2024). On the other hand, it can negatively affect these goals if the intermediation is not efficient, primarily when it grows conventional credit, or has no screening for the environment, or is not located in strong institutional environments (Dong & Arshad, 2026; He et al., 2022; Yang & Ni, 2022).

Given these theoretical mechanisms, financial institution efficiency is expected to play an important role in promoting inclusive green growth by improving the allocation and quality of financial resources.

H1: Financial institution efficiency has a significant positive effect on inclusive green growth.

Financial Market Efficiency and Inclusive Green Growth

The link between financial market efficiency and inclusive green growth is more complicated than that of financial institution efficiency. While numerous studies have identified positive links between efficient financial markets and green growth, it is still

unclear whether such benefits are inclusive or not, especially in the developing world, where financial systems are still advancing (Abbas et al., 2024; Ahmed et al., 2023; Liu et al., 2024). The literature indicates that a good financial market can enhance the effectiveness of finance, which in turn facilitates the financing of environmentally friendly projects, renewable energy investments and green technologies (Ngo et al., 2022; Yildirim et al., 2025; Zhao et al., 2026). For both banking sector development and stock market development it is documented that they have positive short- and long-term relationship with green growth for highly polluting economies (Ahmed et al., 2023).

A number of studies demonstrate that the stock markets foster green recovery through technological innovation and investment in cleaner industries (Chi et al., 2023; Ngo et al., 2022; Sheng & Gao, 2023). Based on evidence from China, a larger stock market can lead to more volatility of green growth, although the development of the financial market with the help of stock markets can dampen the volatility of green growth if technological innovation accompanies financial expansion (Cao et al., 2021). Developed financial systems support productive sectors and facilitate capital mobilisation for green investment and for cleaner production of energy (Han & Gao, 2024; Wang & Chen, 2024).

Although these positive results are promising, the empirical evidence is not as consistent. However, a series of emerging research studies suggest that increased financial markets does not necessarily yield greener and more inclusive development outcome, particularly in developing countries where the capacity for regulation and environmental governance is comparatively low (Raman et al., 2025; Yildirim et al., 2025; Zhao et al., 2026). The literature suggests that financial market efficiency is likely to facilitate inclusive green growth if financial markets focus on financing green innovation, renewable energy, and environmentally responsible investment, and provide access to finance to a broader group.

The mixed findings suggest that the direction and magnitude of the relationship between financial market efficiency and inclusive green growth cannot be assumed a priori and may depend on country-specific institutional and regulatory conditions. This is particularly relevant for Bangladesh, where capital markets remain less developed than the banking sector and where environmental considerations may not be fully incorporated into market-based investment decisions.

H2: Financial market efficiency has a significant effect on inclusive green growth.

Fiscal Policy and Inclusive Green Growth

Fiscal policy is one of the most important policy tools for inclusive green growth as it can directly influence economic incentives and priorities for public investments. Previous literature focus three main fiscal instruments: public spending, environmental taxation and green subsidies and shows that their impact is highly dependent on their design and application. Effective fiscal policy more likely focuses financial resources on clean technologies, environmental protection and social welfare, rather than just expanding public spending, and serves to foster inclusive development and environmental

sustainability (Okombi & Ndoum Babouama, 2024; Wu et al., 2025). Evidence from China shows that public spending in social welfare and ecological protection are both substantial and important for inclusive green growth, thus signifying a need for quality spending, not just quantity spending (Wu et al., 2025). Recent empirical evidence from emerging markets suggests that effective fiscal policy can reduce carbon emissions, foster green innovation and ensure macroeconomic stability (Muslim, 2025). Environmental taxes discourage environmentally harmful activities and promote greener production. Effective and transparent revenue management ensures inclusive green growth (Okombi & Ndoum Babouama, 2024). Evidence from China shows that environmental taxes reduce carbon emission and promote green economic growth over the short term (Yu et al., 2023). However, environmental taxes also have significant policy challenges. Without proper revenue distribution, environmental taxes may increase income inequality, deepen energy poverty or provide less welfare for the households, especially among lower income groups (Mpofu, 2022; Yan & Wang, 2024). The social impacts of environmental taxation may not only be influenced by the tax itself, but also by the way governments allocate the fiscal revenues generated through the tax.

Governments are increasingly using green subsidies and tax incentives to encourage green investment. By lowering financing barriers and increasing external funds, tax incentives generate greater scope for investing in green technologies and environmentally friendly (Wang et al., 2022; Xu et al., 2023). Some studies show that subsidy can encourage and facilitate green innovation, especially in technology-intensive industries; others conclude that poorly designed subsidy programs can decrease the efficiency of innovation (Wang et al., 2022; Zhang et al., 2025). The literature suggests fiscal policy instruments are best suited to inclusive green growth if they are well-designed, and targeted.

Accordingly, fiscal policy is expected to provide financial support for environmental protection and social inclusion while creating incentives for sustainable economic activities.

H3: Fiscal policy has a significant positive effect on inclusive green growth.

Institutional Quality and Inclusive Green Growth

The institutional quality is one of the most influential factors analyzed in the literature on inclusive green growth. The impact of better governance on environmental sustainability and inclusive economic growth is not uniform in countries or in specific dimensions of governance (Ahmed et al., 2022; Sun et al., 2025). Some institutional elements are more directly linked to the enhancement of environmental performance, while others play a more direct role in fostering social inclusion and fair economic opportunities (Ofori et al., 2022; Ofori & Figari, 2023).

Government effectiveness emphasizes implementation of the policies, better provision of public services and better capacity of governments to implement sustainable

development goals (Ofori et al., 2022; Ofori & Figari, 2023). Cross-country evidence indicates that good institutions also foster inclusive growth through enhancing the efficient operation of economic and political institutions, while legal institutions alone seem to have a more modest impact (Munir et al., 2022). The same results are found for Sub-Saharan Africa where better institutions reduce environmental costs that can be associated with rapid economic growth, helping countries to achieve more balanced and sustainable development (Kamah et al., 2021).

Effective corruption control and compliance to the rule of law boosts the effectiveness of environmental taxation, globalization and other green development measures by enhancing policy credibility and minimising gaps in policy implementation (Ofori & Figari, 2023; Okombi & Ndoum Babouama, 2024). Transparency and public accountability is also crucial for promoting investment in renewable energy, optimising ecological efficiency and improving investor and stakeholder confidence (Sun et al., 2025; Teklie & Yağmur, 2024).

The impact of governance is different in each institutional size and country; some elements are more influential than others. In general, the governance features like government effectiveness, regulatory quality, corruption control, accountability and strong enforcement mechanisms are most strongly correlated with inclusive green growth.

Overall, government effectiveness, regulatory quality, corruption control, accountability, and effective enforcement are expected to strengthen the capacity of governments to implement policies that simultaneously support environmental sustainability and social inclusion.

H4: Institutional quality has a significant positive effect on inclusive green growth.

Research Gaps: Evidence from South Asia and Bangladesh

Research focusing on South Asia provides growing evidence that financial development, institutional quality, and green growth are closely interconnected, although the nature of these relationships is not always consistent. There are several panel studies reports that financial development and institutional quality both positively affect long-run green growth (Ahmed et al., 2022). Hunjra et al. (2020) state that financial development can increase CO₂ emissions if financial resources are allocated for conventional capital accumulation instead of environmentally sustainable technologies. Their findings also show that the impact of these negative environmental factors can be dampened when institutional quality is high, suggesting that good governance is crucial to determine the results of financial development. Research on major carbon-intensive economies indicates that government spending expansion has positive long run effects on green growth, especially if the financial institutions and markets both are efficient (Liu et al., 2024). Good governance lowers the negative environmental effects of fiscal policy in OIC countries, especially for lower-income nations (Rusanti et al., 2026). Similarly, in the ASEAN-6 region, financial development's impact on green growth is moderated by good

governance, with this effect being more pronounced for financial markets than financial institutions (Bui & Thi Doan, 2025).

The evidence on Bangladesh is much more limited. Most of the empirical findings come from a wider panel of South Asian or SAARC countries and not from country specific analysis. Some of the research has indicated that financial development has helped increase environmental pollution in Bangladesh (Khalid et al., 2021) and other studies have suggested that the negative impact of financial development can be mitigated by the development of better institutions which help to improve environmental governance (Hunjra et al., 2020). Overall, the literature shows that financial development, fiscal policy and institutional quality all are important factors in facilitating green growth. However, none of these factors have been explored in Bangladesh. So it is important to explore the interaction among these factors jointly in Bangladesh. The present study aims to provide a comprehensive understating of these factors to achieve inclusive green growth.

METHODOLOGY

Model specification

The purpose of this study is to analyze the effect of Financial Institution Efficiency (FIE), Financial Market Efficiency (FME), Fiscal Policy (FIS), Institutional Quality (INQ), and Natural Resources (NTR) on Inclusive Green Growth (IGG) in the context of Bangladesh. Building on the extended production framework of Cobb & Douglas (1928), this study defines econometric model as a model that includes financial, institutional, fiscal, and natural resource dimensions as important determinants of sustainable economic performance. The basic econometric model is the following:

$$IGG_t = \beta_0 + \beta_1 FIE_t + \beta_2 FME_t + \beta_3 FIS_t + \beta_4 INQ_t + \beta_5 NTR_t + \varepsilon_t \quad (1)$$

In Equation (1), t denotes the annual observation period, and ε_t is the stochastic error term. The estimated coefficients β capture the marginal effects of the explanatory variables on green economic growth, holding the remaining factors constant.

Data and source

The study uses annual time series data from 1990 to 2025 to investigate the influence of financial institution efficiency (FIE), financial market efficiency (FME), fiscal policy (FIS), institutional quality (INQ), and natural resources (NTR) on inclusive green growth (IGG) for the case of Bangladesh. IGG, FIE, FME, FIS, INQ, and NTR are the data sets included in the dataset. The values of these variables were retrieved from the World Development Indicators (WDI, 2024).

The Inclusive Green Growth (IGG) is built as a multidimensional composite index based on Principal Component Analysis (PCA). The index reflects the inclusive green growth approach by integrating three dimensions: the economic, the social and the environmental. Economical dimension includes GDP per capita (constant 15 US\$) and

gross capital formation (% of GDP), reflecting economic success and productive investments. The social dimension includes indicators of human development, digital inclusion and schooling such as the life expectancy at birth (years), internet users (as a percentage of the population) and school enrollment (gross enrollment ratio, %). The environmental dimension covers resource sustainability (renewable energy consumption in % of total final energy consumption) and environmental quality (forest area in % of land area; CO₂ emissions in metric tons per capita). Higher CO₂ emissions reflect a lower environment performance, which is why this variable is considered an undesirable indicator and it is reversed in the direction used for the construction of the indicator.

Financial institution efficiency (FIE) is the efficiency of financial intermediation, as measured by Financial Institution Efficiency Index. Financial market efficiency (FME) is the efficiency of capital allocation, which is measured by the Financial Market Efficiency Index. Fiscal policy (FIS) is proxied by government expenditure as a percentage of GDP. The institutional quality (INQ) has been calculated by principal component analysis (PCA) of government effectiveness and control of corruption. Natural resources (NTR) are measured as total natural resource rents expressed as a percentage of GDP.

Table 1. Variables description

Variables	Description	Units	Source
IGG	Green economic growth	Index (constructed using Principal Component Analysis [PCA] from standardized economic, social, and environmental indicators).	WDI
FIE	Financial institution efficiency	Index	IMF
FME	Financial market efficiency	Index	IMF
FIS	Fiscal policy	Government expenditure (% of GDP)	WDI
INQ	Institutional quality	PCA composite index of government effectiveness and control of corruption	WDI
NTR	Natural resources	% of GDP	WDI

Source: Data processed (2026)

Data Analysis

The Kernel Regularized Least Squares (KRLS) estimator suggested by Hainmueller & Hazlett (2014) is used in this study to examine the factors explaining inclusive green growth. KRLS is a nonparametric machine learning method that estimates relationships without making any assumption about the functional form. This flexibility allows the method to capture nonlinear effects and complex interactions which cannot be represented by simple linear models. By allowing the data to determine the underlying functional relationships, KRLS reduces the likelihood of specification errors and

produces more reliable estimates. Its regularization mechanism also helps prevent overfitting and boosts the accuracy of estimation, especially when the explanatory variables have complicated relations. The characteristics of KRLS make it appropriate for evaluating the impact of financial institution efficiency, financial market efficiency, fiscal policy, institutional quality and natural resources on inclusive green growth. The KRLS model is defined as:

$$\hat{y} = K(K + \lambda I)^{-1}y \quad (1)$$

Here, $\hat{y}$ is the vector of predicted values, λ controls the complexity of the model, K is the kernel matrix, I is the identity matrix and y is the vector of values of the dependent variable. The form of the kernel function $k(x_i, x_j)$, can be any positive definite kernel, but one of the most common specifications is the Radial Basis Function (RBF) kernel.

$$k(x_i, x_j) = \exp\left(-\frac{\|x_i - x_j\|^2}{2\sigma^2}\right) \quad (2)$$

In this case, σ is the bandwidth parameter for the kernel that sets the extent to which observations are similar. By minimizing the objective function, the KRLS estimator not only fits the model well but also controls its complexity to lessen the danger of overfitting and enhance the model's predictive power.

$$\min_{\alpha} \|y - K\alpha\|^2 + \lambda\alpha^T K\alpha \quad (3)$$

Where α represents the set of coefficients in vector form. The remedy to this optimization issue is provided by:

$$\alpha = (K + \lambda I)^{-1}y \quad (4)$$

Accordingly, the predicted values $\hat{y}$, are obtained as follows:

$$\hat{y} = K\alpha = K(K + \lambda I)^{-1}yy \quad (5)$$

While KRLS has a number of methodological benefits, it also has a number of drawbacks. First, the estimation procedure is computation intensive, as it calls for a kernel matrix,

which can become cumbersome for very large data sets. Secondly, the accuracy of the estimates relies on the choice of an appropriate kernel function and its tuning parameters. Third, the method can be influenced by influential observations or outliers if they are not properly dealt with prior to estimation. Finally, KRLS is well suited for nonlinear relationships and complex interactions; however, the nonparametric form of the KRLS results in less easily interpretable estimated effects as compared to those from standard parametric models. This is not likely to be a relevant issue in this study as the length of the sample is modest and the primary interest is in the possible non-linear effects of financial institution efficiency, financial market efficiency, fiscal policy, institutional quality and natural resources on inclusive green growth.

RESULTS

Summary statistics

Descriptive statistics of the variables are shown in Table 2. The mean of inclusive green growth (IGG) is 0.125, ranging between -1.535 and 1.565 and showing a significant difference throughout the sample period. There is also significant dispersion on financial institution efficiency (FIE), financial market efficiency (FME), institutional quality (INQ), fiscal policy (FIS) and natural resources (NTR) all of which have experienced variations in financial, institutional and resource conditions. Most variables are positively skewed, and have moderate kurtosis values, indicating longer right tails. All variables are statistically significantly not normal at the 1% level, so flexible estimation methods like KRLS can be used.

Table 2. Summary statistics

Variables	Mean	Median	Std. Dev.	Min.	Max.	Skew.	Kurt.	Shapiro-Wilk
IGG	0	1	-1.535	1.565	0.125	1.750	0	0.432***
FIE	0.473	0.047	0.365	0.528	-0.807	2.485	0.473	0.234***
FME	0.170	0.136	-0.030	0.568	1.040	3.804	0.170	0.765***
INQ	-0.597	0.130	-0.959	-0.428	-1.025	3.754	-0.597	0.873***
FIS	1.826	0.084	1.620	1.979	-0.331	3.035	1.826	0.912***
NTR	0.633	0.171	0.413	0.964	0.542	1.889	0.633	0.931***

Source: Data processed (2026)

Correlation

The Pearson correlation coefficients of the study variables are presented in Table 3. The financial institution efficiency (FIE), institutional quality (INQ), and fiscal policy (FIS) are positively and significantly related to inclusive green growth (IGG), implying that better

performance on these indicators is linked to higher inclusive green growth. The correlations between financial market efficiency (FME) and natural resources (NTR) with IGG are weak and statistically insignificant. There are few INQ-FIS correlations that are not strong and positive; the others are generally low to moderate. The correlation matrix suggests that there are no serious problems of multicollinearity between the explanatory variables, so they can be used in regression analysis.

Table 3. Correlation table

Variables	IGG	FIE	FME	INQ	FIS	NTR
IGG	1.000					
FIE	0.500*	1.000				
FME	-0.127	-0.305	1.000			
INQ	0.758*	0.122	0.334*	1.000		
FIS	0.889*	0.221	0.109	0.821*	1.000	
NTR	0.042	-0.186	-0.173	-0.096	-0.030	1.000

Source: Data processed (2026)

Variance Inflation Factor (VIF)

The values of the variance inflation factor (VIF) are presented in Table 4 to check if multicollinearity exists among the explanatory variables. The VIF values are between 1.108 and 3.788; and the average VIF was 2.217 which is well below the common accepted threshold of 10. The VIF value for the various variables is not very high with the exception of INQ (3.788), FIS (3.454) and the other variables show relatively low VIF values. These results suggest that there is no multicollinearity in the estimated model, and therefore the explanatory variables can be used simultaneously in the model with no impact on reliability of the regression estimates.

Table 4. VIF test

Variables	VIF	1/VIF
INQ	3.788	0.264
FIS	3.454	0.289
FME	1.457	0.687
FIE	1.276	0.784
NTR	1.108	0.902
Mean VIF	2.217	.

Source: Data processed (2026)

Normality test

Table 5 shows the results of the normality and randomness tests of the study variables. Both Jarque-Bera (JB) and Shapiro-Jarque (SJ) statistics are statistically significant at 1% level for all the variables, thus rejecting the normality hypothesis. Likewise, the Runs Z

test is used to test for randomness for all series. The results of the Mann-Kendall (MK) Tau statistics show that most variables have significant trends except financial market efficiency (FME) which has insignificant trend. Overall the results imply that the data are not normally distributed and there are underlying trends in the data, which makes the use of flexible and robust estimation methods like KRLS appropriate.

Table 5. Normality test

Variable	JB Statistic	SJ Statistic	Runs Z	MK Tau
IGG	49.906***	3255.854***	-16.875***	0.194***
FIE	21.547***	286.418***	-15.672***	0.317***
FME	43.959***	34.923***	-15.795***	0.011
INQ	17.832***	88.184***	-16.881***	-0.988***
FIS	27.264***	192.539***	-16.630***	0.531***
NTR	24.009***	1788.906***	-16.882***	1.000***

Source: Data processed (2026)

Nonlinearity test

The nonlinearity test was performed for all the study variables at various embedding dimensions (M2–M6) and the results are given in Table 6. Positive and statistically significant test statistics are obtained for all variables and dimensions at 1% level of significance, thus rejecting the assumption of linearity. Furthermore, the test statistics are monotonically increasing with the embedding dimension, suggesting complex nonlinear dynamics in the data. The results of these revealed that the linear model may not be sufficient to capture the relations between the variables. Hence, the Kernel Regularized Least Squares (KRLS) estimator is suitable, as it is specially developed for modelling the nonlinearity without any prespecified functional form.

Table 6. Nonlinearity test

Dimension	IGG	FIE	FME	INQ	FIS	NTR
M2	91.284***	82.615***	298.437***	142.386***	1189.543***	438.927***
M3	116.752***	114.829***	503.168***	214.571***	2014.876***	706.385***
M4	148.693***	163.482***	918.274***	334.219***	3688.429***	1218.963***
M5	196.815***	248.936***	1776.843***	548.732***	7198.541***	2287.156***
M6	272.104***	396.571***	3615.924***	956.684***	14852.377***	4418.293***

Source: Data processed (2026)

Unit root test

Results of Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are presented in Table 7. Under both tests, financial institution efficiency (FIE) is stationary at the levels, and fiscal policy (FIS) is stationary only at the ADF test. The unit root tests suggest that inclusive green growth (IGG), financial market efficiency (FME), institutional quality (INQ) and natural resources (NTR) are unit rooted at levels. All variables are stationary at conventional significance levels after being first differenced under both the ADF and PP tests. The results suggest that the variables are integrated of

order one I(1) which supports the use of cointegration and long run estimation techniques.

Table 7. Unit root test

Variables	IGG	FIE	FME	INQ	FIS	NTR
ADF	-1.556	-4.050***	-2.431	-2.761	-3.845**	-1.601
Δ ADF	-3.480**	-6.069***	-4.089***	-3.429**	-4.528***	-3.157*
PP	-2.212	-4.443***	-2.064	-2.676	-3.001	-1.280
Δ PP	-5.546***	-9.473***	-4.832***	-5.652***	-4.803***	-4.219***

Source: Data processed (2026)

KRLS average marginal effects

In Table-8, the effects of financial institution efficiency (FIE), financial market efficiency (FME), institutional quality (INQ), fiscal policy (FIS), and natural resources (NTR) on inclusive green growth (IGG) in Bangladesh are estimated using “Kernel Regularized Least Squares (KRLS)”. The KRLS estimator estimates the mean marginal effects while taking into account possible nonlinear relationships between the variables, offering a flexible approach to analyze the factors driving inclusive green growth.

The estimates of the KRLS indicate that financial institution efficiency (FIE) is positively and statistically significant to inclusive green growth (Avg. = 3.740, $p < 0.01$). Holding other factors constant, a one-unit increase in FIE, inclusive green growth rises by 3.740 units. This finding indicates that effective financial institutions increase the effectiveness of financial resource allocation, mitigate information gap and increase access to long-term finance for productive investments. They promote cleaner production technologies, green innovation and the growth of environment friendly business activities and improve financial inclusion for companies. The increased efficiency of financial institutions will enable a transition towards a more inclusive and environment friendly economy in the context of Bangladesh's financial constraints in funding sustainable projects. This finding supports Sustainable Finance Theory, which claims that efficient financial intermediation can foster sustainable development by channeling financial resources into investments which provide long-term sustainable economic, environmental and social benefits. The result is also in line with recent research that found that well-functioning financial markets have a positive effect on green investments and sustainable development (Zhou et al., 2025).

The financial market efficiency (FME) value has a negative and statistically significant correlation with inclusive green growth (Avg. = -0.804, $p < 0.01$). A one-unit increase in FME decreases inclusive green growth by approximately 0.804 units. The finding implies that market efficiency does not necessarily imply sustainable investments, although efficient financial markets generally enhance the allocation of capital. In Bangladesh, financial markets can still invest in conventional sectors where short-term returns are higher but impose greater environmental costs. Limited green financial instruments, weak sustainability disclosure, and insufficient environmental incentives may reduce the ability of financial markets to support inclusive green growth. It is noteworthy that the

improvements in market efficiency need to be supported by the efficient regulatory environment and green finance policies to allow the flow of capital towards environmentally responsible investments. This outcome aligns with the Sustainable Finance Theory that highlights the importance of having the right institutional and policy frameworks in place to facilitate the development of financial markets in order to drive sustainable growth (Deng et al., 2023).

Institutional quality (INQ) has a positive and statistically significant effect on inclusive green growth (Avg. = 1.660, $p < 0.01$). In particular, institutional quality has a positive effect on inclusive green growth, with each 1-unit increase in institutional quality corresponding to an increase in inclusive green growth of 1.660 units. Effective institutions enhance the effectiveness of regulation, policy enforcement, reduce corruption and improve public accountability, creating a stable climate for sustainable investment and long-term economic growth. Improved governance also makes public resource allocation more efficient, and increases private sector investment in environment friendly activities. Capacity building can contribute to the better enforcement of environmental laws and better effect of green development policies in Bangladesh. This finding is consistent with Institutional Economics, which emphasizes that well-functioning institutions lower transaction costs, and generate incentives for sustainable economic performance. The result also agrees with recent empirical evidence highlighting the central role of institutional quality in promoting green and inclusive development (Jiang et al., 2023).

In addition, fiscal policy (FIS) positively and statistically significantly affects inclusive green growth (Avg. = 1.660, $p < 0.01$). Holding other variables constant, every additional unit of government spending as a percentage of GDP contributes about 1.660 units of inclusive green growth. This finding suggests that sustainable development is possible through public expenditure, which can be used to fund green infrastructure, the development of renewable energy, environmental protection, education, health care and other public services that reduce environmental degradation and benefit social welfare. Good fiscal policies also encourage private investment by supplying complementary infrastructure and reducing investment risks. For Bangladesh, strategic government spending can drive the country's shift to a low-carbon and inclusive development and help to achieve sustainability targets. The finding supports Keynesian Public Investment Theory, which states that productive investments by the government boost the long-term performance of the economy by boosting productive capacity and solving market failures. Empirical studies in the recent years also agree that targeted fiscal policies have a positive effect on green economic transformation (Cui et al., 2023).

Natural resources (NTR) positively and statistically significantly impacts inclusive growth (Avg. = 0.476, $p < 0.01$). The contribution of natural resource rents to inclusive green growth is around 0.476 units per one unit of the natural resource rents. The finding indicates that when natural resource revenues are properly managed and utilized for investments in productive sectors, natural resource wealth can facilitate sustainable development. With the income from the resources, environmental conservation, green infrastructure, technology development and human capital formation can be paid for,

which will boost both environmental sustainability and economic inclusion. The effective use of NRRs in Bangladesh will minimize reliance on environmentally unsustainable production and can assist in economic diversification. The finding contrasts with the conventional Resource Curse hypothesis, which suggests that resource richness can negatively impact development in the absence of good governance. Instead, the outcome validates the resource-based development vision that holds that the natural resources can sustain growth if they are embedded in good institutions, fiscal stewardship, and good resource management. Empirical research in recent years also indicates that the effects of natural resources on development are strongly influenced by the quality of institutions and public policies (Khan et al., 2023).

Table 8. KRLS average marginal effects

Variables	Avg.	SE	t	P-value	P25	P50	P75
FIE	3.740	0.420	8.893	0.000	0.839	4.310	6.086
FME	-0.804	0.107	-7.514	0.000	-1.526	-0.933	-0.016
INQ	1.660	0.184	9.022	0.000	0.200	1.639	2.704
FIS	1.660	0.267	6.224	0.000	0.162	1.720	2.855
NTR	0.476	0.099	4.817	0.000	-0.090	0.499	0.938
Diagnostics							
Number of obs. = 36			Eff. df. = 20.92				
Lambda = 0.0855			R ² = 0.9952				
Tolerance = 0.036			Looloss = 1.292				

Source: Data processed (2026)

KRLS average pointwise marginal effect

The average pointwise marginal effects, estimated with the Kernel Regularized Least Squares (KRLS) method are presented in figure 1. The analysis shows that the marginal effects of the explanatory variables vary significantly over the range of inclusive green growth (IGG). The efficiency of financial institutions (FIE) is U-shaped, with a negative slope at lower values of IGG and a positive slope at higher values. The relationship between financial market efficiency (FME) and inclusive green growth is an inverted U-shaped curve that gradually decreases at higher green growth levels, suggesting that FME's contribution weakens at higher levels of inclusive green growth. The marginal effects of institutional quality (INQ) and fiscal policy (FIS) are consistently positive and increasing with the rise in inclusive green growth, indicating that their positive impacts grow in strength with rising inclusive green growth. In contrast, natural resources (NTR) demonstrate an inverted U-shaped relationship, with positive marginal effects up to the middle of the IGG distribution before declining at higher levels of inclusive green growth. These nonlinear patterns validate the fact that the effects of the explanatory variables are different for each observation and cannot be adequately modeled as a linear model. The graphical evidence further concludes that the KRLS estimator is appropriate for the complex relationship between the financial institution efficiency, financial market efficiency, institutional quality, fiscal policy, natural resources, and inclusive green growth of Bangladesh.

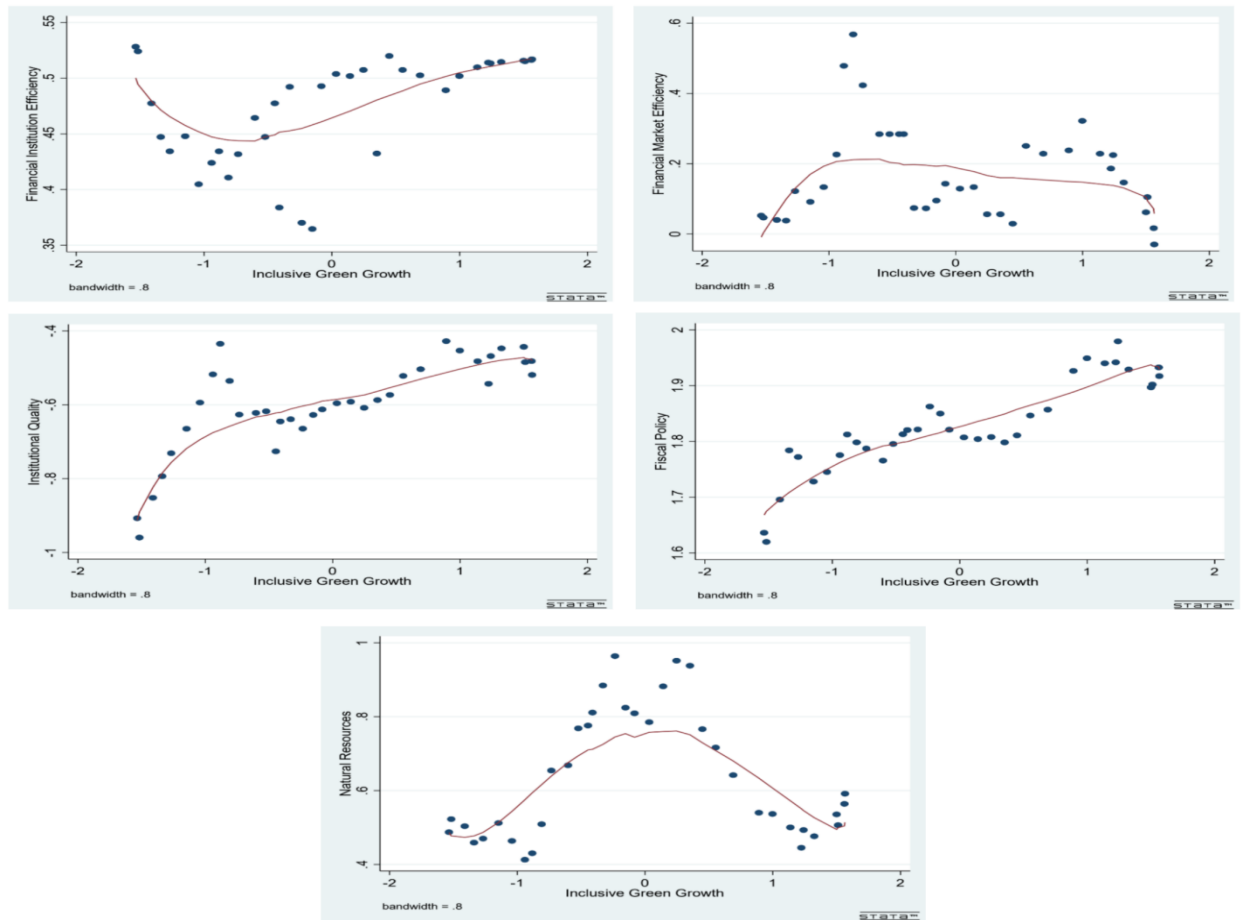


Figure 1. Pointwise marginal effect

Source: Data processed (2026)

DISCUSSION

The positive impact of Financial Institution Efficiency (FIE) supports Hypothesis 1 (H_1) and validates the core tenets of Sustainable Finance Theory (Schoenmaker & Schramade, 2018). The theory posits that efficient financial intermediaries reduce financing frictions, optimize resource allocation, and direct capital toward environmentally friendly innovations and clean production technologies. In Bangladesh, where the financial architecture is overwhelmingly bank-dominated, the operational efficiency of financial institutions is paramount. Efficient banking intermediation enables effective credit screening, lowers monitoring costs, and improves capital flows to green projects, small and medium enterprises (SMEs), and renewable energy initiatives.

This finding aligns with prior empirical literature emphasizing that bank-led financial efficiency fosters green economic performance by easing credit constraints on energy-saving sectors (Wang et al., 2022; Liu et al., 2022; Zhou et al., 2025). Furthermore, the rapid growth of digital financial inclusion in developing contexts enhances operational efficiency and speeds up capital matching for sustainable investments (Mavlutova et al., 2023; Yang & Masron, 2022).

Crucially, the KRLS pointwise marginal effect reveals a U-shaped trajectory for FIE. At initial stages of green growth, the marginal effect of financial institution efficiency is weak or slightly negative, reflecting structural friction where credit expansion may still cater to conventional carbon-intensive manufacturing (such as traditional brick kilns and unsustainable textile processing) without strict environmental screening (Anu et al., 2023; Yang & Ni, 2022). However, as inclusive green growth matures, the marginal effect turns strongly positive and accelerates. This structural shift confirms that once green credit policies and environmental risk management guidelines (such as those instituted by Bangladesh Bank) take firm operational root, banking efficiency transitions from passive credit supply to active green resource allocation (Zhao et al., 2024; Yin et al., 2023).

In sharp contrast to institutional efficiency, Financial Market Efficiency (FME) exhibits a negative effect on inclusive green growth, accepting Hypothesis 2 (H_2) regarding its significance, albeit in a negative direction. This result highlights a systemic misalignment within capital market intermediation in Bangladesh. While market efficiency optimizes capital deployment toward maximum short-term risk-adjusted returns, it does not inherently guarantee sustainable outcomes when market mechanisms lack robust environmental incentives. In developing economies with shallow capital markets and weak ESG disclosure frameworks, efficient securities markets tend to direct liquidity into high-yield, resource-intensive conventional industries rather than long-gestation green projects.

This finding resonates with the theoretical cautions of Sustainable Finance Theory and corroborates empirical studies indicating that financial market development does not automatically translate into green outcomes in lower-income or low-governance environments (Raman et al., 2025; Yildirim et al., 2025; Zhao et al., 2026). While studies from larger or high-polluting economies suggest that stock markets can foster green recovery through technological innovation (Chi et al., 2023; Ngo et al., 2022; Sheng & Gao, 2023), evidence from Belt and Road and developing nations demonstrates that financial expansion without policy synergies can worsen ecological footprints (Anu et al., 2023; Yang & Ni, 2022).

The KRLS pointwise plot reveals an inverted U-shaped curve for FME. Initial market liquidity provides baseline economic benefits, but as green growth advances, unchecked market efficiency diminishes in effectiveness. In a bank-dominated economy like Bangladesh, market efficiency acts as a double-edged sword unless capital markets are explicitly aligned with national sustainability targets through green bonds, green taxonomies, and mandatory ESG reporting.

Fiscal Policy (FIS) demonstrates a positive and statistically significant impact on inclusive green growth, supporting Hypothesis 3 (H_3). Grounded in Keynesian Public Investment Theory (Stiglitz, 1998), productive public expenditure corrects market failures by funding public goods, climate-resilient infrastructure, renewable energy systems, education, and social protection. Given Bangladesh's extreme vulnerability to sea-level rise and climate

hazards (Nicholls et al., 2018; Karim et al., 2019; Molla, 2016), strategic public spending serves as the primary engine for building socio-economic resilience and social inclusion.

These empirical results reinforce literature emphasizing that targeted fiscal expenditure rather than mere quantitative expansion is vital for inclusive green growth (Wu et al., 2025; Okombi & Ndoum Babouama, 2024). Public investments in ecological protection and social welfare reduce income disparities and lower carbon intensity across emerging economies (Muslim, 2025; Liu et al., 2024).

The KRLS non-linear inspection shows a monotonic and rising marginal curve for FIS. Early fiscal outlays lay essential physical and human capital foundations (Song et al., 2022), whereas mature green fiscal interventions such as green R&D subsidies, tax incentives, and climate-resilient public infrastructure crowd-in private green investments and reduce structural barriers faced by marginalized populations (Batool et al., 2023; Wang et al., 2022; Xu et al., 2023).

Institutional Quality (INQ) exerts a powerful positive impact on inclusive green growth, accepting Hypothesis 4 (H_4). Grounded in Institutional Economics (North, 1990), sound governance characterized by government effectiveness, regulatory quality, corruption control, and enforcement of the rule of law reduces transaction costs, minimizes policy uncertainty, and deters rent-seeking behavior. In Bangladesh, where institutional vulnerability, bureaucratic rigidity, and reliance on short-term funding have historically constrained mainstreamed climate resilience (Hossain & Huq, 2013; Rahman & Hickey, 2019), high institutional quality ensures that environmental regulations are strictly enforced and green subsidies reach target sectors (Ahmed, 2026; Toufique, 2024).

This outcome strongly aligns with prior regional and cross-country literature. Cross-country studies in South Asia and Sub-Saharan Africa establish that good governance dampens the environmental costs associated with rapid economic growth and enhances the positive impacts of financial development (Ahmed et al., 2022; Hunjra et al., 2020; Kamah et al., 2021). Furthermore, effective corruption control and transparency boost investor confidence and optimize ecological efficiency (Ofori & Figari, 2023; Sun et al., 2025).

The KRLS pointwise marginal curve for INQ displays a consistently upward-sloping pattern across higher levels of green growth. This indicates compounding returns: as institutional capacity strengthens, its ability to enforce green banking mandates, monitor environmental taxation, and coordinate multi-sectoral climate policies becomes increasingly effective (Bui & Thi Doan, 2025; Okombi & Ndoum Babouama, 2024).

CONCLUSIONS

This study aims to assess the impact of financial institution efficiency, financial market efficiency, institutional quality, fiscal policy and natural resources on inclusive green growth in Bangladesh on annual time series data for 1990–2025. The results show that the efficiency of financial institutions, the quality of institutions, fiscal policy, and natural

resources have positive effects on inclusive green growth while financial market efficiency has a negative effect with the Kernel Regularized Least Squares (KRLS) estimator. The results further demonstrate that these relationships are nonlinear and vary across different levels of inclusive green growth. Results also show that these relationships are not linear, but vary across different degrees of inclusive green growth. Overall, the findings of the study point to the need to enhance financial institutions' capacity, improve governance standards, enact effective fiscal policies, and integrate financial markets with the goal of green investment in order to ensure long-term inclusive green growth in Bangladesh.

Policy implication

This study offers significant policy implications that financial institution efficiency has positive impacts with respect to inclusive green growth in Bangladesh. The findings indicate that the financial institutions need to be made more efficient as an integral part of the country's sustainable development plan. Policymakers should enhance the efficiency of the banking sector through better credit allocation, less information asymmetry, greater financial inclusion, and greater access to long-term financing of environmental sustainable projects. Bangladesh Bank should keep encouraging green banking practices in the following ways: green bank preferential refinancing scheme, providing concessional loan facilities to investment in renewable energy and clean technology, and improving environmental risk assessment guideline. Financial institutions should also be encouraged to create new green financial products to support SMEs to implement sustainable production practices. These policy measures are in line with the Sustainable Finance Theory, which is the idea that effective financial intermediation can channel investments towards those that provide economic, environmental, and social benefits. Enhanced efficiency of financial institutions would, therefore, accelerate inclusive green growth, and directly support SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation and Infrastructure) and SDG 13 (Climate Action).

The negative effect of financial market efficiency suggests that improvements in market efficiency of the financial market is not enough to inspire inclusive green growth if the financial resources are not channeled into environmentally friendly investments. Policymakers should further improve the regulatory infrastructure of the capital market by adopting green bonds, sustainability-linked financial instruments, environmental disclosure requirements and incentives for institutional investors to finance low carbon industries. Developing transparent green finance taxonomy and strengthening environmental, social, and governance (ESG) reporting standards would be directed more capital to sustainable industries instead of those that are harmful to the environment. These measures are aligned with Sustainable Finance Theory which highlights that sustainable development in financial markets is achieved only with the right regulatory institutions and environmental policy. A shift in financial market activity to green investments would reinforce inclusive green growth to support SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation and Infrastructure), SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action).

Improved institutional quality is a positive factor and shows that good governance is essential to inclusive green growth. Policymakers should thus make efforts to reform government to enhance effectiveness, regulatory enforcement, anti-corruption measures and transparency and accountability in government institutions. Better institutions will lead to better enforcement of environmental laws, enhance investor confidence, and help to make public funds more efficient in supporting sustainable development initiatives. Improved coordination between the government's different ministries and departments responsible for environmental protection, climate policy and the planning and execution of economic policies should also be improved through institution building; this should increase the policy coherence and implementation. These recommendations are aligned with Institutional Economics, which focuses on how good institutions provide the incentives for long-term economic and environmental outcomes. Enhancing institutional quality would contribute to sound sustainable development and to SDG 16 (Peace, Justice and Strong Institutions), SDG 8 (Decent Work and Economic Growth), and SDG 13 (Climate Action).

The positive impact of fiscal policy shows that the role of government spending in the Bangladesh context is still relevant to encourage inclusive green growth. The focus of public spending must further shift towards sustainable infrastructure, sustainable mobility, environmental protection, education, healthcare, and climate adaptation, and towards green infrastructure and renewable energy. Fiscal measures such as tax credits and investment subsidies may help to boost the private sector's involvement in green industry and green technologies. Government spending needs to also invest in research and development, digital public infrastructure and training in skills of the workforce to enhance productivity and social inclusion in the medium to long term. The recommendations made here are based on Keynesian Public Investment Theory which posits that investment that is productive by the government is able to improve the performance of the economy in the long run by correcting market failure and by stimulating investment. Fiscal policies that are well targeted will boost inclusive green growth, and support SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation and Infrastructure), SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action).

However, the positive impact of natural resources provides grounds for resource abundance to be conducive to inclusive green growth, provided that well-designed governance and sustainable development policies are put in place. Policymakers should seek to improve the efficiency of resource management through strengthening of environmental regulation, incentivizing value-added resource processing, and redirecting natural resource revenues to renewable energy, green infrastructure, environmental protection and human capital. More transparency in resource revenue management and better monitoring would allow for greater resource efficiency and lower environmental degradation. Promotion of technologies for cleaner production and sustainable extraction practices for resource based industries should also be encouraged to protect the ecological assets for coming generations. The policy recommendations adhere to the Resource Based Development Perspective of

suggesting that natural resources are not sustainable development factors on their own but when complemented by well-functioning institutions, good fiscal planning and good governance. Good resource management would support inclusive green growth, and push SDG 8 (Decent Work and Economic Growth), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), and SDG 15 (Life on Land).

Limitations and recommendation

The study has a few limitations to consider. The first is that the analysis is based on data for Bangladesh alone and the findings may not be applicable to countries with different financial systems, institutional structures and levels of development. Second, while the KRLS estimator does well to capture the nonlinear relationship, it does not imply causal effects. Third, the study uses aggregate indicators which may not represent regional and sectoral variation in inclusive green growth. For future research, this analysis may be extended to cross-country comparisons, causal identification methods (e.g. instrumental variable, dynamic panel method), and other factors such as green finance, environmental innovation, carbon pricing and climate policy to better understand the determinants of inclusive green growth.

REFERENCES

- Abbas, S., Dastgeer, G., Nasreen, S., Kousar, S., Riaz, U., Arsh, S., & Imran, M. (2024). How Financial Inclusion and Green Innovation Promote Green Economic Growth in Developing Countries. *Sustainability*, 16(15), 6430. <https://doi.org/10.3390/su16156430>
- Abbass, K., Voinea, C. L., Roijakkers, N., & Xiao, D. (2026). Does financial inclusion enable low-carbon transitions? Nonlinear and threshold evidence for climate change mitigation in emerging economies. *International Journal of Sustainable Development & World Ecology*, 33(2), 258–281. <https://doi.org/10.1080/13504509.2026.2615005>
- Ahmed, F., Kousar, S., Pervaiz, A., & Shabbir, A. (2022). Do institutional quality and financial development affect sustainable economic growth? Evidence from South Asian countries. *Borsa Istanbul Review*, 22(1), 189–196. <https://doi.org/10.1016/j.bir.2021.03.005>
- Ahmed, M., Hafeez, M., Kaium, M. A., Ullah, S., & Ahmad, H. (2023). Do environmental technology and banking sector development matter for green growth? Evidence from top-polluted economies. *Environmental Science and Pollution Research*, 30(6), 14760–14769. <https://doi.org/10.1007/s11356-022-23153-y>
- Ahmed, M. K. (2026). Green Economy and Environmental Governance Pathways toward a Sustainable Future in Bangladesh. *American Journal of Environmental Economics*, 5(1), 1–11. <https://doi.org/10.54536/ajee.v5i1.6262>
- Anu, Singh, A. K., Raza, S. A., Nakonieczny, J., & Shahzad, U. (2023). Role of financial inclusion, green innovation, and energy efficiency for environmental performance? Evidence from developed and emerging economies in the lens of sustainable development. *Structural Change and Economic Dynamics*, 64, 213–224. <https://doi.org/10.1016/j.strueco.2022.12.008>

- Batool, Z., Bhatti, A. A., & Rehman, A. (2023). Ensuring environmental inclusion in developing countries: The role of macroeconomic policies. *Environmental Science and Pollution Research*, 30(12), 33275–33286. <https://doi.org/10.1007/s11356-022-24596-z>
- Bui, N. T., & Thi Doan, T.-T. (2025). Analysis of the impacts of financial development on green growth: How does institutional quality matter? *Asia and the Global Economy*, 5(2), 100111. <https://doi.org/10.1016/j.aglobe.2025.100111>
- Cao, J., Law, S. H., Samad, A. R. B. A., Mohamad, W. N. B. W., Wang, J., & Yang, X. (2021). Impact of financial development and technological innovation on the volatility of green growth—Evidence from China. *Environmental Science and Pollution Research*, 28(35), 48053–48069. <https://doi.org/10.1007/s11356-021-13828-3>
- Chi, Y., Hu, N., Lu, D., & Yang, Y. (2023). Green investment funds and corporate green innovation: From the logic of social value. *Energy Economics*, 119, 106532. <https://doi.org/10.1016/j.eneco.2023.106532>
- Cobb, C. W., & Douglas, P. H. (1928). A theory of production. *The American Economic Review*, 18(1), 139–165.
- Cui, K., Li, X., & Li, G. (2023). What kind of fiscal policies and natural resources efficiency promotes green economic growth? Evidence from regression analysis. *Resources Policy*, 85, 103941. <https://doi.org/https://doi.org/10.1016/j.resourpol.2023.103941>
- Deng, X., Yang, J., Ahmed, Z., Hafeez, M., & Salem, S. (2023). Green growth and environmental quality in top polluted economies: the evolving role of financial institutions and markets. *Environmental Science and Pollution Research*, 30(7), 17888–17898. <https://doi.org/10.1007/s11356-022-23421-x>
- Dong, Z., & Arshad, R. (n.d.). Transforming Resource Efficiency for Sustainable Development: The Synergy of Governance, Finance, Education, and Green Growth Across G20 Nations. *Sustainable Development*, n/a(n/a). <https://doi.org/10.1002/sd.70903>
- Han, J., & Gao, H. (2024). Green finance, social inclusion, and sustainable economic growth in OECD member countries. *Humanities and Social Sciences Communications*, 11(1), 140. <https://doi.org/10.1057/s41599-024-02662-w>
- He, Z., Chen, H., Hu, J., & Zhang, Y. (2022). The impact of digital inclusive finance on provincial green development efficiency: Empirical evidence from China. *Environmental Science and Pollution Research*, 29(60), 90404–90418. <https://doi.org/10.1007/s11356-022-22071-3>
- Hossain, Md. Z., & Huq, N. (2013). Institutions Matter for Urban Resilience: The Institutional Challenges in Mainstreaming Climate Smart Disaster Risk Management in Bangladesh. In W. Leal Filho (Ed.), *Climate Change and Disaster Risk Management* (pp. 169–191). Springer. https://doi.org/10.1007/978-3-642-31110-9_11
- Hunjra, A. I., Tayachi, T., Chani, M. I., Verhoeven, P., & Mehmood, A. (2020). The Moderating Effect of Institutional Quality on the Financial Development and Environmental Quality Nexus. *Sustainability*, 12(9), 3805. <https://doi.org/10.3390/su12093805>
- Hainmueller, J., & Hazlett, C. (2014). Kernel Regularized Least Squares: Reducing

- Misspecification Bias with a Flexible and Interpretable Machine Learning Approach. *Political Analysis*, 22(2), 143–168. <https://doi.org/DOI: 10.1093/pan/mpt019>
- Jiang, Y., Sharif, A., Anwar, A., The Cong, P., Lelchumanan, B., Thi Yen, V., & Thi Thuy Vinh, N. (2023). Does green growth in E-7 countries depend on economic policy uncertainty, institutional quality, and renewable energy? Evidence from quantile-based regression. *Geoscience Frontiers*, 14(6), 101652. <https://doi.org/https://doi.org/10.1016/j.gsf.2023.101652>
- Kamah, M., Riti, J. S., & Bin, P. (2021). Inclusive growth and environmental sustainability: The role of institutional quality in sub-Saharan Africa. *Environmental Science and Pollution Research*, 28(26), 34885–34901. <https://doi.org/10.1007/s11356-021-13125-z>
- Karim, M. E., Karim, R., Islam, M. T., Muhammad-Sukki, F., Bani, N. A., & Muhtazaruddin, M. N. (2019). Renewable Energy for Sustainable Growth and Development: An Evaluation of Law and Policy of Bangladesh. *Sustainability*, 11(20), 5774. <https://doi.org/10.3390/su11205774>
- Khalid, K., Usman, M., & Mehdi, M. A. (2021). The determinants of environmental quality in the SAARC region: A spatial heterogeneous panel data approach. *Environmental Science and Pollution Research*, 28(6), 6422–6436. <https://doi.org/10.1007/s11356-020-10896-9>
- Khan, Z., Hossain, M. R., Badeeb, R. A., & Zhang, C. (2023). Aggregate and disaggregate impact of natural resources on economic performance: Role of green growth and human capital. *Resources Policy*, 80, 103103. <https://doi.org/https://doi.org/10.1016/j.resourpol.2022.103103>
- Liu, H., Jafri, M. A. H., Zhu, P., & Hafeez, M. (2024). Fiscal policy-green growth nexus: Does financial efficiency matter in top carbon emitter economies? *Environment, Development and Sustainability*, 26(8), 20379–20396. <https://doi.org/10.1007/s10668-023-03478-5>
- Liu, H., Yao, P., Latif, S., Aslam, S., & Iqbal, N. (2022). Impact of Green financing, FinTech, and financial inclusion on energy efficiency. *Environmental Science and Pollution Research*, 29(13), 18955–18966. <https://doi.org/10.1007/s11356-021-16949-x>
- Liu, Z., Vu, T. L., Phan, T. T. H., Ngo, T. Q., Anh, N. H. V., & Putra, A. R. S. (2022). Financial inclusion and green economic performance for energy efficiency finance. *Economic Change and Restructuring*, 55(4), 2359–2389. <https://doi.org/10.1007/s10644-022-09393-5>
- Mavlutova, I., Spilbergs, A., Verdenhofs, A., Natrins, A., Arefjevs, I., & Volkova, T. (2023). Digital Transformation as a Driver of the Financial Sector Sustainable Development: An Impact on Financial Inclusion and Operational Efficiency. *Sustainability*, 15(1), 207. <https://doi.org/10.3390/su15010207>
- Molla, I. H. (2016). Environment and Climate Change in Bangladesh: Challenges and the Role of Public Administration. *Resources and Environment*, 6(1), 1–8.
- Mpofu, F. Y. (2022). Green Taxes in Africa: Opportunities and Challenges for Environmental Protection, Sustainability, and the Attainment of Sustainable Development Goals. *Sustainability*, 14(16), 10239. <https://doi.org/10.3390/su141610239>

- Munir, M., Fatima, A., & Iftikhar, S. F. (2022). Exploring the Nexus Between Inclusive Growth and Institutional Quality. *JISR Management and Social Sciences & Economics*, 20(1), 64–85. <https://doi.org/10.31384/jisrmsse/2022.20.1.4>
- Muslim, S. S. (2025). Green Fiscal Policy and Sustainable Economic Growth: Evidence from Emerging Markets. *Review of Human Resources, Organizational Change, and Economic Impact*, 1(1), 12–19. <https://doi.org/10.70865/rhrocei.v1i1.10>
- Nenavath, S., & Mishra, S. (2023). Impact of green finance and fintech on sustainable economic growth: Empirical evidence from India. *Heliyon*, 9(5). <https://doi.org/10.1016/j.heliyon.2023.e16301>
- Ngo, T., Trinh, H. H., Haouas, I., & Ullah, S. (2022). Examining the bidirectional nexus between financial development and green growth: International evidence through the roles of human capital and education expenditure. *Resources Policy*, 79, 102964. <https://doi.org/10.1016/j.resourpol.2022.102964>
- Nicholls, R. J., Hutton, C. W., Lázár, A. N., Neil Adger, W., Allan, A., Whitehead, P. G., Wolf, J., Rahman, Md. M., Salehin, M., Hanson, S. E., & Payo, A. (2018). An Integrated Approach Providing Scientific and Policy-Relevant Insights for South-West Bangladesh. In R. J. Nicholls, C. W. Hutton, W. N. Adger, S. E. Hanson, Md. M. Rahman, & M. Salehin (Eds.), *Ecosystem Services for Well-Being in Deltas: Integrated Assessment for Policy Analysis* (pp. 49–69). Springer International Publishing. https://doi.org/10.1007/978-3-319-71093-8_3
- North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge university press.
- Ofori, I. K., & Figari, F. (2023). Economic globalisation and inclusive green growth in Africa: Contingencies and policy-relevant thresholds of governance. *Sustainable Development*, 31(1), 452–482. <https://doi.org/10.1002/sd.2403>
- Ofori, I. K., Gbolonyo, E. Y., & Ojong, N. (2022). Towards inclusive green growth in Africa: Critical energy efficiency synergies and governance thresholds. *Journal of Cleaner Production*, 369, 132917. <https://doi.org/10.1016/j.jclepro.2022.132917>
- Okombi, I. F., & Ndoum Babouama, V. B.-D. (2024). Environmental taxation and inclusive green growth in developing countries: Does the quality of institutions matter? *Environmental Science and Pollution Research*, 31(21), 30633–30662. <https://doi.org/10.1007/s11356-024-33245-6>
- Putri, I. A., Mushfiroh, L., & Hwihanus, H. (2024). Green Economic Growth: A Global Analysis of Fiscal Expenditures, Institutional Quality, and Stock Markets. *Journal of Environmental Economics and Sustainability*, 1(3), 1–11. <https://doi.org/10.47134/jees.v1i3.345>
- Rahman, H. M. T., & Hickey, G. M. (2019). Assessing Institutional Responses to Climate Change Impacts in the North-Eastern Floodplains of Bangladesh. *Environmental Management*, 63(5), 596–614. <https://doi.org/10.1007/s00267-019-01155-w>
- Raman, R., Ray, S., Das, D., & Nedungadi, P. (2025). Innovations and barriers in sustainable and green finance for advancing sustainable development goals. *Frontiers in Environmental Science*, 12. <https://doi.org/10.3389/fenvs.2024.1513204>

- Rusanti, E., Zulaikha, S., Widiastuti, T., Herianingrum, S., Mawardi, I., & Ryandono, M. N. H. (2026). Fiscal policy, natural resources and Islamic finance on green growth in OIC countries: The moderating role of institutional quality. *International Journal of Islamic and Middle Eastern Finance and Management*, 1–21. <https://doi.org/10.1108/IMEFM-01-2025-0002>
- Sachs, J. D., & Warner, A. M. (2001). The curse of natural resources. *European Economic Review*, 45(4–6), 827–838.
- Schoenmaker, D., & Schramade, W. (2018). *Principles of sustainable finance*. Oxford University Press.
- Stiglitz, J. E. (1998). *Towards a New Paradigm for Development : Strategies , Policies , and Processes*. 1997.
- Shashwat, S., Chhabra, M., & Giri, A. K. (2025). Environmental Externalities of Digital Financial Inclusion: A Green Growth perspective. *Discover Sustainability*, 6(1), 81. <https://doi.org/10.1007/s43621-025-00862-1>
- Sheng, J., & Gao, Y. (2023). Combining the financial development and stock market return for green economic recovery in selected developing economies. *Economic Change and Restructuring*, 56(6), 3885–3908. <https://doi.org/10.1007/s10644-022-09454-9>
- Song, J., Zhou, H., Gao, Y., & Guan, Y. (2022). Digital Inclusive Finance, Human Capital and Inclusive Green Development—Evidence from China. *Sustainability*, 14(16), 9922. <https://doi.org/10.3390/su14169922>
- Sun, X., Meng, Z., Zhang, X., & Wu, J. (2025). The role of institutional quality in the nexus between green financing and sustainable development. *Research in International Business and Finance*, 73, 102531. <https://doi.org/10.1016/j.ribaf.2024.102531>
- Teklie, D. K., & Yağmur, M. H. (2024). The Role of Green Innovation, Renewable Energy, and Institutional Quality in Promoting Green Growth: Evidence from African Countries. *Sustainability*, 16(14), 6166. <https://doi.org/10.3390/su16146166>
- Toufique, M. M. K. (2024). The relationship between institutional quality, industry, energy sources and environmental quality in Bangladesh: Insights from ARDL analysis. *Asian Journal of Empirical Research*, 14(4), 84–95. <https://doi.org/10.55493/5004.v14i4.5237>
- Wang, C., Chen, P., Hao, Y., & Dagestani, A. A. (2022). Tax incentives and green innovation—The mediating role of financing constraints and the moderating role of subsidies. *Frontiers in Environmental Science*, 10. <https://doi.org/10.3389/fenvs.2022.1067534>
- Wang, L., Wang, Y., Sun, Y., Han, K., & Chen, Y. (2022). Financial inclusion and green economic efficiency: Evidence from China. *Journal of Environmental Planning and Management*, 65(2), 240–271. <https://doi.org/10.1080/09640568.2021.1881459>
- Wang, Q., & Chen, X. (2024). Can new quality productive forces promote inclusive green growth: Evidence from China. *Frontiers in Environmental Science*, 12. <https://doi.org/10.3389/fenvs.2024.1499756>

<https://databank.worldbank.org/source/world-development-indicators>

- Wu, Y., Song, L., & Zhou, X. (2025). Can Adjust the Fiscal Expenditure Structure Promote Inclusive Green Growth? Empirical Evidence From China. *Review of Development Economics*, 29(3), 1712–1733. <https://doi.org/10.1111/rode.13185>
- Xu, J., Ng, C.-P., Sam, T. H., Vasudevan, A., Tee, P. K., Ng, A. H. H., & Hoo, W. C. (2023). Fiscal and Tax Policies, Access to External Financing and Green Innovation Efficiency: An Evaluation of Chinese Listed Firms. *Sustainability*, 15(15), 11567. <https://doi.org/10.3390/su151511567>
- Xu, T., Yang, G., & Chen, T. (2024). The role of green finance and digital inclusive finance in promoting economic sustainable development: A perspective from new quality productivity. *Journal of Environmental Management*, 370, 122892. <https://doi.org/10.1016/j.jenvman.2024.122892>
- Yan, J., & Wang, R. (2024). Green Fiscal and Tax Policies in China: An Environmental Dynamic Stochastic General Equilibrium Approach. *Sustainability*, 16(9), 3533. <https://doi.org/10.3390/su16093533>
- Yang, C., & Masron, T. A. (2022). Impact of Digital Finance on Energy Efficiency in the Context of Green Sustainable Development. *Sustainability*, 14(18), 11250. <https://doi.org/10.3390/su141811250>
- Yang, L., & Ni, M. (2022). Is financial development beneficial to improve the efficiency of green development? Evidence from the “Belt and Road” countries. *Energy Economics*, 105, 105734. <https://doi.org/10.1016/j.eneco.2021.105734>
- Yin, X., Wang, D., Lu, J., & Liu, L. (2023). Does green credit policy promote corporate green innovation? Evidence from China. *Economic Change and Restructuring*, 56(5), 3187–3215. <https://doi.org/10.1007/s10644-023-09521-9>
- Yıldırım, F., Ünlü, U., Kuloğlu, A., & Çıtak, Ö. (2025). Modeling and Analysis of the Impact of Quality Growth and Financial Development on Environmental Sustainability: Evidence from EU Countries. *Sustainability*, 17(2), 774. <https://doi.org/10.3390/su17020774>
- Yu, L., Gao, X., Lyu, J., Feng, Y., Zhang, S., & Andlib, Z. (2023). Green growth and environmental sustainability in China: The role of environmental taxes. *Environmental Science and Pollution Research*, 30(9), 22702–22711. <https://doi.org/10.1007/s11356-022-23355-4>
- Zhang, S., Jin, M., Xie, M., & Xu, L. (2025). Environmental policy and corporate green innovation: The role of penalties, taxes, and subsidies in China. *Journal of Environmental Management*, 392, 126730. <https://doi.org/10.1016/j.jenvman.2025.126730>
- Zhao, X., Muhammadullah, S., Kazemzadeh, E., Kostakis, I., Ghosh, S., & Doğan, B. (2026). Economic Growth and Sustainable Development: The Role of Financial Inclusion, FinTech, Eco-Innovation, and Economic Complexity. *Sustainable Development*, 34(S2), 1233–1258. <https://doi.org/10.1002/sd.70322>
- Zhao, X., Zeng, B., Zhao, X., Zeng, S., & Jiang, S. (2024). Impact of green finance on green energy efficiency: A pathway to sustainable development in China. *Journal of Cleaner Production*, 450, 141943. <https://doi.org/10.1016/j.jclepro.2024.141943>

Zhou, Y., Liu, H., Chen, C., & Ma, Y. (2025). The impact of digital inclusive finance on green economic efficiency: Pathways to inclusive sustainability. *Research in International Business and Finance*, 76, 102857. <https://doi.org/https://doi.org/10.1016/j.ribaf.2025.102857>