The Relationship of Green Finance and Green Resource Investment on Green Growth In Brics Country

Fachrial Djannah Rosadi, Lia Nazliana Nasution, Rusiadi

Abstract

The rapid growth of the BRICS countries over the past ten years has exacerbated the climate crisis and threatened global development. Their biggest challenge is balancing the drive for socioeconomic growth with environmental preservation. This study analyzes the impact of green finance, green resource investment, and Renewable Energy Consumption on green growth across time periods (short, medium, and long term) in BRICS countries using a VAR (Vector Autoregression) model and World Bank data (2000-2023). This research, through FEVD results, convey that green finance is the second variable after green growth itself that becomes a policy recommendation for the success of green growth in BRICS countries. Green resource investment is the third variable after green finance as a policy recommendation for successful green growth in BRICS countries. Meanwhile, the results of the VAR estimation show that renewable energy consumption is the variable with the largest contribution, followed by green finance. It can be concluded that the role of green finance greatly influences the success of green growth in BRICS countries.

***Keywords**:* Green Growth, Green Finance, Green Resource Investment, Renewable Energy Consumption.

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Introduction

A green economy is an economic system designed to minimize threats to the environment and prevent the depletion of natural resources, while simultaneously encouraging sustainable development while maintaining environmental sustainability. In research [1] green finance has a positive multiplier effect on the quality of economic growth [2], making it a crucial tool for environmental sustainability in BRICS countries. An 1% increase in financial globalization even boosts green growth by 0.071%. However, the effectiveness of green finance depends heavily on the proper allocation of funds to productive green resource investments [3]. Investment developments in environmentally friendly energy, particularly renewable energy, are showing a very positive trend in the BRICS countries. By 2024, solar power will contribute 36 percent to the addition of electricity generation capacity across all BRICS member countries, a remarkable achievement compared to the 2014-2023 period when its contribution was only 14 percent [4]. This rapid growth was achieved thanks to substantial financial support from various environmentally friendly financing programs, both government and private. Investment in the renewable energy sector has had a tangible impact in the form of economic growth and job creation in BRICS countries, while also proving effective in reducing environmental damage [5].

Green economic growth is key to sustainable development and poverty reduction. Environmental damage and the depletion of natural resources can hinder economic growth. Renewable energy sources such as wind, hydro, solar, geothermal, and biomass play a vital role in achieving the target of zero CO_2 emissions [6], [7]. Sustainable economic development is in line with the use of clean energy because it produces a smaller negative impact on the environment. In research [8] emphasized that sustainable economic growth can only be achieved through regular monitoring of environmental damage to maintain the sustainability of natural resources, as well as the use of renewable energy in production.

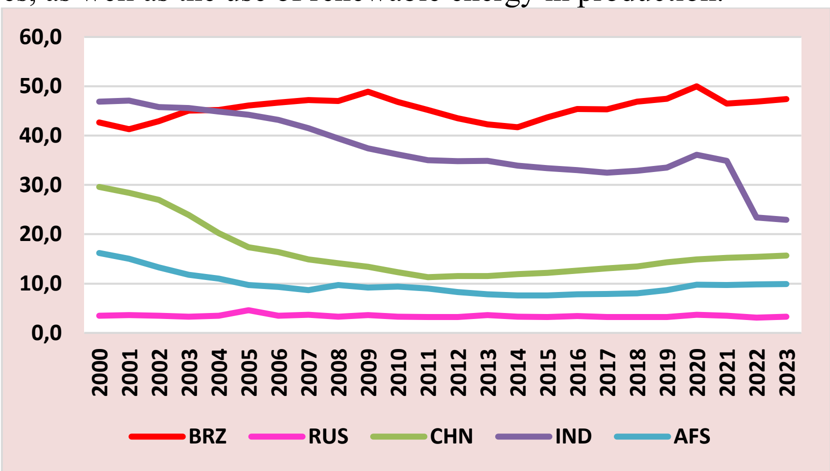

Figure 1.1 BRICS Renewable Energy Consumption Graph 2000-2023

Source: World Bank

Brazil has led the BRICS in renewable energy consumption for decades. In 2011, the country used renewable energy to generate 46.5% of its total primary energy consumption (well above the global average of 13%). This figure peaked at 49.86% in 1990 and bottomed at 41.3% in 2001 [9]. India has the second-highest renewable energy consumption rate, surpassing Brazil at 46.9% in early 2000, compared to Brazil's 42.7%. However, India's renewable energy consumption began to decline in 2002. India's commitment to renewable energy is evident in its remarkable acceleration. In just the first four months of 2025, solar power production surged 32% compared to the same period last year. This underscores a steady and ambitious growth rate [10]. Unlike other BRICS countries, Russia has been slow to adopt renewable energy. They still rely heavily on fossil fuels, so their current clean energy use is very small and shows little signs of change. This places Russia at the bottom of the list among BRICS members in terms of energy transition [11]. Fossil fuels remain a crucial source of government revenue in several

BRICS countries, significantly supporting their economies. Russia tops the list, with nearly a quarter (23.6%) of all government revenue coming from fossil fuel production and consumption. India also receives substantial revenue (17.8%). Meanwhile, fossil fuel revenue contributions are moderate in Brazil and South Africa (6.8% each), and relatively small in China (4.2%) [12].

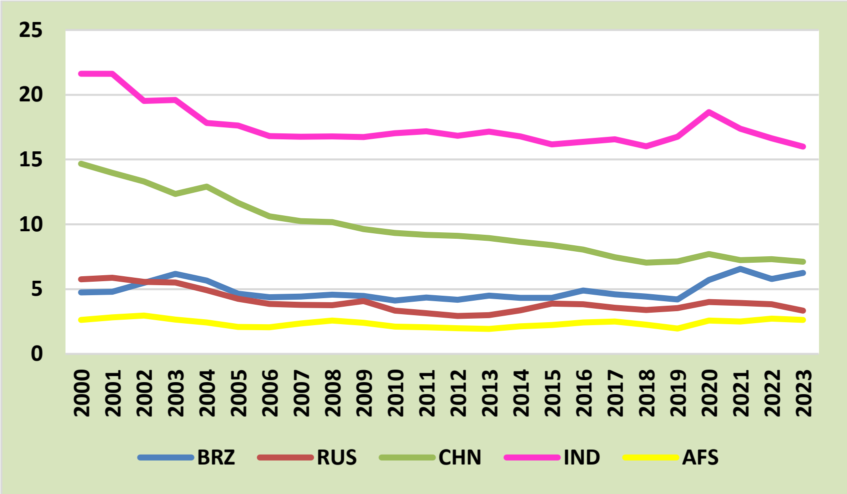

Figure 1.2 BRICS Green Resources Investment Graph 2000-2023

Source: World Bank

In the third quarter of 2024, India achieved $2.4 billion in renewable energy investments for the first time, a remarkable achievement that reflects the country's strong commitment to sustainable development and attracting green investments in the renewable energy sector [13]. These results are in line with the graph above, where the highest level of green resource investment is in the BRICS countries with a value of 18.67% in 2020. This research was conducted due to the encouragement to continue the research conducted by [14], the process towards sustainable growth triggers a paradigm shift towards green growth, in which green finance is also a crucial factor in recovering the economy and financial system from the impact of the crisis.

Literature Review

2.1 Green Finance

Green Finance is specialized funding aimed at financing projects, programs, and policies that support environmental sustainability and sustainable development. The core of Green Finance, which differentiates it from conventional financing, is its dual objective of achieving economic returns while providing tangible benefits to the environment [15] .In practice, green finance stands on four main pillars [16], including: Green Credit (low-cost loans for environmentally friendly projects), Green Securities (capital market instruments such as bonds/shares to finance the environment), Green Insurance (protection from environmental risks and climate change), and Carbon Finance (trading and emission credits to manage and offset emissions).

2.2 Green Growth

The term "Green Growth" was first introduced by the OECD in 2011, defining it as sustainable economic growth while preserving natural resources for human well-being [17], [18], [19]. This concept shifts the traditional view that economic growth and environmental preservation are at odds, to the belief that they can coexist with the right strategies. In the Oxford Review of Economic Policy [20], explaining in more detail that Green Growth aims to create inclusive economic growth while reducing environmental impact through three pillars: technological innovation, resource efficiency, and massive green investment. They emphasized that Green Growth is not just a theory, but a concrete strategy that can be implemented through a combination of government policies, private investment, and environmentally friendly changes in consumer behavior.

2.3 Stakeholder Theory

In the book Strategic Management: A Stakeholder Approach [21] first introduced Stakeholder Theory which states that companies are responsible not only to shareholders, but also to employees, customers, suppliers, local communities, and the environment. Research conducted by [22] in the Journal of Business Ethics reinforces this theory by explaining that Green Finance is a concrete application of Stakeholder Theory, where financial institutions and companies acknowledge their responsibilities to all parties, including the environment and future generations. In this case, Green Finance is not merely pursuing short-term profits, but rather creating long-term value for all parties by considering the environmental and social impacts of investments, thus supporting more equitable, inclusive, and sustainable economic development.

Research Methodology

In this study, we used secondary data from the World Bank website covering the period 2000-2023. To analyze the quantitative data, this study used Eviews 10 with the Vector Autoregression (VAR) method. The VAR model was first developed by [23] to analyze the relationship between economic variables in depth without getting caught up in the problem of exogenous variables [24]. The uniqueness of this model is that all variables are treated as endogenous, allowing estimation to be performed simultaneously or incrementally. Through the VAR approach, we can test the simultaneous relationship between variables and their integration over time. This test aims to identify the simultaneous relationship between exogenous and endogenous variables by considering the time dimension (time lag). The VAR method plays a crucial role in identifying factors such as the reciprocal impacts between variables, the degree of data persistence, and delayed reactions. This approach provides a solid and reliable empirical understanding for policy formulation and projections in the macroeconomic and development domains [25].

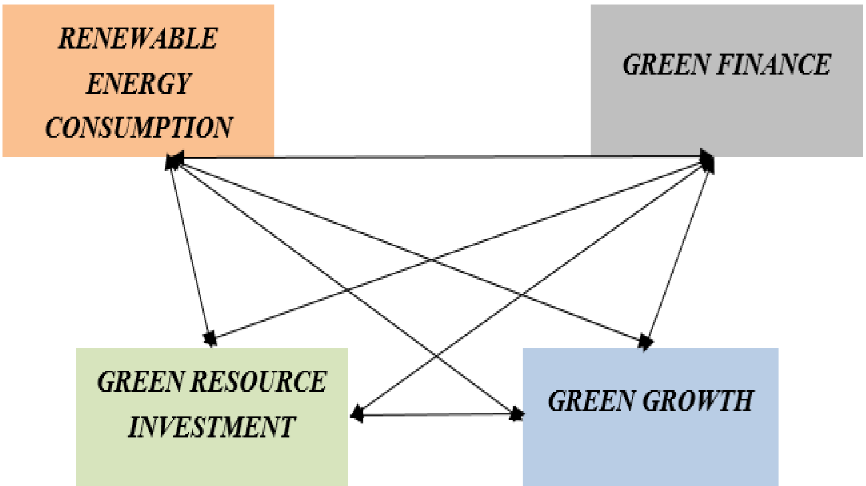

Figure 3.1 VAR Conceptual Framework

The VAR model equation above can be summarized into the following equation:

GGt = β10GFt-p + β11GRIt-p + β12RECt-p +et1
GFt = β20GGt-p + β21GRIt-p + β22RECt-p +et1
GRIt = β30GGt-p + β31GFt-p + β32RECt-p +et1
RECt = β40GGt-p + β41GFt-p + β42GRIt-p +et1

Details:
GG : Green Growth
GF : Green Finance
GRI : Green Resource Investment
REC : Renewable Energy Consumption

Results

4.1 Stationery Test

In VAR model analysis, the first step in testing the classical assumptions is to assess the stationarity of the data. A time series data set is classified as stationary if its mean and variance remain stable or do not experience systematic, sustained shifts over time [26], [27]. The criteria for ensuring data stationarity, based on the results of the Augmented Dickey-Fuller (ADF) Test, are met if the resulting probability value is less than 0.05. In addition, the calculated t-statistic value must absolutely exceed the McKinnon critical value applicable at the 1% level of significance.

Table 4.1 Stationary Test Results

Variables	ADF Value	McKinon Critical Value On Significance Level 1%	Prob	Note
GF	-11.17716	-3.486551	0.0000	Stationary
GRI	-10.90004	-3.486551	0.0000	Stationary
GG	-11.50550	-3.486551	0.0000	Stationary
REC	-10.65295	-3.486551	0.0000	Stationary

Source: Eviews 10, data processed 2025

Table 1.4 shows the results of the Augmented Dickey Fuller (ADF) test, which indicates no stationary variables at the initial level. Therefore, the data was retested using the First Difference method. The results showed that all four variables green finance, green resource investment, green growth, and renewable energy consumption were stationary at the First Difference. This is evident from the ADF statistical value, which is below the McKinnon critical value at the 1% confidence level. With all variables stationary, further analysis can be conducted

4.2 Lag Length Test

To determine the optimal lag, the Akaike Information Criterion (AIC) and the Schwarz Criterion (SC) are used. A lag is considered optimal and efficient when its AIC and SC values are the lowest compared to other lags. The following presents the results of the selection between lag 1 and lag 2.

Table 4.2 Lag Length Test Results

Standard Error	Lag 1	Lag 2
Determinant residual covariance (dof adj.)	0.000476	0.000373
Determinant residual covariance	0.000399	0.000265
Log likelihood	-202.6391	-171.4530
Akaike information criterion	3.871985	3.771873
Schwarz criterion	4.349364	4.655666
Number of coefficients	20	36

Source: Eviews 10, data processed 2025

The results of the lag determination show that the Akaike Information Criterion (AIC) value at lag 2 is 3.771873, lower than lag 1 which is 3.871985. This means that VAR at lag 2 is more optimal than lag 1. Therefore, this study uses lag 2 for analysis.

4.3 AR Root Table

The stability of a VAR system can be identified through the inverse roots of the AR characteristic polynomial. The system is declared stable if all modulus values in the AR roots table are below 1. The following presents the results of the Roots of Characteristic Polynomial test:

Table 4.3 Lag Stability Test of Structure

Root	Modulus
0.993364	0.993364
0.981465	0.981465
0.857718	0.857718
0.716015	0.716015
0.390461	0.390461
0.225758	0.225758
-0.142041 - 0.075113i	0.160679
-0.142041 + 0.075113i	0.160679

Source: Eviews 10, data processed 2025

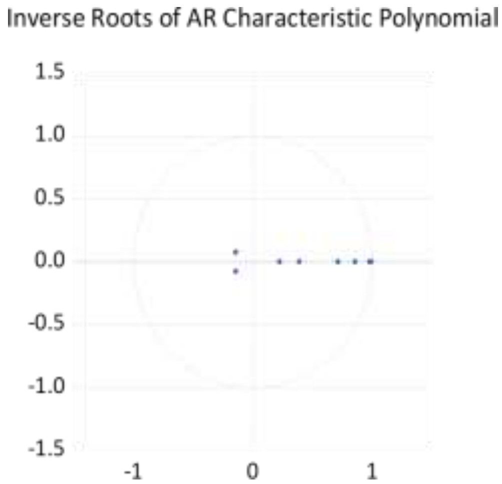

Figure 4.1 Stability of Lag Structure

Source: Eviews 10, data processed 2025

Based on Table 4.3, all roots modulus values are less than 1, while the graphic visualization shows the position of the roots points perfectly contained within the circle area. This finding confirms the stability of the model through the Roots of Characteristic Polynomial and Inverse Roots of AR Characteristic Polynomial tests, where all unit roots are distributed within the circle boundary. Since the lag stability condition has been met, the VAR analysis stage can proceed to the next process.

4.4 Johansen Cointegration Test

The Johansen cointegration test has been completed, and its findings reveal how the variables are related to each other in the long run. The following are the detailed results of the Johansen cointegration test.

Table 4.4 Johansen Cointegration Test Results Table

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistics	Critical Value	Prob.**
None *	0.304019	61.64762	47.85613	0.0015
At most 1 *	0.129945	23.59218	29.79707	0.0182
At most 2	0.078392	8.976270	15.49471	0.3676
At most 3	0.003845	0.404508	3.841466	0.5248

Source: Eviews 10, data processed 2025

Based on the cointegration test results obtained from the two equations, it is clear that they have a close and stable relationship. Essentially, these two equations are cointegrated at the 5% significance level (as shown in the test results table). This is a good sign, as it indicates a strong long-term correlation or relationship between the variables studied.

4.5 VAR Estimation Results

VAR estimation reveals how these variables influence each other. The first and second principal influences (contributions) of each variable on the others are presented in the following table.

Table 4.5 VAR Estimation Results

Variables	Contribution Percentage			
	GG	GF	RE	GRI
GG	0.217997	0.910162	2.095843	-0.771504
GF	-0.067605	-0.391278	0.069339	-0.117276
REC	0.006692	0.006594	-0.150252	-0.029034
GRI	-1.99E-05	-0.058882	-0.278965	0.090007

Source: Eviews 10, data processed 2025

From the results of the VAR model calculations, we can clearly see how each variable influences the others. According to research conducted by [28], [29], [30], wisely designed renewable energy policies play a crucial role in encouraging investment flows and accelerating the technological innovation needed to create a sustainable built environment. Likewise, the results of these efforts [31]. Green finance acts as a bridge between funding sources and the green economy, and drives innovation in the renewable energy sector through various means. These results are in line with the VAR estimation results above, where renewable energy consumption is the largest variable influencing green growth, followed by green finance.

4.6 IRF Results

Impulse Response Function (IRF) is a test in VAR that shows the dynamic response of each variable to a change of one standard deviation. According to Manurung (2009) in [32], IRF measures the direction of movement of a variable due to changes in another variable. With this model, we can see the influence between variables in the short, medium, and long term. Meanwhile, citing [33] the Impulse Response Function (IRF) tracks the effects of a shock (sudden change) to a variable on the entire system (all related variables) over time. Technically, the IRF measures the dynamic response of each variable to an innovation of one standard deviation. The following table summarizes the findings regarding the interrelationships between variables at each time point.

Table 4.6 IRF VAR Test Results

Variables	Term	GG	GF	RE	GRI
GG	Short	+			
	Intermediate	+	+	-	-
	Long	+	-	+	-
GF	Short	+	+		
	Intermediate	+	+	-	+
	Long	+	+	-	+
RE	Short	+	-	+	
	Intermediate	+	-	+	-
	Long	+	-	+	-

Source: Eviews 10, data processed 2025

In summary, these findings suggest that each different standard error has a unique impact. When we measure a one-standard-deviation change in each studied variable, we observe varying responses. The effects of these variables are highly dynamic over time, whether in the short, medium, or long term. For example, a variable that initially exhibits a negative effect may become positive in the future. Conversely, a variable that initially exhibits a positive effect may reverse to negative. Overall, this study found both positive and negative responses. This implies that all studied variables are related to each other, whether over short-term or long-term time periods.

4.7 FEVD Results

The FEVD method, commonly known as Variance Decomposition, aims to project the percentage contribution of variance to each endogenous variable within a VAR framework. This contribution is measured in response to specific movements or shocks to certain variables in the model.

Table 4.7 FEVD VAR Test Results

Variables	**Policy Recommendations**		
	JP	**JM**	**JPJ**
GG	GG	GG	GG
	-	GF	GF
GF	GF	GF	GF
	GG	GG	GG
RE	RE	RE	RE
	GG	GF	GF
GRI	GRI	GRI	GRI
	GG	GG	GG

Source: Eviews 10, data processed 2025

Details:
JP : Short Term
JM : Intermediate Term
JPJ : Long Term

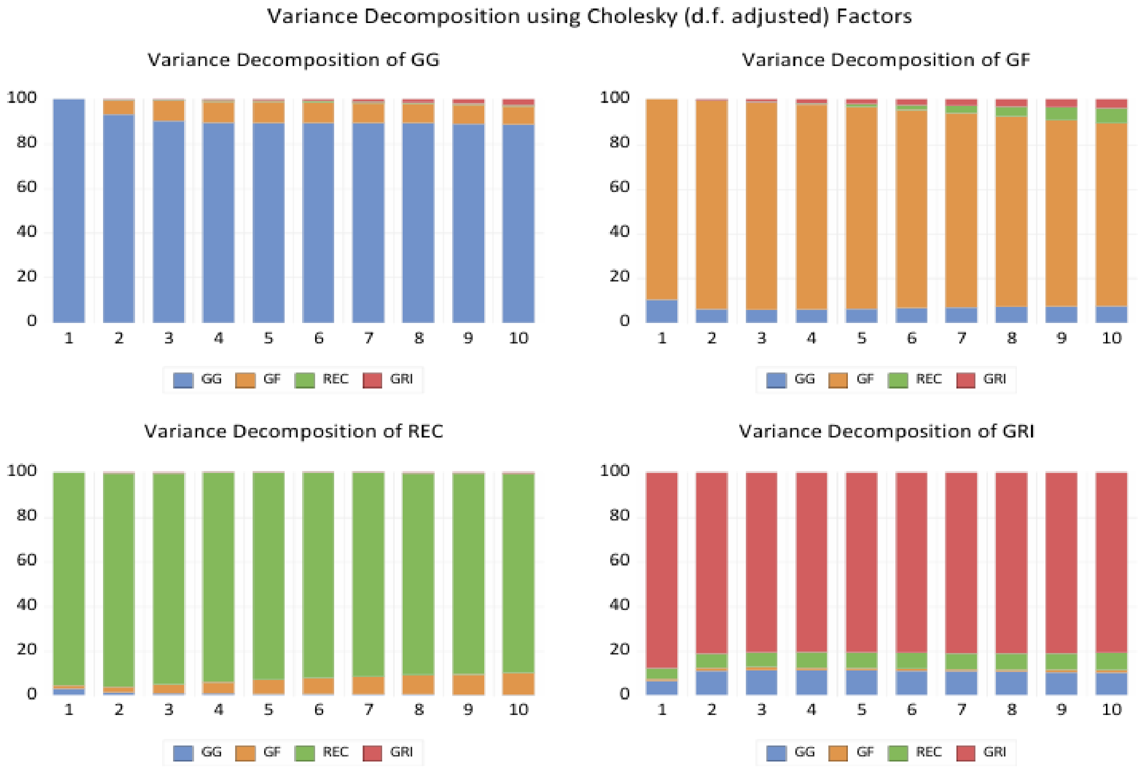

Figure 4.2 Graphic Stacked FEVD VAR
Source: Eviews 10, data processed 2025

From the table above, it can be seen that the second variable which is a recommendation for the success of green growth in the medium and long term is the green finance variable, where each has a percentage value of 31.86% and 29.67% respectively. This is strikingly different from the findings [34] which showed the opposite result, this study revealed a worrying finding: the probability of green finance growth actually having a negative impact on green growth was above 75.86%. However, the research results attached by [35] have the same results, where green finance has been proven to be a significant positive driver for progress towards more sustainable economic growth. The research conducted by [36] Green finance is an integral part of the concept of low-carbon green growth, creating a close link between financing, environmental improvement efforts, and economic development. Green finance markets are markets for assets and funds that support renewable energy and environmentally friendly projects. Recently, a robust green finance market has been considered crucial for the development of renewable energy technologies [37], [38], [39]. Green resource investment is the third variable recommended as a policy factor for successful green growth, with a long-term contribution of 2.36%. This finding aligns with research findings that indicate that investment in renewable energy has no significant impact on green economic growth in the agricultural sector, but shows a positive relationship with the industrial sector in 15 APEC countries [40].

Conclusion

5.1 Conclusion

This study examines the influence of green finance, green resource investment, and renewable energy consumption on green growth in BRICS countries from 2000 to 2023 using a Vector Autoregression (VAR) model. The main conclusions are as follows:

1. Green finance plays a strategic role as the second most important variable after green growth itself, especially in the medium and long term. The FEVD results show that green finance contributes 31.86% (medium term) and 29.67% (long term) to variations in green growth. This demonstrates that mobilizing funds for environmentally friendly projects through instruments such as green bonds and sustainable credit has a positive multiplier effect on economic growth. Green finance not only accelerates investment in the green sector but also creates a financial ecosystem that supports environmentally friendly technological innovation.
2. Renewable energy consumption is the most dominant factor driving green growth in the BRICS, followed by green finance. VAR estimates demonstrate that increasing the use of clean energy sources such as solar, wind, and hydroelectricity significantly impacts the quality of sustainable economic growth. This confirms that the transition from fossil fuels to renewable energy is a key foundation for achieving optimal green growth.

5.2 Suggestion

Based on the conclusions that have been outlined, this study proposes several policy recommendations and suggestions for further research as follows:

1. BRICS governments should prioritize renewable energy infrastructure investment in their green growth strategies. Since renewable energy consumption has been shown to contribute significantly to green growth, public spending and fiscal incentives should be focused on the development of solar, wind, hydroelectric, and biomass power plants. Fossil fuel subsidies should be gradually shifted to renewable energy, while removing regulatory barriers that hinder private investment. Ambitious yet realistic renewable energy consumption targets should be set, tailored to each country's specific circumstances, to ensure a sustainable energy transition.
2. Developing a robust and inclusive green finance ecosystem is an urgent priority given its significant impact in the medium and long term. BRICS monetary authorities and financial institutions need to strengthen regulations on green finance instruments such as green bonds, sustainable loans, and climate funds. The establishment of a green

development bank or specialized financing institution could address the financing gap for environmentally friendly projects.

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