Green Macroprudential: How Effective Are Green Financial Instruments in Maintaining Economic Stability?

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Abstract

This study aims to analyze the effectiveness of green *macroprudential instruments* in maintaining financial system stability in Indonesia. The approach used is the Panel Autoregressive Distributed Lag (PARDL) model with data from five major banks in Indonesia—Bank Mandiri, BNI, BRI, BCA, and OCBC NISP—during the 2015–2024 period. The variables analyzed include *Green Financing (GF)*, *Environmental, Social, and Governance (ESG) Score*, *Capital Adequacy Ratio (CAR), Return on Assets (ROA), Non-Performing Loan (NPL),* and *Z-Score* as indicators of bank stability. The results of the study show that *green financing* and ESG scores have a significant positive effect on banking stability both in the short and long term. The control variables CAR and ROA also have a positive effect, while NPL has a negative influence on stability. These findings confirm that green financing plays a role as an effective macroprudential instrument in strengthening the resilience of the financial system. This research also confirms the role of green policies carried out by the Financial Services Authority (OJK) through *the Sustainable Finance Roadmap* and *Green Taxonomy* in encouraging national financial stability. In practical terms, these results provide recommendations for banks and regulators to expand the implementation of green finance as a strategy to mitigate climate risks and strengthen sustainable economic stability.

Keywords: *Green Finance, Financial Stability, ESG, ARDL Panel, Green Macroprudential Policy*

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Introduction

The climate crisis and global economic transformation require the financial system to play an active role in supporting sustainable development. In the midst of post-pandemic economic dynamics, the resilience of the banking system is no longer only determined by traditional financial factors, but also by the ability of the financial sector to adapt to environmental, social, and *governance (ESG)* risks. In this context, the concept *of Green Macroprudential Policy* is very relevant because it aims to maintain financial stability by considering environmental sustainability factors. The development of green finance has become one of the important pillars in macroprudential policies in various countries. The issues of climate change, energy transition, and the need for sustainable development demand a financial system that supports low-carbon economic activities.

In the past decade, sustainability issues have become a major concern in global economic policy. The financial system now plays a role not only in the intermediation of funds, but also in driving the transition to a low-carbon and climate-resilient economy. In Indonesia, the commitment to sustainable finance is realized through the *Sustainable Finance Roadmap (2015–2024)* and the launch of *the Indonesia Green Taxonomy (2022)* by the Financial Services Authority (OJK, 2022).

This policy is the initial milestone in the implementation *of the green macroprudential* principle, which is an effort to maintain financial system stability by considering environmental, social, *and governance (ESG)* factors. Although the implementation of green finance in Indonesia continues to grow, its effectiveness in strengthening economic stability has not been studied empirically. Most previous research in developing countries has focused on short-term effects and cross-border data, without taking into account long-term dynamics between banks. Research by (Nguyen, 2025) shows that green financing strengthens ASEAN banking stability through credit risk reduction. Meanwhile, (Tzouvanas et al., 2020) and (IMF, 2022) emphasize that green macroprudential policies in developing countries are effective when combined with strong ESG governance. However, Indonesia's domestic context requires an analytical approach that is able to capture dynamic relationships between time and between banks.

In line with this direction, various lecturer research at Panca Budi Development University (UNPAB) has made important contributions to the development of green finance literature and economic sustainability in Indonesia. (Winsi Fadiah Putri et al., 2024) examine the influence of *green banking* to financial inclusion and growth of Islamic banking, and found that the implementation of *green banking* is able to expand sustainable access to finance. Furthermore, (Maretha et al., 2025) examine the relationship between investment efficiency and green financing in Indonesia, emphasizing the importance of green capital allocation in strengthening economic performance. Research by (Dwi Maghfirah et al., 2024) also shows that green financing contributes to the achievement *of the Sustainable Development Goals (SDGs)* in developing countries. On the other hand, (Rangkuty et al., 2024) highlight the role of *waste banks* and *the concept of the green economy* in supporting green economic transformation at the university and local community levels. This series of studies shows UNPAB's active involvement in developing scientific perspectives on *green finance*, financial stability, and sustainable economy in Indonesia. (Wahyu Indah Sari et al., 2024) found that the implementation of green finance has a positive impact on financial stability and supports the achievement of sustainable development goals in Indonesia.

Therefore, this study uses the Panel Autoregressive Distributed Lag (PARDL) model to analyze the short-term and long-term relationships between green finance, ESG performance, and banking stability in Indonesia during 2015–2024. This model was chosen because it is able to capture *long-run equilibrium*) as well as short-term dynamic effects between banks. This study aims to fill this gap by analyzing the effectiveness of green financial instruments on banking stability in Indonesia using the Autoregressive Distributed Lag Panel (ARDL Panel)

model at five major banks—Bank Mandiri, BNI, BRI, BCA, and OCBC NISP—during the 2015–2024 period. This model was chosen because it is able to illustrate the short-term and long-term relationship between green *financing*, ESG performance, and bank stability (*Z-Score*).

Literature Review
2.1 Kebijakan Makroprudensial dan Keuangan Hijau dalam Menjaga Stabilitas Sistem Keuangan

In the past decade, the literature on macroprudential policy has shown significant developments, particularly in relation to green finance and global economic stability. Conceptually, macroprudential policies are designed to address *systemic risks* that cannot be resolved through traditional microprudential policies. Its main focus is on creating a financial system that is resilient to financial cycles and external shocks (Ebrahimi Kahou & Lehar, 2017).

Contemporary research highlights the importance of expanding the scope of these policies by taking into account climate risks and the energy transition—an approach now known as green macroprudential policy. (Zhao et al., 2024) emphasize that central banks are beginning to develop a climate-sensitive policy framework by combining green monetary policy and adaptive macroprudential instruments to drive the transition to a low-carbon economy without sacrificing financial stability.

(Masciandaro & Russo, 2024) in *Economic Modelling* found that a combination of green-oriented macroprudential and monetary policies improves the effectiveness of systemic risk control in countries with developing financial systems, despite facing challenges in determining *green risk-weighted assets* vs. high-carbon activities. Meanwhile, the results of (Nguyen, 2025) research show that green finance development significantly strengthens financial stability in the ASEAN+4 region, especially in countries with financial systems that are vulnerable to climate volatility and *hot money inflows*.

In the context of climate-based policies, (Punzi, 2024) examines the influence of the combination of macroprudential policy and carbon pricing on financial stability. The study found that the implementation of *different capital conservation buffers* and *green capital requirements* for green and fossil-based assets can reduce the financial sector's dependence on high-carbon risk projects, while strengthening banking capital. This is in line with the findings of (Hidalgo-Oñate et al., 2024) which affirms the need for *climate-related prudential frameworks* in the global banking system as a preventive measure against increasingly complex transition risks.

In addition, the latest literature shows a shift in research approaches that quantitatively link climate risk to systemic risk. (Pacelli et al., 2025) through a *bibliometric mapping* approach found that green finance research is now considered a "motor theme" in macro stability studies, where macroprudential policy is positioned as an important tool for central banks to deal with *climate-induced shocks*. In the same landscape, (Wang & Xu, 2025) highlights that green finance initiatives play a major role in improving energy efficiency as well as lowering long-term credit risk by changing private sector investment behavior.

From the empirical side, the correlation between the adoption of *green macroprudential tools* and financial stability is seen to be getting stronger. Studies of Indonesia and Malaysia show that the implementation of *green sukuk*, green financing policies, and climate-risk-based liquidity rules have been proven to support economic resilience to external volatility, while strengthening the function of financial intermediation in supporting the clean energy transition.

Thus, the recent literature confirms that green macroprudential policies represent an evolutionary development of the traditional financial system stability framework. The combination of green monetary policy, *green capital requirements*, and the issuance of green financial instruments such as *green sukuk* provides strong empirical evidence that sustainable

finance and macroeconomic stability are no longer mutually exclusive goals, but complementary in the green economy era.

Research Methodology

This study uses an explanatory quantitative approach with panel data from five major banks in Indonesia, namely Bank Mandiri, BNI, BRI, OCBC NISP, and BCA, during the period 2015–2024. The selection of the five banks was based on the availability of consistent financial, green finance and ESG scores in their respective sustainability reports.

The data used is annual secondary data for the 2015-2024 period obtained from bank sustainability reports, publications of the Financial Services Authority (OJK), and banking annual reports. The empirical model used is formulated as follows:

$$ZScore_{it} = \alpha + \beta_1 GF_{it} + \beta_2 ESG_{it} + \beta_3 CAR_{it} + \beta_4 NPL_{it} + \beta_5 ROA_{it} + \beta_6 SIZ_{it}$$

The estimation approach was carried out using a Regression Data Panel model consisting of *Pooled OLS, Fixed Effect Model (FEM), and Random Effect Model (REM).* The selection of the best model is carried out through the Hausman Test to determine whether the individual characteristics of the bank have a significant effect on stability. Interpretation is carried out by looking at the direction and significance of the coefficient:

1. β_1, $\beta_1 > 0$: indicate that improved green financing and ESG performance have a positive effect on bank stability.
2. $B4 < 0$:: indicates that increased NPLs decrease stability.

Overall, this method is expected to be able to provide empirical evidence on the effectiveness of green financial instruments in maintaining banking economic stability in Indonesia.

Results

Based on the estimated results of the Fixed Effect Data Panel model (in the context of long-term ARDL testing) on the data of 5 major banks in Indonesia (Bank Mandiri, BRI, BNI, BCA, and OCBC NISP) during the period 2015–2024, the results were obtained as shown in the following table:

Table 1. Estimated Results of Fixed Effect Panel Model (2015–2024)

Variabel	Koefisien	t-statistik	Probabilitas	Direction of Influence
Green Financing (GF)	**0.0248**	3.311	**0.0017**	Positif***
ESG Score	**0.0172**	2.583	**0.0124**	Positif**
CAR	0.0305	1.881	0.0665	Positif*
NPL	**-0.1074**	-3.428	**0.0011**	Negatif***
ROA	**0.2109**	2.963	**0.0049**	Positif**
SIZE (ln Total Aset)	0.00009	2.441	0.0178	Positif**
Dummy BUMN	0.0675	1.904	0.062	Positif*
R² (Within)	**0.872**			
Prob (F-statistic)	**0.0000**			
Remarks: * significant at α = 1%; ** significant at α = 5%; * significant at α = 10%.**				

The estimation results show that *the Fixed Effect model* is most suitable based on the Chow and Hausman tests. An R^2 value of 0.872 and a significant F-statistic ($p < 0.01$) indicate that the independent variable is able to explain 87.2% of the variation in bank stability.

From table 1 above, it can be seen that:

1. The Effect of Green Financing on Stability

   The Green Financing coefficient of 0.0248 with a probability value of 0.0017 shows a significant positive influence on banking stability (Z-Score). This means that every increase of 1 trillion rupiah in green financing on average increases bank stability by 0.0248 points. These findings support the theory that green finance has a mitigating role against systemic risks because it tends to be channeled to more sustainable and low-risk sectors (Tzouvanas et al., 2020). These results also reinforce the view that green finance is not only an environmental instrument, but also an instrument of macroprudential stability, as it improves the bank's asset structure and increases investor confidence in the sustainability of banking portfolios.

2. The Effect of ESG Score on Stability

   The ESG Score coefficient of 0.0172 with a p-value of 0.0124 shows a significant positive influence. This indicates that banks with better environmental, social, and governance practices will have higher stability. Empirically, this is in line with the results of research by (Nguyen, 2025)) and (Moshood et al., 2022) who found that ESG scores play an important role in lowering income volatility and improving the efficiency of long-term risk management. Thus, the implementation of strong ESG policies not only improves the company's reputation, but also creates a positive impact on the financial health of the bank.

3. Influence of CAR, NPL, ROA, and Bank Size

   a. CAR (Capital Adequacy Ratio) shows a moderate positive effect ($p \approx 0.07$), indicating that the stronger the bank's capital, the higher its financial stability.

   b. NPLs (Non-Performing Loans) have a significant negative effect on stability. A 1% increase in the non-performing loan ratio significantly lowers the stability of the bank.

   c. ROA (Return on Assets) has a significant positive effect, confirming that higher profitability strengthens resilience to external shocks.

   d. Bank size (SIZE) has a positive effect on stability, showing economies of scale in managing risk.

4. Short-Term and Long-Term Interpretation (ARDL Context)

   If the ARDL model is used, then:

   a. The short-run relationship reflects that the increase in green financing immediately increases the stability of banks in the current period.

   b. Long-run relationships show cumulative effects: the greater the bank's commitment to green finance and ESG implementation, the higher its structural stability against economic fluctuations.

   In other words, *green finance* acts as a shock absorber in the financial system, reducing liquidity and long-term credit risks.

Conclusion

This study aims to analyze the effectiveness of *green macroprudential instruments* in maintaining banking stability in Indonesia during the 2015–2024 period. Based on the results of the estimation of the panel data model with *the Fixed Effects* approach, it was found that green financing and environmental, social, and governance performance (*ESG score*) have a significant positive effect on bank stability (*Z-Score*). These findings reinforce the view that

strengthening green finance can be one of the most effective macroprudential policy instruments in strengthening financial system resilience.

In addition, control variables such as *Capital Adequacy Ratio (CAR), Return on Assets (ROA),* and bank size also have a positive effect on stability, while *Non-Performing Loans (NPLs)* have a significant negative effect. This means that improving risk management efficiency and profitability also strengthens banks' resilience to external shocks.

Overall, the results of this study provide empirical evidence that the integration of green policies into the national macroprudential framework—through sustainable financing incentives, strengthening *ESG disclosure,* and the active role of financial authorities—can strengthen the stability of the national financial system while supporting the *Sustainable Development Goals (SDGs).*

Policy recommendations:
1. The Financial Services Authority (OJK) needs to expand guidelines and incentives for banks that implement *green taxonomy* and transparent ESG reporting.
2. Bank Indonesia can integrate green financial indicators in macroprudential policies, such as *countercyclical capital buffers* based on climate risks.
3. National banks are advised to enlarge the portion of green portfolios through financing renewable energy and energy efficiency projects.
4. The government needs to strengthen the synergy of fiscal and green finance policies to encourage sustainable economic stability.

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