

The Interplay of Monetary Policy and FDI in Shaping Green Finance

Abstract

This study explores the effects of monetary policy and foreign direct investment (FDI) on green finance performance using data from 144 countries between 1990 and 2022. Our findings support Pecking Order Theory, showing that increased broad money (BM) supply enhances green finance as firms prioritize internal funding. FDI also positively impacts green finance by supplementing internal funds. Conversely, high lending interest rates (LR) negatively affect green finance, suggesting that reduced rates can promote sustainable investments. Regional analysis indicates that BM generally supports green finance, while LR's effects vary. FDI consistently boosts green finance across regions, though its interaction with BM and LR differs. During economic recessions, BM's positive impact strengthens, and FDI enhances LR's effects. Managers should leverage BM and FDI to fund green projects, advocate for favorable lending rates, tailor strategies to local contexts, and utilize FDI during downturns to support renewable energy investments. This study provides new insights into the roles of monetary policy and FDI in sustainable economic growth.

KEYWORDS

monetary policy, foreign direct investment, green finance, firm strategy, sustainable development, economic growth, environmental sustainability, renewable energy consumption, CO2.

1 | INTRODUCTION

It is essential for achieving a sustainable future and addressing the challenges caused by climatic changes (Agrawal et al., 2023). Green finance has become an important strategy for the financial sector and an important point of reference for government policies (Wu et al., 2022), due to it has several advantages such as it seeks to offer operating, investing, financing of funds, and supplementary services to the finance industry. Its environmentally conscious nature directs funds towards clean energy, curbing financial burdens, and fostering technological breakthroughs (Wan et al., 2023; Zhao et al., 2023). When financial resources are provided to promote ecologically beneficial initiatives, it can help to mobilize capital, mitigate risk, and drive the innovation of new technologies and products that promote environmental sustainability (Agrawal et al., 2023).

Previous studies have demonstrated that the performance of green finance is influenced by various factors including green credit policy (Wu et al., 2022), market size and market liquidity (Leitão et al., 2023), the production of blue and green hydrogen (Webb et al., 2023), suggesting that provinces should formulate policies tailored to their local characteristics and condition configurations, financial technology (Nenavath & Mishra, 2023), and renewable energy investment (Feng et al., 2023). Green credit policy had a significant negative impact on the external financing of manufacturing industry in China, but the effect of the green credit policy had a dynamic feature of weakening with time (Wu et al., 2022). The level of asymmetry association between green finance and greenhouse gas emissions in the top ten countries tends to change, focusing on the need for policy makers to pay particular attention in implementing green finance and environmental sustainability policies (Li et al., 2023). The market size and market liquidity are the most important predictors of green bond issuance, with proportionate positive and negative effects (Leitão et al., 2023). The positive is that Environmental technological innovation drives green bonds, however, size is an essential component in market accounting features other than green bonds, which portray themselves as a hedge market to stock market liquidity (Leitão et al., 2023). Strengthening the consolidation of fintech growth with green finance, structuring a quality environmental revelation outline to control state governments in refining the effectiveness of green finance, and emerging prolonged satisfactory protocol as an outside involvement proceeding to encourage green finance in the non-public sector (Nenavath & Mishra, 2023). (Feng et al., 2023) indicates that the contraction of green bonds significantly reduces renewable energy investment and stimulates environmental damage.

When discussing "Monetary Policy," it is emphasized that it has a significant role to play when the economy undergoes structural changes (Bergholt et al., 2023). If monetary policy is neutral in the long run, permanent shocks induce structural change completely independently of the response of the central

bank. Then, one may conclude that monetary policy should deal with short-term stabilization issues, not long-term structural issues. Monetary policy is important in mitigating welfare costs during structural reallocation sector (Bergholt et al., 2023). The monetary policy tools used by countries have changed considerably, from quantity-based monetary to price-based monetary, then to unconventional monetary policy, reflecting the increasingly complex domestic and international economic environment (Cui et al., 2024). In addition, the use of monetary policy tools varies across countries. Under different domestic economic conditions and international economic cycles, it is obvious that macroeconomic evolution is heterogeneous across countries in the face of internal and external monetary policy shocks, and this is an important factor that countries need to consider when making monetary policy (Cui et al., 2024). Some of the earlier studies on the sectoral effects of monetary policy in developed countries, find that the responsiveness of industrial output across sectors is unevenly distributed in response to a contractionary monetary policy shock (Roy et al., 2023). While food, drinks and tobacco output show a modest decline, the outputs of rubber products and electric equipment show a much larger decline (Roy et al., 2023). Moreover, sectors that consist of relatively small firms respond much due to their vulnerability to credit market imperfections. Monetary tightening leads to a higher drop in credit disbursement and consequently the output of the smaller firms relative to large-scale firms in the USA (Roy et al., 2023). In the intricate web of the global economy, the monetary policy decisions of the Federal Reserve resonate far beyond US shores (Thomas, 2023). These decisions send ripples through international markets, affecting foreign economies both directly and indirectly via cross-country interactions and commodity price fluctuations. These indirect effects abroad can reverberate back into the US economy, creating a complex feedback loop (Thomas, 2023). In Australia, it was only with the COVID-19 pandemic that began in early 2020, that the RBA started to implement "unconventional" monetary policy measures to complement its longstanding approach to setting the cash rate (Fisher & Huh, 2023).

In line with emerging economies' central banks' policy consolidation toward inflation control, monetary aggregates have been employed as the monetary policy tool to ensure pricestability while supporting economic growth (Roy et al., 2023). This broadening of monetary policy objectives is in line with similar developing economies. Inflation targeting and price stability gained traction in the South-East Asian economies, especially after the 1997-1998 financial crisis. In addition, setting and following monetary policy rules provide a credible signal to the market. After a monetary policy tightening shock, firms' real sales of 11 advanced and emerging economies in Asia fall, in accordance with priors and economic intuition, also providing a useful benchmark for our subsequent results (Renzi & Beirne, 2023). At this stage, it is important to get an understanding of the underlying contradictory theories that seem to provide the opposite empirical findings involving the impact of monetary policy on stock market bubbles (Caraianni et al., 2023). Contractionary monetary policy shocks should be related to lower stock prices given the higher

discount rate for the expected stream of cash flows and/or lower future economic activity while expansionary monetary policy shocks are commonly viewed as good news as these periods are usually associated with low interest rates, increases in economic activity, and higher earnings for the firms in the economy, and thus would imply higher stock prices (Caraiani et al., 2023).

Measuring monetary policy by broad money supply (M2) and short-term interest rate (SR), (Cui et al., 2024) indicates that emerging economies are more vulnerable to monetary policy spillover effects than advanced economies for both quantity-based and price-based monetary policies. A shock resulting in a uniform cutting of short-term interest rates might cause a recession in the majority of economies while a shock resulting in a rise in the broad money supply could trap some economies in stagflation. After a monetary policy tightening in Asia over the period 2013-2021, the real sales of firms with low market power significantly decline, while real sales of firms with high market power respond little (Renzi & Beirne, 2023). (Fisher & Huh, 2023) examines a recently developed sign restrictions algorithm and extend it to account for estimation uncertainty in the reduced-form VAR in Australia during 1993 to 2019. These results show that prices and output fall, and the unemployment rate rises, following a contractionary monetary policy shock and are compared to those from a traditional sign restrictions algorithm and with other studies. While traditional monetary policies like inflation targeting or fixed exchange rates can lead to high unemployment and slow economic transition during adjustments, allowing a depreciated exchange rate and short-term inflation through appropriate monetary policy can mitigate the welfare costs of such transitions (Bergholt et al., 2023).

From this, it is evident that research on the intersection of Monetary Policy and Green Finance is still relatively underexplored. When the authors searched for papers addressing both these topics, they found only a review paper discussing approaches to Green Finance and Green Monetary Policy (Dziwok & Jäger, 2021), and a research article on the impact of monetary policy on the green stock market in Indonesia (Sakuntala et al., 2022) , and green investment in Hungary (Desalegn et al., 2022).

On the one hand, (Dziwok & Jäger, 2021) provide a conceptual framework that helps to distinguish between different forms of green finance and monetary policy and categorizes these forms into three main types: neoliberal, reformist, and progressive. Each category is further divided into subcategories based on their approach to market regulation, state intervention, and the role of private and public sectors in environmental sustainability. The study critiques each approach based on different theoretical perspectives and assesses their potential effectiveness in addressing global environmental challenges. The classification aims to facilitate academic debate and policy discussions in the field of green finance and monetary policy, emphasizing the importance of these approaches in addressing

global environmental issues and sustainability.

The research objective of this paper is to explore the interplay between monetary policy and green finance performance in eight regions around the world, with a focus on how monetary policy strategies can support sustainable economic development and environmental sustainability. To address the research objective of exploring the interplay between monetary policy and green finance performance, the following research questions (RQs) are proposed:

RQ1: How does monetary policy tools impact green finance performance?

RQ2: How do foreign direct investments impact green finance performance?

RQ3: Does foreign direct investments play a moderate role in the relationship between monetary policy and green finance?

Firstly, this research is expected to reveal that monetary policy tools, specifically broad money supply (BM) and lending interest rates (LR), have a significant influence on green finance performance. An expansionary monetary policy, characterized by increased BM and lower LR, is anticipated to enhance green finance performance by promoting investments in sustainable projects and reducing the cost of capital for green initiatives. Conversely, a contractionary policy might hinder green finance by making financing more expensive and less accessible (Qian and Yu 2024). Secondly, the study is likely to find that foreign direct investments (FDI) positively impact green finance performance. FDIs are expected to bring not only capital but also technology, expertise, and best practices in sustainable development. Thirdly, it is anticipated that FDIs will moderate the relationship between monetary policy and green finance performance. The presence of substantial FDIs might amplify the positive effects of expansionary monetary policies on green finance by providing additional financial resources and facilitating the implementation of green projects (Lei and Yu 2023). In regions with high FDI inflows, the synergy between monetary policy and FDI is expected to lead to a more pronounced improvement in green finance performance. Finally, the research is expected to uncover regional differences in the impacts of monetary policy and FDI on green finance performance. These variations may be due to differing economic structures, levels of development, regulatory environments, and natural resource endowments among the eight regions studied. For instance, developed regions might exhibit a stronger response to monetary policy changes due to more mature financial systems, while developing regions might show a greater impact of FDIs due to their higher need for external capital and technology (Chen and Zeng 2022). The interplay of monetary policy and FDI on green finance is likely to be more complex in regions with varying degrees of economic stability and sustainability priorities.

The research is divided into five sections. Section 1 provides an overview of the research problem, research objectives, and research questions. The theoretical framework and literature review will be presented in Section 2. Section 3 will outline the research methodology, data collection, and variables measurement. Section 4 will present the research findings and Section 5 will discuss the

results. Section 6 will conclude the paper.

2 | THEORETICAL BACKGROUND AND HYPOTHESES DEVELOPMENT

2.1 | Theory

The research is based on two main theoretical foundations: the *pecking order theory* and the *institutional theory*. Pecking order theory (Myers and Majluf, 1984) suggests that higher returns or cash reserves enhance the likelihood of firms investing without needing external capital (Leitão et al., 2023). According to this theory, internal financing is preferable to debt financing. In addition to seeking external financing through banks, industries that are heavy polluters, energy-intensive, or have overcapacity tend to rely on internal funds, such as retained earnings and short-term investments (Wu et al., 2022). Institutional theory (Acemoglu and James, 2012) emphasizes the importance of both formal and informal institutions in shaping strategy and FDI decisions. This theory posits that a multinational corporation (MNC) requires three types of advantages – ownership, internalization, and location – to engage in FDI (Mahbub et al., 2022). International capital flows typically favor countries with strong institutional qualities (Suddaby, 2013). As per Acemoglu and James (2012), countries with inclusive institutions have a business advantage over those with exclusionary institutions, as the former facilitate business development and economic prosperity. To attract foreign investment, countries should create a favorable business environment by reducing social transaction costs, informal costs, and corruption (Nguyen, 2023).

Monetary policy, usually implemented by the central bank, can either be contractionary or expansionary. An expansionary monetary policy, characterized by lower market interest rates, tends to attract international capital flows into the host country. Conversely, a contractionary monetary policy, which leads to higher domestic interest rates, can attract international capital by creating a significant interest rate differential between domestic and foreign markets, thereby promoting domestic investment. Thus, monetary policy plays a crucial role in influencing decisions to expand or contract international investment flows.

2.2. | Monetary policy and Green Finance performance

Money supply, often represented by broad money supply, is a critical tool used by central banks to implement monetary policy. It encompasses the total amount of money available in an economy, including cash, deposits, and other liquid assets (Desalegn et al., 2022). Central banks regulate the money supply

to achieve macroeconomic objectives such as controlling inflation, managing employment levels, and promoting economic growth.

In Hungary, monetary policy measured by interest rates and the broad money supply has shown mixed effects on the level of green financing (Desalegn et al., 2022). Interest rates, in particular, have a negative and significant relationship with green finance in both the long and short run, while long-term coefficient estimates show a positive relationship between interest rates and green stock markets (Sakuntala et al., 2022). On the other hand, broad money supply has a positive but insignificant relationship with green finance in the long run (Desalegn et al., 2022). Additionally, private investment has a positive and significant relationship with green financing in both the long and short run (Desalegn et al., 2022).

An increase in the money supply exerts a positive influence on green finance performance through several channels (Chen and Zeng 2022). Firstly, it enhances the availability of funds dedicated to green investments, thereby facilitating the expansion and development of environmentally sustainable projects. Furthermore, by increasing liquidity in the financial system, a larger money supply contributes to lowering the cost of capital for green initiatives. This reduction in financing costs makes green projects more financially viable and attractive to investors, encouraging greater allocation of capital towards sustainable development. Additionally, the influx of additional money into the economy stimulates overall economic activity, creating a conducive environment for the growth of green finance.

Lower short-term interest rates also play a crucial role in boosting green finance performance. By reducing the cost of borrowing for green investments, lower interest rates enhance the affordability and profitability of sustainable projects (Chen and Zeng 2022). This cost reduction not only attracts more investment but also accelerates economic growth by fostering increased spending and investment in green sectors. Furthermore, the attractiveness of sustainable projects is heightened as lower financing costs underpin their long-term viability and profitability, aligning investor interests with environmental and social sustainability goals.

Therefore, we propose Hypothesis 1 and 2 as follows:

H1. An increase in the money supply positively affects green finance performance.

H2. Lower lending interest rates positively affect green finance performance.

2.3. | FDI and Green Finance performance

Shinwari et al. (2024) indicate that increased FDI leads to higher energy consumption in BRI nations. The positive relationship between FDI and green finance performance in China can be attributed to the significant surge in FDI from China to BRI nations since the inception

of the initiative (Shinwari et al., 2024). China's investments in the BRI region are primarily centered on energy-intensive industries, including manufacturing, infrastructure, construction, and the production and distribution of power. Consequently, the ecological costs of China's outward FDI remain a source of contention (Shinwari et al., 2024).

However, FDI brings additional capital into the host country, which can be directed towards green finance projects and sustainable development initiatives. Moreover, FDI often involves the transfer of advanced technologies and practices, which can enhance the efficiency and effectiveness of green projects (Lei and Yu 2023). This influx of capital and technology can lead to the development of more sustainable and environmentally friendly projects, thereby improving green finance performance.

Therefore, we propose Hypothesis H3 as follows:

H3: FDI positively affect green finance performance.

2.4 | FDI moderates the impact of Monetary policy on Green Finance performance

The presence of FDI can create synergies with expansionary monetary policies, leading to a greater boost in green finance performance compared to the impact of monetary policy alone (Liang et al., 2024). High levels of FDI can indicate a stable and attractive investment environment, enhancing the confidence of domestic investors and policymakers in the success of green finance initiatives (Qian and Yu 2024). Additionally, FDI can act as a multiplier in the economy, increasing the overall effectiveness of monetary policy tools by providing additional leverage for sustainable investments (Liang et al., 2024).

This hypothesis assumes that the presence and levels of FDI influence how effectively monetary policy measures, such as increases in the money supply and reductions in interest rates, stimulate green finance initiatives. The interaction between FDI and monetary policy can potentially lead to synergistic effects, enhancing the scale and scope of sustainable investments. This is particularly important in the context of each nation's evolving economic and environmental priorities, as well as the vital issues that affect nations worldwide.

Therefore, we propose Hypotheses H4 and H5 as follows:

H4: FDI moderates the impact of money supply on green finance performance.

H5: FDI moderates the impact of lending interest rates on green finance performance.

2.5. | Other factors and Green Finance performance

Besides the factors of monetary policy tools and FDI, there are other elements affecting green finance performance, such as

renewable energy consumption (Wu et al., 2022; Hwang and Sánchez Díez, 2024), and CO2 emissions (Diaz-Rainey et al., 2023; Qiu et al., 2024).

Renewable energy consumption reduces greenhouse gas emissions and other pollutants, improving environmental quality and contributing positively to green finance metrics (Wu et al., 2022). High levels of renewable energy consumption can drive innovation and attract investments in green technologies and infrastructure, further boosting green finance performance. Given the high potential for renewable energy transitions to induce profound changes in regional trade patterns and energy markets, its influence might extend beyond a country's local green economic growth. Hwang and Sánchez Díez (2024) confirm that the transition to renewable energy significantly boosts green economic growth.

High CO2 emissions indicate a high level of environmental degradation, which negatively affects the sustainability aspect of green finance performance. Countries with higher CO2 emissions may face stricter environmental regulations and policies, influencing their green finance initiatives and overall performance (Diaz-Rainey et al., 2023). Conversely, a reduction in CO2 emissions suggests that a well-developed financial infrastructure can significantly contribute to sustainable practices, particularly in the transportation sector. Qiu et al. (2024) highlight the positive impact of green mobility innovations in reducing CO2 emissions, emphasizing the importance of adopting and integrating eco-friendly transportation technologies.

In **Table 1**, each research question (RQ) is linked to a hypothesis, a reference supporting the hypothesis, the expected direction of the relationship, and the theoretical framework guiding the hypothesis.

Table 1. Research Questions, Hypothesis, Theory.

RQ	Hypothesis	Reference	Expected sign	Theory
RQ1	H1. An increase in the money supply positively affects green finance performance.	(Desalegn et al., 2022); Chen and Zeng 2022)	(+)	Pecking order theory
	H2. Lower lending interest rates positively affect green finance performance.	(Desalegn et al., 2022; Sakuntala et al., 2022; Chen and Zeng 2022)	(-)	Institutional theory
RQ2	H3: FDI positively affect green finance performance.	(Liang et al, 2024; Qian and Yu 2024)	(+)	Pecking order theory
RQ3	H4: FDI moderates	(Liang et al, 2024;	Moderate	Institutional theory

the impact of money supply on green finance performance.	Lei and Yu (2023)		
H5: FDI moderates the impact of lending interest rates on green finance performance.			

3 | METHODOLOGY

3.1. | Measuring Green Finance Performance

We follow (Sohag et al., 2019b) to measure green finance performance (GreenF) as a dependent variable. (Sohag et al., 2019b) define green performance by ensuring the efficient use of renewable resources after deducting the damage due to greenhouse gases, the exploitation of natural resources and other negative externalities.

$$GreenP_{i,t} = GDP_{i,t} + EE_{i,t} - NRP_{i,t} - NFD_{i,t} - CO2_{i,t}$$

Where:

$GreenP_{i,t}$ is Green Finance performance of country i in year t

$GDP_{i,t}$ is gross domestic product of country i in year t

$EE_{i,t}$ is education expenditure of country i in year t

$NRP_{i,t}$ is monetary value of depleted minerals such as coal, crude oil, and natural gas of country i in year t

$NFD_{i,t}$ is the monetary value of forest depletion of country i in year t

$CO2_{i,t}$ is monetary value of carbon dioxide emissions of country i in year t

We also use green bonds (GreenB) as a dependent variable to measure Access to green finance.

3.2. | Measuring Monetary Policy

We follow (Cui et al., 2024) to choose the logarithm of broad money supply (BM) and short-term lending interest rate (LR) as the proxy variables for quantity-based and price-based monetary policy tools, respectively. As short-term policy rates at the zero-interest rate lower bound cannot measure the stance of monetary policy, this paper uses the short-term shadow interest rate constructed by Wu and Xia (2016) to represent short-term interest rates during the period of zero interest rate lower bound in the U.S. At the meantime, one-year or two-year Treasury yields are used as a proxy for short-term interest rates in countries with zero or negative interest rates, such as Australia, Canada, the United Kingdom, the European Union countries, Japan and Switzerland,

while short-term interest rates, such as the three-month interbank lending rate, the deposit rate or the policy rate, are used to measure the stance of monetary policy in both developed and developing countries that have not reached the zero-interest-rate floor. Data on broad money supply and interest rates from the World Bank database.

3.3. | Measuring Foreign direct investments

Foreign direct investments (FDIs) are long-term investments that take place outside of the investor's economic or physical boundaries (Desalegn et al., 2022). The recipient country of FDI is equipped with both capital and technology flows that will aid in its development. In this case, when one country seeks to invest in another, the benefit sought must be greater than the risks encountered (Hamid et al. 2020). We follow (Hamid et al. 2020) to obtain yearly FDI inflow to country i in year t . Then, we take the form $\log(1 + FDI_{i,t})$ in the main regression.

3.4. | Measuring Control variables

We follow previous studies to add control variables which impact green finance performance, such as renewable energy consumption (Wu et al., 2022; Hwang and Sánchez Díez, 2024), and CO2 emissions (Diaz-Rainey et al., 2023; Qiu et al., 2024).

Renewable energy consumption. This paper uses renewable electricity output as the main source of renewable energy, following Wu et al. (2022) and Hwang and Sánchez Díez (2024). Private energy investment is also an important indicator for determining renewable energy investment. The shift from non-renewable to renewable energy sources is the result of accelerated economic growth and may spur private investors to participate in renewable energy investment.

CO2 emissions. The Environmental Kuznets Curve assumption shows that CO2 emissions expand with continued growth and decline after reaching a certain growth level (Diaz-Rainey et al., 2023; Qiu et al., 2024). As a result, this paper uses CO2 emissions as a control variable in the regression model.

3.5. | Data collection

We use yearly data from 1990 to 2022 from 144 countries around the world. Our research examines the relationship between green finance performance and the amount of green GDP (GreenP) and the issuance of green bonds (GreenB) globally. We obtained the Green GDP (GreenP) data from the World Bank database, while the green bonds data were collected from ADB reports. Country-level data on monetary policy tools, such as broad money (BM) and lending interest rate (LR), as well as FDI, and CO2 emissions, were also sourced from the World Bank database, an annual global panel dataset. The main advantage of this dataset for our analysis is the availability of harmonized cross-country financial information across multiple periods,

allowing us to investigate countries' responses to monetary policy in a consistent manner. Data on current renewable energy consumption was obtained from IMF databases. All model variables are transformed to their natural logarithmic form.

3.6. | Research Model

To address H1, H2, and H3, which explore whether monetary policy and FDI impact Green finance performance, we employ Fixed Effect Models 1, 2, 3, and 4 as follows:

$$\text{Model 1 : } GreenP_{i,t+1} = \beta_0 + \beta_1 \times BM_{i,t} + \beta_2 \times CO2_{i,t} + \beta_3 \times REC_{i,t} + \varepsilon_{i,t}$$

$$\text{Model 2 : } GreenP_{i,t+1} = \beta_0 + \beta_1 \times LR_{i,t} + \beta_2 \times CO2_{i,t} + \beta_3 \times REC_{i,t} + \varepsilon_{i,t}$$

$$\text{Model 3 : } GreenP_{i,t+1} = \beta_0 + \beta_1 \times FDI_{i,t} + \beta_2 \times CO2_{i,t} + \beta_3 \times REC_{i,t} + \varepsilon_{i,t}$$

$$\text{Model 4 : } GreenP_{i,t+1} = \beta_0 + \beta_1 \times BM_{i,t} + \beta_2 \times LR_{i,t} + \beta_3 \times FDI_{i,t} + \beta_4 \times CO2_{i,t} + \beta_5 \times REC_{i,t} + \varepsilon_{i,t}$$

To address H4 and H5, which examines the influence of FDI on the impact of monetary policy on green finance performance, we propose Research Model 5 as follows:

$$\text{Model 5 : } GreenP_{i,t+1} = \beta_0 + \beta_1 \times BM_{i,t} + \beta_2 \times LR_{i,t} + \beta_3 \times FDI_{i,t} + \beta_4 \times BM_{i,t} \times FDI_{i,t} + \beta_5 \times LR_{i,t} \times FDI_{i,t} + \beta_6 \times CO2_{i,t} + \beta_7 \times REC_{i,t} + \varepsilon_{i,t}$$

Where β_0 is constant, $\beta_{i,t}$ is the correlation coefficient of country t in year t , $\varepsilon_{i,t}$ is the error term; $GreenP_{i,t+1}$ is Green finance performance of country i in year $t+1$; $BM_{i,t}$ is Broad money supply of country i in year t ; $LR_{i,t}$ is Lending interest rate of country i in year t ; $FDI_{i,t}$ is Foreign direct investment inflow to country i in year t ; $CO2_{i,t}$ is the level of CO2 emissions of country i in year t ; $REC_{i,t}$ is the level of renewable energy consumption of country i in year t ; $BM_{i,t} \times FDI_{i,t}$ is the interaction term between Broad money supply and Foreign direct investment inflow; $LR_{i,t} \times FDI_{i,t}$ is the interaction term between Lending interest rate and Foreign direct investment inflow.

Theoretically, because this is panel data, the study should use regressions of Ordinary Least Squares (OLS), Fixed Effects (FE), and Random Effects (RE). To choose between OLS and FE, the F-test was employed. To decide between FE and RE, the Hausman test was applied. Through these two tests, we determined the best regression model. We also evaluated for heteroskedasticity or autocorrelation, and in case of such issues, Feasible Generalized Least Squares (FGLS) regression was utilized.

Since the selected countries are located in eight regions around the world, their economic and political activities are closely interlinked within each region. However, each country possesses

distinct characteristics that evolve over time due to cultural factors and geographical location. These features are not observable in the model, potentially biasing the estimated results. Therefore, this study employs Fixed Effects with year effects (FE year) regression to account for time invariance and each country's unique characteristics. FE year regression allows evaluating changes in different factors while holding time constant. The research draws conclusions from a combination of the discussed regression methods, forming the basis for robustness checks to assess result reliability.

The Variance Inflation Factor (VIF) assesses multicollinearity in regression analysis. Multicollinearity occurs when independent variables in a multiple regression model are correlated, potentially impacting regression outcomes negatively. A maximum VIF less than 3 indicates no significant multicollinearity in the research model. In Table 4, we found that multicollinearity was not a primary concern.

Prior to conducting panel data regression analysis, Unit Root Tests (URT) and Cointegration Tests (CT) are essential to validate the reliability of regression outcomes. This study applies the Hausman test and the Im-Pesaran-Shin (IPS) test to confirm data stationarity over the sample period and growth rate. Additionally, the Kao test and Padroni test are used to determine the presence of long-term cointegration associations. Stata SE 17 is employed to execute the Harris-Tzavalis (HT) and Im-Pesaran-Shin tests, ensuring the stationarity of series for each variable and verifying data validity.

4. | RESULTS

4.1. | Descriptive Statistics

Table 2 presents the descriptive statistics of the variables used in the analysis. The mean values for each variable are as follows: Green finance performance (GreenP) has a mean of 23.86, with a standard deviation of 3.10, ranging from 15.30 to 32.24. Green bonds (GreenB) have a mean of 5.13, with a standard deviation of 11.39, ranging from 0.0025 to 99.43. Broad money (BM) has a mean of 23.72, with a standard deviation of 5.37, ranging from -8.82 to 37.01. Lending interest rate (LR) has a mean of 0.39, with a standard deviation of 0.15, ranging from 0.005 to 0.65. Foreign direct investment (FDI) has a mean of 23.89, with a standard deviation of 3.08, ranging from 15.99 to 32.24. CO2 emissions (CO2) have a mean of 4.16, with a standard deviation of 5.14, ranging from 0.022 to 47.66. Renewable energy consumption (REC) has a mean of 32.47, with a standard deviation of 29.77, ranging from 0.01 to 98.34.

Table 2. Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
GreenP	13,292	23.86	3.10	15.30	32.24
GreenB	13,292	5.13	11.39	0.0025	99.43
BM	13,292	23.72	5.37	-8.82	37.01
LR	13,292	0.39	0.15	0.005	0.65
FDI	13,292	23.89	3.08	15.99	32.24
CO2	13,292	4.16	5.14	0.022	47.66

REC	13.292	32.47	29.77	0.01	98.34
-----	--------	-------	-------	------	-------

GreenP: Green finance performance; GreenB: green bonds; BM: Broad money; LR: Lending interest rate; REC: Renewable energy consumption; CO2: CO2 emissions

4.2. | Pearson correlation results

Table 3 presents Pearson correlations among the variables. Of particular interest are the correlations of Broad money (BM), Lending interest rate (LR), and Foreign direct investment (FDI) with Green finance performance (GreenP). Broad money shows a strong positive correlation with GreenP (0.6221***), indicating that higher levels of broad money are associated with greater green finance performance. In contrast, lending interest rate exhibits a weak negative correlation with GreenP (-0.0124), suggesting a minimal relationship between lower interest rates and higher green finance performance. Foreign direct investment demonstrates a very strong positive correlation with GreenP (0.9999***), suggesting a near-perfect positive relationship between FDI and green finance performance. Significant correlations between our dependent variable and control variables are evident (CO2, REC).

Table 3. Pearson correlation.

Variable	GreenP	BM	LR	FDI	CO2	REC
GreenP	1					
BM	0.6221 0.0000	1				
LR	-0.0124 0.4054	-0.0571 0.0002	1			
FDI	0.9999 0.0000	0.64 0.4790	-0.0126 0.3989	1		
CO2	0.295 0.0000	0.0897 0.0000	-0.0523 0.0021	0.2935 0.0000	1	
REC	-0.2314 0.0000	-0.0423 0.0039	0.0398 0.0193	-0.2258 0.0000	-0.5609 0.0000	1

GreenP: Green finance performance; BM: Broad money; LR: Lending interest rate; REC: Renewable energy consumption; CO2: CO2 emissions

Table 4 shows the Variance inflation factors (VIFs) which has Max VIF is 1.91, therefore multicollinearity amongst the determinant variable set is unlikely to be an issue (Kutner et al., 2004).

Table 4. VIF.

Variable	VIF	1/VIF
FDI	2.99	0.334924
BM	2.48	0.403328
CO2	1.65	0.607877
REC	1.41	0.711195
LR	1.01	0.990718
Mean VIF	1.91	

GreenP: Green finance performance; BM: Broad money; LR: Lending interest rate; REC: Renewable energy consumption; CO2: CO2 emissions

4.3. | Regression results

Table 5 presents the regression results investigating the impact of monetary policy tools, FDI, and their interactions on Green finance performance (GreenP). To address hypotheses H1, H2, and H3, which explore the individual impacts of monetary policy and FDI on GreenP, we employed Fixed Effect Models 1 through 4. Model 1 shows that Broad money (BM) has a

significantly positive effect on GreenP ($\beta = 0.396^{***}$), indicating that an increase in broad money supply is associated with higher levels of green finance performance. Model 2 indicates that Lending interest rate (LR) negatively affects GreenP ($\beta = -0.142^{***}$), suggesting that lower interest rates enhance green finance performance. Model 3 demonstrates that Foreign direct investment (FDI) has a strongly positive impact on GreenP ($\beta = 1.00^{***}$), highlighting the substantial contribution of FDI to green finance initiatives. Model 4 incorporates BM, LR, FDI, CO2 emissions (CO2), and renewable energy consumption (REC). FDI continues to show a positive effect on GreenP ($\beta = 1.003^{***}$), while BM ($\beta = 0.0216^{***}$) and LR ($\beta = -0.465^{***}$) retain their significant influences. CO2 ($\beta = -0.000892^{***}$) and REC ($\beta = -0.000693^{***}$) also show negative associations with GreenP.

To address hypotheses H4 and H5, which examine the moderation effects of FDI on the relationship between monetary policy tools and GreenP, we propose Model 5. This model reveals significant interactions: BM x FDI ($\beta = -0.000810^{**}$) and LR x FDI ($\beta = 1.930^{***}$), indicating that FDI moderates the impacts of broad money and lending interest rate on GreenP. The BM x FDI interaction term indicates that the relationship between broad money supply (BM) and GreenP is moderated by the presence of FDI. Specifically, as FDI inflows increase, the positive impact of broad money on GreenP diminishes slightly. This suggests that while an increase in broad money generally supports green finance performance, this effect is less pronounced in economies with higher levels of FDI. One possible interpretation is that FDI inflows might influence the allocation of financial resources differently, potentially directing investments away from green finance initiatives despite increased broad money availability. The coefficient for LR x FDI is significantly positive, revealing that the relationship between lending interest rates (LR) and GreenP is significantly strengthened by FDI. Lower lending interest rates typically stimulate green finance performance by reducing the cost of capital for sustainable projects. When FDI is present, this effect is amplified, suggesting that FDI inflows enhance the positive impact of lower interest rates on promoting green finance activities. This could be due to FDI bringing in additional capital and expertise that synergistically boosts the effectiveness of monetary policy measures aimed at promoting sustainable investments.

Table 5. Regression result (Dependent variable is Green Finance Performance).

Var	(Model 1) GreenP	(Model 2) GreenP	(Model 3) GreenP	(Model 4) GreenP	(Model 5) GreenP
BM	0.396*** [158.49]			0.00186*** [-15.12]	0.0216*** [-32.76]
LR		-0.142*** [-3.29]		-0.00266*** [-3.36]	-0.465*** [-17.08]
FDI			1.00*** [14601.59]	1.003*** [4916.89]	0.979*** [1426.95]
CO2	-0.125*** [34.46]	-0.237*** [35.48]	-0.000533*** [-15.74]	-0.000892*** [-17.51]	-0.000632*** [-13.13]
REC	-0.0134*** [-36.15]	-0.00437*** [-6.10]	-0.000462*** [-50.14]	-0.000693*** [-49.30]	-0.000556*** [-41.09]
BM x FDI					-0.000810* [30.68]
LR x FDI					1.930***

FDI					[17.01]
Cons	13.46*** [220.14]	23.09*** [485.08]	0.0299*** [16.39]	0.00950*** [3.41]	0.580*** [35.91]
Obs	13,292	13,292	13,292	13,292	6,973

(t statistics in brackets; * p<0.05, ** p<0.01, *** p<0.001)

GreenP: Green finance performance; BM: Broad money; LR: Lending interest rate; REC: Renewable energy consumption; CO2: CO2 emissions; BM x FDI: interaction term between Broad money and FDI; LR x FDI: interaction term between Lending interest rate and FDI

4.4. | Robustness check

To ensure the robustness of our findings, we substitute GreenP with Green bonds (GreenB) as the dependent variable and observe consistent directional results, as detailed in **Table 6**. Additionally, employing Fixed Effect Model (FEM) and Generalized Method of Moments (GMM) models reaffirms the stability of our results across different methodologies. The results consistently show significant coefficients with the expected signs. Under the Fixed Effect Model (FEM) for GreenB, we find significant effects for several variables. Broad money (BM) shows a positive impact ($\beta = 4.912^{***}$), while lending interest rate (LR) indicates a negative impact ($\beta = -66.91$), though it is not statistically significant. Foreign direct investment (FDI) remains significantly positive ($\beta = 3.807^{***}$), reflecting its substantial influence on GreenB. The interaction terms BM x FDI ($\beta = -0.179^{***}$) and LR x FDI ($\beta = -258.3$) also show notable impacts, although LR x FDI is negative and not statistically significant in this model.

In contrast, the GMM model with GreenP reaffirms significant impacts similar to those in the FEM for GreenP. Broad money (BM) continues to exhibit a positive influence ($\beta = 0.0312^*$), while lending interest rate (LR) shows a negative impact ($\beta = -0.2199$), and FDI remains significantly positive ($\beta = 1.510^{***}$). The interaction terms BM x FDI ($\beta = -0.061^*$) and LR x FDI ($\beta = 1.10927^*$) also confirm significant moderation effects of FDI on the relationship between monetary policy tools and GreenP. Additionally, CO2 ($\beta = -0.078^{***}$) and REC ($\beta = -1.188^*$) exhibit significant influences in this model.

Table 6. Regression result of Model 5 with different dependent variables.

Variable	(FEM) GreenP	(FEM) GreenB	(GMM) GreenP	(GMM) GreenB
BM	0.0216*** [-32.76]	4.912*** [-3.53]	0.0312* [-2.66]	0.0964 [1.10]
LR	-0.465*** [-17.08]	-66.91 [1.33]	-0.2199 [-1.63]	-9.360*** [3.08]
FDI	0.979*** [1426.95]	3.807*** [-2.80]	1.510*** [3.67]	0.0752* [3.80]
BM x FDI	-0.00810*** [30.68]	-0.179*** [3.54]	-0.061* [2.83]	-0.00317 [-0.99]
LR x FDI	1.930*** [17.01]	-258.3 [-1.47]	1.10927* [2.83]	32.89*** [-2.93]
CO2	-0.000632*** [-13.13]	-0.0749 [-1.47]	-0.078*** [3.01]	-0.00551* [-1.76]
REC	-0.000556*** [-41.09]	0.00893 [1.00]	-1.188* [-2.89]	-0.00523*** [-6.48]
Constant	0.580*** [35.91]	1.063*** [2.87]	0.6135*** [28.12]	2.258*** [8.89]
Obs	6,973	6,973	6,973	6,973

(t statistics in brackets; * p<0.05, ** p<0.01, *** p<0.001)

GreenP: Green finance performance; GreenB: green bonds; BM: Broad money; LR: Lending interest rate; REC: Renewable energy consumption; CO2: CO2 emissions; BM x FDI: interaction term between Broad money and FDI; LR x FDI: interaction term between Lending interest rate and FDI

4.5. | Regression results by region

To investigate the regional variations in the relationship between expansionary monetary policy and green finance, particularly considering the moderating role of foreign direct investment (FDI), we segment our dataset into eight main regions based on the World Bank report classifications: European Union and Western Europe (Region 1), Eastern Europe and Central Asia (Region 2), East Asia and Pacific (Region 3), Latin America and Caribbean (Region 4), Middle East and North Africa (Region 5), North America (Region 6), South Asia (Region 7), and Sub-Saharan Africa (Region 8). The results are summarized in **Table 7**.

Table 7. Regression results by region.

Region	1	2	3	4
BM	0.02	0.02***	0.03***	-0.03***
LR	0.54	0.24	-1.18***	-0.05
FDI	1.02***	1.03***	0.96***	0.98***
BM x FDI	-0.05	-0.08***	-0.01***	0.01***
LR x FDI	-2.31*	-1.04*	4.45***	0.22
Control	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Constant	-0.63	-0.80	0.97***	0.63***
Obs	846	846	846	846

Region	5	6	7	8
BM	0.01***	0.12***	0.02***	-0.01
LR	0.23	-0.42***	-0.58***	-1.18
FDI	1.02***	0.88***	1.00***	1.00***
BM x FDI	-0.05	0.03***	-0.06***	0.02*
LR x FDI	-0.97	1.08	2.40*	0.84
Control	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Constant	-0.45***	3.62***	-2.72***	-0.06
Obs	846	846	846	846

(* p<0.05, ** p<0.01, *** p<0.001)

GreenP: Green finance performance; BM: Broad money; LR: Lending interest rate; REC: Renewable energy consumption; CO2: CO2 emissions; BM x FDI: interaction term between Broad money and FDI; LR x FDI: interaction term between Lending interest rate and FDI

Broad money (BM) shows varying impacts across regions, with significant positive effects observed in Eastern Europe and Central Asia (Region 2), East Asia and Pacific (Region 3), Latin America and Caribbean (Region 4), North Africa (Region 5) and North America (Region 6), indicating that increased broad money supply generally supports green finance performance in these regions. Lending interest rate (LR) exhibits mixed results, with significant negative impacts in East Asia and Pacific (Region 3), North America (Region 6) and South Asia (Region 7), suggesting that lower interest rates may not universally benefit green finance activities across all regions. Foreign direct investment (FDI) consistently demonstrates positive effects across all regions, highlighting its role in enhancing green finance performance. The interaction terms BM x FDI and LR x FDI further elucidate regional differences in the moderation effects of FDI on monetary policy tools. For instance, in East Asia and Pacific (Region 3) and South Asia (Region 7), the interaction between broad money

and FDI (BM x FDI) shows significant positive effects, indicating that FDI inflows strengthen the relationship between broad money supply and green finance performance. Conversely, in European Union and Western Europe (Region 1), the interaction between lending interest rate and FDI (LR x FDI) exhibits a significantly negative impact, suggesting that FDI may mitigate the positive effects of lower lending rates on green finance.

4.6. | Regression result in different economy state

Table 8 presents the regression results categorized by different economic conditions. We divide the dataset into two groups: economies with positive GDP growth and those with negative GDP growth at specific times. Both groups show significantly negative correlations for BM and LR, with stronger negative correlations observed in economies experiencing positive growth. The moderating effect of FDI is more pronounced in economies with positive growth compared to those with negative growth.

When $GDP_Gro < 0$, the coefficient of BM x FDI is 0.0008233***, indicating a statistically significant positive interaction between broad money (BM) and foreign direct investment (FDI). This suggests that in economies experiencing negative growth, FDI inflows enhance the positive relationship between broad money supply and green finance performance. The coefficient of LR x FDI is -1.718811***, showing a statistically significant negative interaction between lending interest rates (LR) and FDI. This implies that lower lending rates have a less positive effect on green finance performance when FDI is present in economies with negative growth. The coefficient of REC is 0.0006762***, indicating a statistically significant positive relationship between renewable energy consumption and green finance performance in economies with negative growth. This suggests that despite economic downturns, investments in renewable energy continue to positively impact green finance initiatives.

When $GDP_Gro > 0$, the coefficient of BM x FDI is -0.009311***, showing a statistically significant negative interaction between BM and FDI. This implies that in economies experiencing positive growth, FDI inflows diminish the positive impact of broad money supply on green finance performance. The coefficient of LR x FDI is 1.787809***, indicating a statistically significant positive interaction between LR and FDI. This suggests that lower lending rates have a stronger positive effect on green finance performance when FDI is present in economies with positive growth. The coefficient of REC is -0.0005581***, showing a statistically

significant negative relationship between REC and green finance performance in economies with positive growth. This indicates that the positive impact of renewable energy consumption on green finance is reduced when economies are growing positively.

Table 8. Regression results in different economy state.

GreenP	GDP_Gro < 0	GDP_Gro > 0
BM	0.0221655***	0.0255084***
LR	-0.4134608***	-0.4470269***
FDI	0.9798014***	0.9770984***
BM x FDI	0.0008233***	-0.009311***
LR x FDI	-1.718811***	1.787809***
CO2	-0.0007336***	-0.0006393***
REC	0.0006762***	-0.0005581***
Constant	0.5741914***	0.654981***
Obs	3,077	3,896

(* p<0.05, ** p<0.01, *** p<0.001)

GreenP: Green finance performance; BM: Broad money; LR: Lending interest rate; REC: Renewable energy consumption; CO2: CO2 emissions; BM x FDI: interaction term between Broad money and FDI; LR x FDI: interaction term between Lending interest rate and FDI

4.7. | Regression result in different economic recession

In **Table 9**, we present regression results during periods of economic recession. The dataset is divided into recession times (2007, 2008, 2019, 2020) and normal times (the remaining years). The table compares the effects of broad money (BM), lending interest rate (LR), the LR x FDI interaction term, and renewable energy consumption (REC) when $ecorec=0$ and $ecorec=1$. When $ecorec=0$ (indicating absence of economic recession), BM shows a coefficient of 0.02345***, indicating a statistically significant positive relationship with green finance performance. LR exhibits a coefficient of -0.412***, signifying a statistically significant negative impact. The interaction term LR x FDI has a coefficient of -1.721***, highlighting a significant negative moderation effect of FDI on LR. REC shows a coefficient of 0.000612***, indicating a significant positive relationship with green finance. In contrast, during $ecorec=1$ (indicating economic recession), BM has a coefficient of 0.02537***, LR is -0.438***, LR x FDI is 1.801***, and REC is -0.000524***. These results suggest that during economic recessions, BM's positive impact on green finance strengthens slightly, while LR's negative impact intensifies. Moreover, FDI enhances the positive effect of LR on green finance, whereas REC's positive impact diminishes.

Table 9. Regression results in different economic recession time.

GreenP	ecorec = 0	ecorec = 1
BM	0.0219075***	-0.0193037***
LR	-0.4831811***	0.4298138***
FDI	0.9792691***	0.981906***
BM x FDI	1.718811***	1.787724***
LR x FDI	-0.0008233***	0.0007142***
CO2	-0.0007011***	-0.0010916***
REC	0.0004882***	-0.0007579***
Constant	0.5822892***	0.5199387***
Obs	2,821	4,152

(* p<0.05, ** p<0.01, *** p<0.001)

GreenP: Green finance performance; BM: Broad money; LR: Lending interest rate; REC: Renewable energy consumption; CO2: CO2 emissions; BM x FDI: interaction term between Broad money and FDI; LR x FDI: interaction term between Lending interest rate and FDI

5. | DISCUSSION

This section critically examines the empirical findings pertaining to the impact of monetary policy on green finance, drawing upon various hypotheses and theoretical frameworks in the literature. The analysis centers on the results summarized in **Table 10**.

Table 10. Summary results.

HP	Reference	Expected sign	Results	Support theory
H1	(Desalegn et al., 2022); Chen and Zeng 2022)	(+)	Support	Pecking order theory
H2	(Desalegn et al., 2022; Sakuntala et al., 2022; Chen and Zeng 2022)	(-)	Support	Institutional theory
H3	(Liang et al, 2024; Qian and Yu 2024)	(+)	Support	Pecking order theory
H4	(Liang et al, 2024; Lei and Yu 2023)	Moderate	Support	Institutional theory
H5			Support	

H1 asserts that an increase in the money supply enhances green finance performance, a hypothesis our study supports, consistent with the Pecking Order Theory. This suggests that increased liquidity facilitates investment in sustainable projects, aligning with previous research findings (Desalegn et al., 2022). H2 posits that lower lending interest rates positively impact green finance performance, which our analysis also supports. This finding underscores the role of Institutional Theory in explaining how reduced borrowing costs incentivize investments in green initiatives, as noted in both Desalegn et al. (2022) and Sakuntala et al. (2022). H3 examines the positive impact of Foreign Direct Investment (FDI) on green finance, a relationship affirmed by our findings and consistent with the Pecking Order Theory. This highlights FDI's role in providing additional capital and expertise crucial for advancing sustainable projects (Liang et al., 2024). H4 and H5 aim to explore how FDI moderates the effects of monetary policy tools—money supply and lending interest rates—on green finance performance. Our results show that FDI indeed moderates these relationships, supporting the Institutional Theory. This suggests that economic policies promoting FDI can amplify the effectiveness of monetary measures aimed at fostering green finance activities, as discussed by Liang et al. (2024).

Moreover, the results reveal that Broad money (BM) has diverse impacts across regions, notably positive in Eastern Europe and Central Asia (Region 2), East Asia and Pacific (Region 3), Latin America and Caribbean (Region 4), North Africa (Region 5), and North America (Region 6). Conversely, Lending interest rate (LR) shows significant negative effects in East Asia and Pacific (Region 3), North America (Region 6), and South Asia

(Region 7). Foreign direct investment (FDI) consistently demonstrates positive effects across all regions, indicating its role in enhancing green finance performance. In East Asia and Pacific (Region 3) and South Asia (Region 7), the interaction between broad money and FDI (BM x FDI) significantly enhances the relationship between broad money supply and green finance performance. However, in European Union and Western Europe (Region 1), the interaction between lending interest rate and FDI (LR x FDI) exhibits a notably negative impact, suggesting FDI may counteract the positive effects of lower lending rates on green finance.

During economic downturns, FDI strengthens the positive relationship between broad money supply and green finance performance, while the positive impact of lower lending rates on green finance diminishes when FDI is present in economies with negative growth. Interestingly, there is a significant positive association between renewable energy consumption (REC) and green finance performance in economies experiencing negative growth, indicating ongoing support for green initiatives despite economic challenges. In contrast, in economies with positive growth, FDI inflows reduce the positive effect of broad money supply on green finance performance. Lower lending rates have a stronger positive impact on green finance performance in the presence of FDI. However, REC shows a statistically significant negative relationship with green finance performance in economies with positive growth, suggesting that the benefits of renewable energy consumption for green finance diminish when economies are growing positively.

Finally, during times of economic stability, BM demonstrates a statistically significant positive relationship with green finance performance. LR exhibits a significant negative impact, and FDI moderates this effect negatively. REC continues to show a significant positive relationship with green finance. Conversely, during economic recessions, BM's positive impact on green finance slightly strengthens, while LR's negative impact intensifies. Additionally, FDI enhances the positive effect of LR on green finance, whereas REC's positive impact diminishes under recessionary conditions. These findings underscore the nuanced dynamics of monetary policy tools, FDI, and REC in shaping green finance outcomes across different economic contexts.

6. | CONCLUSION

6.1. | Theoretical contribution

The empirical findings from our study provide valuable insights into the implications of monetary policy and foreign direct investment (FDI) on green finance performance, contributing to two prominent theoretical frameworks: Pecking order theory and Institutional theory. Our results support Pecking order theory, which posits that firms prioritize financing sources based on the pecking order of internal

funds, debt, and external equity. Hypothesis H1, which suggests that an increase in the money supply positively affects green finance performance, aligns with this theory. The statistically significant positive relationship between broad money (BM) and green finance performance across different economic conditions and regions underscores the role of liquidity in facilitating investments in sustainable initiatives. This finding implies that as the availability of broad money increases, firms may opt to fund green projects more readily, adhering to the preference for internal financing before external debt or equity. Furthermore, Hypothesis H3, which asserts that FDI positively affects green finance performance, also supports Pecking order theory. The consistent positive effects of FDI across various regions indicate that foreign investments bring in additional capital and expertise, enhancing the capacity of local economies to undertake green finance initiatives. This aligns with the notion that FDI can supplement internal funds (broad money) in financing sustainable projects, thereby supporting the prioritization of internal resources as per the pecking order theory.

Our findings also contribute to Institutional theory, which emphasizes the role of institutional factors and regulatory environments in shaping economic behaviors and outcomes. Hypothesis H2, which proposes that lower lending interest rates positively affect green finance performance, supports this theory. The significant negative impact of lending interest rates (LR) on green finance in certain regions, particularly during economic growth phases, suggests that institutional factors such as regulatory frameworks and policy interventions influence the accessibility and cost of capital for green investments. Lower lending rates are expected to reduce the cost of financing for sustainable projects, aligning with institutional efforts to promote green finance through favorable monetary policies. Moreover, Hypothesis H4 and H5 explore how FDI moderates the impacts of monetary policy tools (BM and LR) on green finance performance. The findings indicate mixed effects across regions, underscoring the contextual nature of institutional influences on FDI's interaction with monetary policies. In regions where FDI amplifies the positive effects of broad money supply or lending interest rates on green finance, institutional environments likely facilitate synergies between foreign investments and local policy frameworks. Conversely, in regions where FDI mitigates these effects, institutional factors may impose constraints or regulatory challenges that offset the intended benefits of monetary easing on green finance initiatives.

6.2. | Policy implications

The findings from our study offer several policy implications for enhancing green finance performance. Policymakers can consider strategies that ensure sufficient liquidity in financial markets to facilitate investments in sustainable projects. This may involve maintaining accommodative monetary policies during periods of economic stability to support green finance initiatives and consider targeted interest rate adjustments or incentives to encourage financial institutions to lend at preferential rates to green projects.

Moreover, governments can incentivize and facilitate FDI inflows by creating an attractive investment climate, reducing bureaucratic barriers, and offering tax incentives specifically tailored to green sectors. This would enhance the availability of capital and technological expertise necessary for advancing sustainable projects.

The regional variations in the impacts of BM, LR, and FDI underscore the importance of tailored policy responses. Policymakers should consider regional economic dynamics and institutional frameworks when designing and implementing green finance policies. Strategies should be flexible to accommodate diverse regional needs and conditions, fostering a conducive environment for sustainable investments.

During economic downturns, FDI plays a crucial role in strengthening the positive relationship between broad money supply and green finance performance. Policymakers can leverage FDI to mitigate the adverse effects of economic recessions on green finance, potentially by channeling FDI towards green infrastructure and renewable energy projects. Conversely, during economic growth phases, policies should be designed to manage the potentially dampening effect of FDI on the positive impacts of BM and LR on green finance.

The positive association between REC and green finance performance in economies experiencing negative growth highlights the resilience of renewable energy investments. Policymakers should continue to promote policies that support renewable energy adoption, such as subsidies, tax incentives, and regulatory frameworks that encourage investment in clean energy technologies. However, in economies with positive growth, policymakers should address the challenges identified where REC's positive impact on green finance diminishes.

6.3. | Limitation and future research

While our current study focuses on national-level data, there is ample opportunity for future research to explore the firm-level dynamics of green finance performance and its impact on both FDI and monetary policy. Specifically, investigating how firms' initiatives in green finance attract FDI and subsequently influence monetary policy decisions could provide deeper insights. Research in this direction

could elucidate how firms' sustainability practices and investments in green projects not only enhance their attractiveness to foreign investors but also shape national monetary policies aimed at promoting sustainable economic growth. Understanding these firm-level dynamics could offer nuanced perspectives on the mechanisms through which green finance initiatives contribute to broader economic and environmental sustainability goals. Moreover, such research could inform policymakers and business leaders alike on strategies to optimize the synergies between green finance, FDI attraction, and effective monetary policy frameworks, fostering a more sustainable and resilient economic environment globally.

ORCID

REFERENCES

- Agrawal, R., Agrawal, S., Samadhiya, A., Kumar, A., Luthra, S., & Jain, V. (2023). Adoption of green finance and green innovation for achieving circularity: An exploratory review and future directions. *Geoscience Frontiers*. <https://doi.org/10.1016/j.gsf.2023.101669>
- 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>
- Bergholt, D., Røisland, Ø., Sveen, T., & Torvik, R. (2023). Monetary policy when export revenues drop. *Journal of International Money and Finance*, 137. <https://doi.org/10.1016/j.jimonfin.2023.102893>
- Caraiani, P., Gupta, R., Nel, J., & Nielsen, J. (2023). Monetary policy and bubbles in G7 economies using a panel VAR approach: Implications for sustainable development. *Economic Analysis and Policy*, 78, 133-155. <https://doi.org/10.1016/j.eap.2023.02.006>
- Cui, B., Li, J., & Zhang, Y. (2024). Asymmetries in the international spillover effects of monetary policy: Based on TGVAR model. *North American Journal of Economics and Finance*, 69. <https://doi.org/10.1016/j.najef.2023.102029>
- Desalegn, G., Fekete-Farkas, M., & Tangl, A. (2022). The Effect of Monetary Policy and Private Investment on Green Finance: Evidence from Hungary. *Journal of Risk and Financial Management*, 15(3). <https://doi.org/10.3390/jrfm15030117>
- Diaz-Rainey, I., Corfee-Morlot, J., Volz, U., & Caldecott, B. (2023). Green finance in Asia: challenges, policies and avenues for research. In *Climate Policy* (Vol. 23, Issue 1, pp. 1-10). Taylor and Francis Ltd. <https://doi.org/10.1080/14693062.2023.2168359>
- Dziwok, E., & Jäger, J. (2021). A Classification of Different Approaches to Green Finance and Green Monetary Policy. *Sustainability*, 13(21), 11902. <https://doi.org/10.3390/su132111902>
- Feng, Y., Xiao, Z., Zhou, J., & Ni, G. (2023). Asymmetrically examining the impact of green finance and renewable energy consumption on environmental degradation and renewable energy investment: The impact of the COVID-19 outbreak on the Chinese economy. *Energy Reports*, 9, 5458-5472. <https://doi.org/10.1016/j.egy.2023.04.361>
- Fisher, L. A., & Huh, H. seung. (2023). Systematic monetary policy in a SVAR for Australia. *Economic Modelling*, 128. <https://doi.org/10.1016/j.econmod.2023.106519>
- Hohberger, S., Ratto, M., & Vogel, L. (2023). The macroeconomic effects of unconventional monetary policy: Comparing euro area and US models with shadow rates. *Economic Modelling*, 127. <https://doi.org/10.1016/j.econmod.2023.106438>
- Hwang, Y. K., & Sánchez Díez, Á. (2024). Renewable energy transition and green growth nexus in Latin America. *Renewable and Sustainable Energy Reviews*, 198. <https://doi.org/10.1016/j.rser.2024.114431>
- Leitão, J., Ferreira, J., & Santibanez-González, E. (2023). Green finance sources in Iberian listed firms: A socially responsible investment approach. *Journal of Cleaner Production*, 427. <https://doi.org/10.1016/j.jclepro.2023.139259>
- Li, C., Faridi, M. Z., & Nazar, R. (2023). How does green finance asymmetrically affect greenhouse gas emissions? Evidence from the top-ten green bond issuer countries. *Borsa Istanbul Review*, 23(4), 887-894. <https://doi.org/10.1016/j.bir.2023.03.002>
- Li, Q., Zhao, M., Hei, P., Li, F., & Zhang, K. (2024). Driving sustainable development: Exploring the Nexus of financial inclusion, green mobility, and CO2 emissions in China's natural resource landscape. *Resources Policy*, 89, 104656. <https://doi.org/10.1016/j.resourpol.2024.104656>
- 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>
- Renzhi, N., & Beirne, J. (2023). Corporate market power and monetary policy transmission in Asia. *Pacific Basin Finance Journal*, 82. <https://doi.org/10.1016/j.pacfin.2023.102132>
- Roy, R., Bashar, O. H. N. M., & Bhattacharya, P. S. (2023). The cross-industry effects of monetary policy: New evidence from Bangladesh. *Economic Modelling*, 127. <https://doi.org/10.1016/j.econmod.2023.106479>
- Sakuntala, D., Majid, M. S. A., Aliasuddin, & Suriani, S. (2022). Causality between Green Stock Market with Monetary Policy, Global Uncertainty, and Environmental Damage in Indonesia. *International Journal of Energy Economics and Policy*, 12(6), 215-223. <https://doi.org/10.32479/ijeep.13348>
- Shinwari, R., Wang, Y., Gozgor, G., & Mousavi, M. (2024). Does FDI affect energy consumption in the belt and road initiative economies? The role of green technologies. *Energy Economics*, 132. <https://doi.org/10.1016/j.eneco.2024.107409>
- Sohag, K., Taşkın, F. D., & Malik, M. N. (2019a). Green economic growth, cleaner energy and militarization: Evidence from Turkey. *Resources Policy*, 63. <https://doi.org/10.1016/j.resourpol.2019.101407>
- Sohag, K., Taşkın, F. D., & Malik, M. N. (2019b). Green economic growth, cleaner energy and militarization: Evidence from Turkey. *Resources Policy*, 63. <https://doi.org/10.1016/j.resourpol.2019.101407>
- Thomas, L. (2023). Ripple effect: Disentangling the global impact web of US monetary policy. *Finance Research Letters*, 58. <https://doi.org/10.1016/j.frl.2023.104431>
- Webb, J., Longden, T., Boulaire, F., Gono, M., & Wilson, C. (2023). The application of green finance to the production of blue and green hydrogen: A comparative study. *Renewable Energy*, 219. <https://doi.org/10.1016/j.renene.2023.119236>
- Wu, S., Wu, L., & Zhao, X. (2022). Impact of the green credit policy on external financing, economic growth and energy consumption of the manufacturing industry. *Chinese Journal of Population Resources and Environment*, 20(1), 59-68. <https://doi.org/10.1016/j.cjpre.2022.03.007>
- Zhao, L. T., Li, F. R., & Wang, D. S. (2023). How to achieve the common developments of green finance and clean energy in China? Evidence from coupling coordination evaluation. *Ecological Indicators*, 155. <https://doi.org/10.1016/j.ecolind.2023.111011>
- Zuo, L., & Luo, S. (2024). Resource dependency and green growth paradigm: Exploring interstice mechanism using financial resource availability and FDI in EAP region. *Resources Policy*, 92, 104941. <https://doi.org/10.1016/j.resourpol.2024.104941>