MACROPRUDENTIAL POLICIES AND BANK EFFICIENCY NEXUS: THE MODERATOR ROLE OF COUNTRY GOVERNANCE

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Abstract

Although macroprudential policies (MAPPs) are widely implemented to safeguard financial stability (Ćehajić & Košak, 2022), their implications for bank efficiency remain insufficiently investigated, with most existing studies concentrating only on conventional banks' (CBs) (Chen et al., 2022). This study examined the impact of MAPPs on Islamic banks (IBs) and CBs' efficiency in countries that meet a standard where 1 per cent share of Islamic banking assets is in their total domestic banking sector assets. Using bank-level panel data from 14 countries (2006–2021) and ordinary least squares (OLS), fixed- and random-effects models, the results indicated that MAPPs reduced bank efficiency, with effects varying by bank type. In addition, the coefficient of CBs was slightly higher than that of IBs. Country governance (CG) significantly strengthened the negative effect of MAPPs on CBs' efficiency, but not for IBs. Regression in the high-income and low-income group countries showed a similar sign to the basic regression results. Furthermore, additional robustness tests showed that MAPP is negatively related to both types of banks' efficiency. These results are highly relevant for policymakers aiming to design macroprudential frameworks that stabilise the economy without disproportionately hindering banking efficiency.

Keywords: Macroprudential Policies, DEA, Conventional Banks, Islamic Banks, Country Governance

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1. INTRODUCTION

By the end of 2023, the Islamic finance sector reached USD 3.38 trillion; a rise of 4% in assets as measured in US dollars year over year (Islamic Financial Service Board, 2023). Various stakeholders, including policymakers and academicians, are now paying attention to the rise of Islamic finance. They spend a lot of time focusing on this unique banking system and on the difference between conventional banks (CBs) and Islamic banks (IBs).

The international financial scene has seen various implementations of macroprudential policies (MAPPs) over the past decades, especially after the 2008 financial crisis. MAPPs are designed to safeguard the overall stability of the financial system and prevent systemic risks that could lead to financial crises. It can also regulate banks to some extent. For example, MAPPs are effective in modifying bank risk-taking (Altunbas et al., 2018), wherein increased bank risk in reaction to anticipated monetary policy laxity may be contained by stricter leverage and liquidity ratios (Farhi & Tirole, 2012). Credit cycle stabilisation has also been reported to be commonly achieved through the use of macroprudential regulations (Gambacorta & Murcia, 2020). Nevertheless, the effects of MAPPs have not yet been thoroughly explored, particularly with regard to some characteristics like stability and efficiency.

These rules make it more difficult for banks to plan operations, which has a mixed effect on various areas of the banks' operations. On the one hand, additional regulations and reporting requirements brought by these policies impair their efficiency. Bank lending operations may be constrained by some macroprudential instruments, such as loan-to-value (LTV) ratios or debt-to-income (DTI) ceilings. On the other hand, a less competitive banking market and endogenous growth drivers are the result of tightened policies (Chen et al., 2022). All of these will improve the efficiency of banks.

Following the above, this study sought to discover whether MAPPs impose a positive or negative effect on the efficiency of banks in countries where Islamic banking assets constitute at least 1% of the total domestic banking sector assets. Focusing on these countries ensures that Islamic finance plays a meaningful role in the financial system, allowing for a valid comparison between IBs and CBs under similar macroprudential conditions. More importantly, no studies in the literature had examined whether country governance (CG) moderates the impact of MAPPs and bank efficiency. Thus, this study filled this gap by examining the moderator role of CG between MAPPs and two types of banks' efficiency.

Two factors led to the selection of the sample. First, to examine the impact of MAPPs on two types of banks' efficiency, data developed by Alam et al. (2019) was chosen in this study. MAPPs have been the subject of numerous studies, such as Altunbas et al. (2018), Chen et al. (2022), Davis et al. (2022), González (2022), and Igan et al. (2023). Based on previous evidence, there are two main MAPPs, where one is from Cerutti et al. (2017) and the other is from Alam et al. (2019). The former covers the period of 2001–2013 and provides information on 12 instruments. The latter covers a longer period and provides a total of 17 individual tools. Hence, the latter was chosen in this study. Then, secondly, the banks in the nations that satisfied the criteria for this study were those whose Islamic banking assets accounted for more than 1% of their overall domestic banking sector assets. This study obtained balanced panel data for banks in 14 countries by merging bank data, country-level control variables, and macroprudential data.

Based on the sample data, the results indicated that MAPPs decreased bank efficiency in the basic regression model, but the coefficient differed between IBs and CBs. Additionally, the moderating effect of CG on the MAPP and bank efficiency nexus was significant only in CBs. The negative influence of MAPPs on bank efficiency was amplified in countries where the level of CG was high. MAPPs showed a similar outcome on bank efficiency in high-income and low-income countries groups. The effect was more pronounced in low-income countries groups. Additional robust tests confirmed the basic regression results. Hence, the efficiency of banks and financial stability should be balanced by policymakers. Additionally, policymakers should work to strengthen CG since it may inevitably lessen the detrimental effects of MAPP on the efficiency of banks.

Compared to earlier research, this study offers two significant advances. First, as far as we are aware, little research has been done on the impact of MAPPs on the efficiency of IBs and CBs. While MAPPs are primarily designed to enhance financial stability, their implications for banking efficiency remain insufficiently explored, particularly in the context of IBs operating alongside CBs. The study makes scholarly contributions by demonstrating the distinct ways in which MAPPs impact the two banking systems and by offering policymakers guidance on creating macroprudential frameworks that are balanced and preserve stability without compromising banking effectiveness. Second, the moderating effect of CG on the impact of MAPP on banks' efficiency had hardly been explored. This study adds to the body of knowledge by examining how CG influences the relationship between MAPP and bank efficiency.

The following sections comprise the remainder of the paper. Section 2 reviews the literature. Section 3 describes data and methods. Section 4 presents the empirical findings. Section 5 highlights the main findings and policymakers' implications.

2. LITERATURE REVIEW

2.1. Theoretical background

Theoretically, the nexus between MAPP and bank efficiency has become increasingly important in the financial field. Nonetheless, there is still disagreement over the findings of MAPP's effect on bank efficiency. The influence of MAPP on banks has not been the subject of much theoretical research. Since MAPP falls under the category of bank regulation, this study used a regulation-related theory to explain the impact of MAPP on bank efficiency.

The impact of bank regulation on bank efficiency is essentially the subject of two theoretical viewpoints (Al Azizah & Haron, 2025; Benjakik & Habba, 2024; Michael et al., 2023; Mohammed et al., 2024). The public interest view is the first one. This concept holds that bank owners and creditors will have a similar stance on risk if regulations force them to raise their risk reserves (Barth et al., 2005).

Additionally, capital adequacy requirements make banks lend with greater caution as they act as a safety net against losses, which prevents banks from generating a large number of non-performing loans (Barth et al., 2005).

The private interest view is the opposite one. This point contends that financial regulations may make room for regulators, giving them more negotiating power when it comes to rent-seeking (Beck et al., 2006). If regulatory authorities engage in banking activities due to personal interests, the efficiency of banks is likely to be compromised. Barth et al. (2008) contended that capital restrictions in accordance with the Basel standards have no effect on the stability and efficiency of the banking system in many countries. In fact, in certain instances, regulations worsen the efficiency of banks as banks begin to engage in riskier activities. In conclusion, there is disagreement on how regulation affects banks from a theoretical standpoint.

2.2. Empirical evidence

Mohd Noor et al. (2020) analysed the impact of regulation on the efficiency of IBs in 15 countries. They calculated efficiency using the data envelopment analysis (DEA) method and examined supervisory power, capital requirement, activity restrictions, and private monitoring as proxies of country regulation and supervision. The regression results indicated that capital requirement was negatively connected with the efficiency of IBs, and the other three indices were positively connected with the efficiency of IBs.

The research conducted by Barth, Caprio, et al. (2013) created indexes that represent regulations for banks using the survey response. Using this method, indices of bank regulation for 180 countries ranging from 1999 to 2011 were created. This study also drew attention to the relationship that exists between capital requirements and bank efficiency, showing that higher capital stringency is associated with higher bank efficiency. A positive nexus was also documented in banks in 22 EU countries (Chortareas et al., 2012).

Barth, Lin, et al. (2013) examined the impact of regulations on the efficiency of banks in 72 countries. The results indicated that restrictions on bank activities decreased bank efficiency, while capital regulation increased bank efficiency. Pessarossi and Weill (2015) investigated the nexus between capital ratio requirements and the efficiency of commercial banks in China. The implementation of capital requirements between 2004 and 2008 led to an enhancement in the efficiency of banks. Since shareholders were required to contribute more capital, this brought debtors' and shareholders' risk attitudes into line and improved bank efficiency.

Djalilov and Piesse (2019) examined the impact of regulations on the efficiency of banks in 21 transition countries. The sample comprised non-balanced panel data spanning 12 years from 319 banks. The stochastic frontier model was used to calculate efficiency, and the data from World Bank surveys were taken as the proxy for regulations. Generalized method of moments (GMM) results indicated that as the level of activity restrictions increased, the efficiency of banks increased. However, other tools, such as capital requirements, market discipline, and supervisory power, proved to be ineffective. In a lenient regulatory environment, banks may face challenges in effectively managing multiple business operations simultaneously (Pasiouras et al., 2009).

The different sample selection and regulations may account for disparities regarding the impact of regulations in earlier research. Previous research has primarily focused on the impact of micro prudential-oriented regulations on banks; however, the impact of MAPPs, particularly with regard to the efficiency of banks, has not received as much attention. Previous research on the interaction between MAPPs and banks has mostly concentrated on the connection between MAPPs and banks' risk and conduct. In terms of the former, many studies contend that MAPPs reduce the risk of banks. For example, tightening MAPPs reduces the expected default frequency (EDF) and Z-score, which are proxies of bank risk (Altunbas et al., 2018). While capital-based measures like sector-specific capital buffers tend to encourage increased risk-taking, tougher regulation in the form of exposure constraints tends to reduce banks' levels of risk-taking (Ezer, 2019). Bank risk-taking is also decreased by tightening measures like minimum capital requirements and increased deposit levies (Cordella & Pienknagura, 2013). Stronger macroprudential supervision leads to a consistent reduction in bank risk-taking, and the magnitude of this effect varies across different credit cycles (Zhang et al., 2018). Because banks are subject to tighter regulatory supervision and are more likely to make sensible decisions, banks are more stable overall when operating under a strict macroprudential framework (Matos et al., 2025). For the latter, scholars have argued whether MAPPs reduce lending. For example, Ćehajić and Košak (2022) contended that MAPPs improve financial institutions' soundness, but they may also limit lending, especially for smaller businesses that depend heavily on bank credit and have few other financing options. Mirzaei et al. (2021) documented that MAPPs limited credit growth, and bank state ownership weakened the negative relationship. Ely et al. (2021) investigated the transmission mechanisms of MAPPs on banks' risk. The results indicated that MAPPs greatly reduced bank risk through the leverage channel.

Overall, the research mentioned above did not go beyond this study to look at how changes in bank operations impacted bank efficiency in relation to MAPPs.

Only a few studies have investigated how MAPPs affect banks' performance, and the outcome has been mixed. For example, Chen et al. (2022) examined the impact of MAPP on the efficiency of CBs in 36 emerging economies. The results indicated that MAPPs are positively correlated with efficiency and regulating the credit cycle policies, which had a more pronounced effect.

Davis et al. (2022) investigated the impact of MAPP on bank profitability in a global bank sample. The results revealed that MAPPs were negatively correlated with bank profitability (proxied by the returns on average assets (ROAA) and equity (ROAE)). Restrictions on lending behaviour tended to boost profitability while decreasing the growth of loans, presumably because banks can replace loans with non-interest income. Additionally, the impact differs depending on the economic growth of the country, the type of bank, and the historical period. Kang et al. (2025) examined the nexus between MAPPs, bank risk, and efficiency in China,

and argued that bank efficiency mediates the impact of MAPPs on bank risk. They found that tighter MAPPs generally enhance bank efficiency, which in turn reduces bank risk.

Overall, the relationship between the effectiveness of CBs, IBs, and MAPPs was not covered in the previous studies. But given the debate above, a hypothesis can be developed:

H1: MAPPs decrease the efficiency of both kinds of banks.

Previous research has confirmed that CG can affect banks' efficiency. The effectiveness of both kinds of banks has been found to be favourably connected with certain aspects of this governance, such as voice and accountability, whereas CBs are significantly impacted by certain indices, such as regulatory quality and rule of law (Kamarudin et al., 2022). Elamer et al. (2020) examined the impact of CG on bank risk management in 10 Middle East and North Africa (MENA) countries. They concluded that banks located in better-governed countries were more likely to commit to higher levels of risk disclosure. Ahamed et al. (2021) also documented that if banks aspired to enhance efficiency, good CG at the country-level was indispensable. Good CG would strengthen the impact of corporate social responsibility (CSR) on the efficiency of banks since a high degree of CG would lower agency costs and improve efficiency (Belasri et al., 2020).

H2: CG can moderate the relation between MAPPs and both types of banks' efficiency.

3. DATA AND METHODOLOGY

This study gathered data from a variety of sources. First, data about the bank was extracted from the Bureau van Dijk Bankfocus database for the period 2006 to 2021. All banks whose primary DEA score-calculating factors were unavailable were disqualified. Second, the MAPPs acted as a measure of the level of MAPPs. Third, country-level macroeconomic data, such as inflation and gross domestic product (GDP) growth rate, were gathered from World Development Indicators (WDI). Fourth, CG came from the Worldwide Governance Indicators (WGI). Finally, this study merged data from Bankfocus, the MAPPs Database, WDI, and WGI, and selected these 14 countries.

3.1. Dependent variable: Data envelopment analysis score as a proxy of bank efficiency

Following the studies of Alexakis et al. (2019), Barth, Lin, et al. (2013), Haque and Brown (2017), Hussain et al. (2021), Mateev et al. (2022), and Nguyen (2018), this study chose the following variables presented in Table A.1 in the Appendix.

3.2. Independent variable: Macroprudential policies

A variety of macroprudential instruments had been developed and put into place by monetary authorities and financial regulators in developing nations even prior to the onset of the global financial crisis; these tools had not been tightened or eased in recent years. These policies can be divided into two types from the purpose of MAPPs. One type leads to a higher level of stability by improving the resilience of the banking system when facing unfavourable uncertainty. The other type achieves stability through reducing the procyclicality of credit growth and liquidity provision. Capital requirements and leverage restrictions were the most common measures in the former, while changes in reserve requirements and regulations on foreign currency transactions were commonly observed in the latter. In order to create an annual variable, this study aggregates the utilisation of multiples of the simple sum of the 12 months.

In line with Luo and Kamarudin (2024), this study constructs annual policy data by adding 12 months' data. The MAPPs in a given year were measured using a three-year averaged value, in accordance with the methodology of Altunbas et al. (2018) and Chen et al. (2022). Table 1 presents the average macroprudential index of the sample.

Table 1. The average macroprudential index of the sample

Country	*Average*	*Country*	*Average*
Algeria	0.24	Kyrgyzstan	2.74
Bahrain	-0.13	Malaysia	4.56
Bangladesh	2.09	Oman	3.67
Indonesia	4.83	Pakistan	4.03
Jordan	1.10	Senegal	1.71
Kenya	0.52	Sudan	0.24
Kuwait	1.16	Tunisia	1.60

Source: Authors' calculation.

3.3. Moderating variable: Country governance

Following the study of Evensen and Sovacool (2024), this study created a single composite CG for each year by averaging all WGI indicator scores collectively. Since each dimension of the WGI ranges from -2.5 (weak governance) to +2.5 (strong governance), the constructed composite CG index likewise ranges within this scale, with higher values reflecting more sound and effective governance practices.

3.4. Control variable

Three bank-level variables were considered, including bank size, credit risk, and capitalisation. The size of the bank was defined as the natural logarithm of total assets. Bigger banks could profit from their scale, resulting in improved efficiency (Barth, Lin, et al., 2013; Belasri et al., 2020; Izzeldin et al., 2021). Credit risk was controlled by using the ratio of loan loss reserves to gross loans. This ratio can also represent the quality of the loan. Kamarudin et al. (2022) noted that conventional banks' efficiency is positively correlated with credit risk because increased operating expenses, such as staff costs and general and administrative costs, contribute to higher efficiency. The level of capitalisation index was gauged by the equity over total assets (VanHoose, 2007). Generally speaking, banks with more capital are better able to handle risks (Ren et al., 2024). Regarding country-level variables, GDP growth (annual %) and consumer price index (CPI) were documented to have a significant impact on bank efficiency by Aslam et al. (2024) and Nasim et al. (2023). Economic growth boosts people's income, which in turn improves banks' profitability (Aslam et al., 2024). Besides, banks may increase the interest income they receive on their loan portfolios if inflation increases (Karkowska et al., 2025).

3.5. Econometric model

The data for the variables above are summarised in Table A.2 in the Appendix.

Following previous scholars (Banker & Natarajan, 2008), this study utilised the following to check *H1* and *H2*. Furthermore, this study followed the procedure illustrated in Figure 1 to determine the most appropriate estimation method among ordinary least squares (OLS), fixed-effects (FE), and random-effects (RE) models. Specifically, if the Breusch-Pagan Lagrange Multiplier (BP-LM) test is not significant, OLS is not selected. Similarly, if the Hausman test statistic exceeds the 5% significance level, the RE model is not chosen.

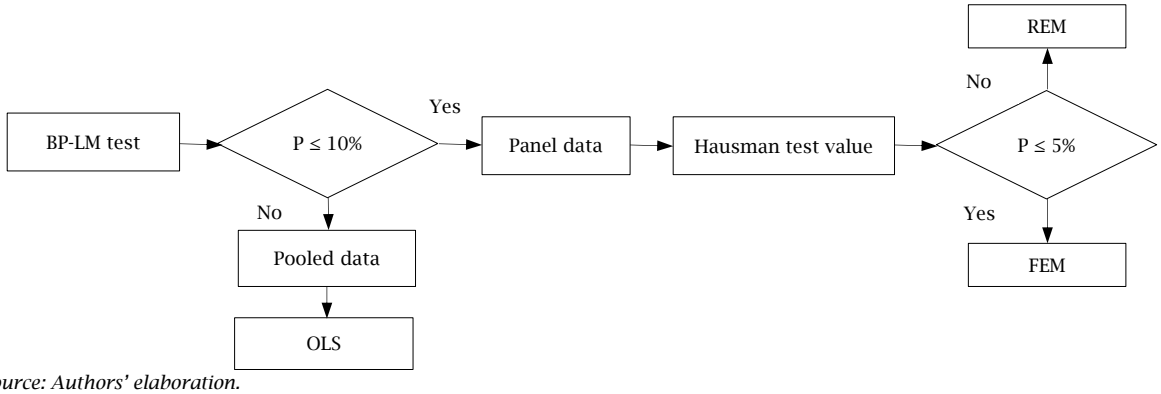
$$Inte_{it} = \alpha_0 + \alpha_1 MAPPS_{jt} + \sum_{a=1}^{3} \beta_a BC_{it} + \sum_{b=1}^{2} \delta_b CC_{jt} + \varepsilon_{ijt} \quad (1)$$

$$Inte_{it} = \alpha_0 + \alpha_1 MAPPs_{jt} + \alpha_2 CG_{jt} + \alpha_3 MAPPs_{jt} * CG_{jt} + \sum_{a=1}^{3} \beta_a BC_{it} + \sum_{b=1}^{2} \delta_b CC_{jt} + \varepsilon_{ijt} \quad (2)$$

where:

- $Inte_{it}$ = efficiency of bank *i* at time *t* (log);
- $MAPPs_{jt}$ = MAPPs of country *j* at time *t*;
- CG_{jt} = CG of country *j* at time *t*;
- BC_{it} = bank-level control variable of bank *i* at time *t*;
- CC_{jt} = country-level control variable of country *j* at time *t*;
- ε_{ijt} = the error term.

Figure 1. Model selection flowchart



Source: Authors' elaboration.

4. EMPIRICAL RESULTS

4.1. Descriptive statistics

Table 2 presents the descriptive statistics of variables and the variance inflation factor (VIF) value. For the main variable, the mean value of the efficiency was -2.863 (in log terms) with a standard deviation of 1.647. The mean value of the *MAPPs* was 2.833 with a standard deviation of 0.159. According to the VIF value, the variables in the regression model did not significantly exhibit multicollinearity. The correlation matrix in Table 3 confirmed that there was no multicollinearity issue in the regression estimation.

Table 2. Descriptive statistics and variance inflation factor

Variable	*N*	*Mean*	*Std. dev.*	*Min*	*Max*	*VIF*
Inte	5165	-2.863	1.647	-13.03	0	-
MAPPs	5165	2.833	4.386	-13	16	1.08
InAsset	5165	14.26	1.75	7.983	19.16	1.56
capital	5165	15.94	14.18	0.075	199.8	1.41
quality	5165	5.451	9.821	-38.29	147.9	1.11
gdp	5165	3.933	3.199	-17	10.91	1.14
CPI	5165	4.872	0.451	4.098	9.696	1.25
CG	5165	-0.397	0.493	-1.666	0.465	1.4

Source: Authors' calculation using Stata.

Table 3. Correlation matrix

Variable	*Inte*	*MAPPs*	*InAsset*	*capital*	*quality*	*gdp*	*CPI*	*CG*
Inte	1							
MAPPs	-0.154***	1						
InAsset	0.157***	0.027*	1					
capital	-0.001	-0.016	-0.481***	1				
quality	-0.059***	-0.117***	-0.149***	0.250***	1			
gdp	0.004	0.198***	-0.031**	-0.062***	-0.128***	1		
CPI	-0.259***	-0.048***	-0.164***	0.018	0.086***	-0.235***	1	
CG	0.110***	0.164***	0.377***	-0.062***	-0.138***	0.008	-0.372***	1

*Note: * p < 0.1, ** p < 0.05, *** p < 0.01.*
Source: Authors' calculation using Stata.

4.2. Basic results

The FE model was the most suitable to be used in this study, as the p-value of the BP test and the Chi-square of the LM test were significant at the 1% level or lower, and the p-value of the Hausman test was significant at the 1% level or lower in Table 4.

The FE models in Table 4 showed that *MAPPs* reduce CBs and IBs' efficiency, and the impact of *MAPPs* on CBs was larger than on IBs. The negative sign of both types of banks can be explained by the following two reasons.

On the one hand, when macroprudential measures are applied with more tightening by financial regulators, banks may be required to comply with additional regulations and reporting requirements. This can lead to higher compliance costs for both CBs and IBs, which diverts resources away from core banking activities and potentially reduces overall efficiency. On the other hand, bank lending operations may be constrained by some macroprudential instruments, such as LTV ratios or DTI ceilings. Although these regulations aim to curb excessive risk-taking and advance financial stability, they may also restrict banks' capacity to lend to creditworthy borrowers, which may undermine efficiency. This view is consistent with Davis et al. (2022), who concluded that MAPPs restrict credit-driven practices and improve short-term stability (in the case of capital requirements).

In terms of the bigger absolute value of the coefficient of CBs, this can be explained by the different asset composition. IBs offer ownership-based financing like *Mudarabah* and *Musharakah*, as well as asset-based financing like *Murabahah*, whereas CBs often have more conventional loan-based assets. The efficiency of CBs may be more directly impacted by macroprudential instruments than that of IBs. Another plausible reason is that IBs deal with more risk sharing, build closer ties to tangible objects, and stay low on leverage (Ahmed & Elsayed, 2019), so the negative effect of tightened macroprudential measures will be lower.

In terms of control variables, the impact of inflation was significantly negative at 1% level for both types of banks. This can be explained by the uncovered profit that results from the unexpected inflation that is not expected by the manager (Kamarudin et al., 2022). Additionally, changes were not made in a timely manner, causing expenditures to increase more quickly than income. Furthermore, moral hazard was more serious during the inflation period. People who default on their loans crowd the counter of banks. All the above would suppress the efficiency of banks. In terms of the insignificant relationship between GDP growth and IBs, this may be explained by different engagement levels of traditional lending and borrowing activities. CBs primarily engage in traditional lending and borrowing activities, which are more sensitive to changes in the overall economic environment. When the GDP growth rate is high, there might be greater demand for loans, and an unmatched level of risk management leads to lower quality of loans for CBs, which in turn affects their efficiency negatively. Unlike CBs, IBs engage less in interest-based lending and borrowing. As a result, the advantages of economic growth, such as more demand for loans and more chances for investment, might not immediately improve their effectiveness.

Interestingly, the results of this study showed that increases in bank size are positively but not significantly associated with both types of banks' efficiency. This could be the result of inefficiencies brought on by larger organisations' bureaucratic lethargy (Bolibok, 2024). Decision-making procedures frequently slow down and become more hierarchical as banks grow, which lessens their operational agility and offsets possible scale economies. The conclusion partly aligns with the findings of Ojeyinka and Akinlo (2021), who also documented that bank size is not statistically significantly related to efficiency, and when the size is larger, efficiency is lower. Additionally, the relationship between the quality of the loan and banks' efficiency was not significant for CBs but significant and negative for IBs. This may result from the increase in non-performing loans, which would undermine the efficiency of banks (Ozili, 2017). A similar negative result can be seen in Jubilee' et al. (2022). Finally, a significantly positive correlation can be found in terms of capitalisation. In order to be more stable in global competition, banks must have a strong capital structure. In addition, banks with lower capital ratios would also have higher leverage, risk, and increased lending costs (Kamarudin et al., 2022).

Table 4. Basic regression result

Variable	*CB*			*IB*		
	OLS	***FE***	***RE***	***OLS***	***FE***	***RE***
_cons	2.347***	4.313***	2.874***	-1.413*	-2.029	-2.099*
	(0.53)	(0.72)	(0.55)	(0.77)	(1.51)	(1.09)
lnAsset	0.150***	0.045	0.149***	0.105***	0.069	0.104*
	(0.02)	(0.06)	(0.02)	(0.04)	(0.10)	(0.06)
CPI	-1.471***	-1.545***	-1.565***	-0.629***	-0.401***	-0.488***
	(0.09)	(0.12)	(0.09)	(0.07)	(0.08)	(0.08)
gdp	-0.020**	-0.056***	-0.036***	0.007	-0.009	-0.001
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
quality	0.002	-0.003	0.000	-0.026***	-0.018***	-0.020***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
capital	0.004**	0.011***	0.006**	0.018***	0.023***	0.018***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
MAPPs	-0.074***	-0.079***	-0.077***	-0.024**	-0.068***	-0.058***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
N	3961	3961	3961	1204	1204	1204
r2	0.139	0.120		0.140	0.083	
r2_a	0.138	0.045		0.135	-0.004	
F	106.601***	83.103***		32.378***	16.645***	
BP-LM	chibar2(01) = 107.86***			chibar2(01) = 188.18***		
chi2			588.121***			115.961***
Hausman	chi2(6) = 61.18***			chi2(6) = 30.59***		

*Note: Standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01.*

4.3. Heterogeneity analysis

We also considered that because the global banking system is not uniform, the global sample may conceal important impacts in the subsamples. Thus, the impact of *MAPPs* on bank efficiency can be influenced by various factors, including a country's income level. Different income levels may lead to diverse levels of financial systems, regulatory environments, and financial sector characteristics, which affect how *MAPPs* affect the efficiency of banks in each country. Therefore, depending on the country's income level, the transmission method of *MAPPs* to bank efficiency may vary. Hence, the upper middle income and high income were divided in this study into the high-income group, and the lower middle income and low income into the low-income group. Following this, the effect of *MAPPs* on bank efficiency was tested for countries in the high-income group and the low-income group.

Table 5 shows the regression results in the high-income and low-income groups. Compared to high-income countries, low-income countries were far more affected by *MAPPs* for both types of banks. This can be explained by the following reasons. Financial systems in low-income countries may be less diversified, with fewer alternative sources of funding and investment opportunities. This limited diversification can make it harder for banks to adjust their operations when faced with stricter regulatory requirements. Another plausible reason may be that these policies are more severely and strictly applied in emerging markets and developing economies (Davis et al., 2022).

Table 5. Heterogeneity analysis

Variable	***High-income***					
	CB			***IB***		
	OLS	***FE***	***RE***	***OLS***	***FE***	***RE***
_cons	7.748***	9.582***	8.591***	10.805***	10.495***	10.649***
	(1.06)	(1.18)	(1.08)	(2.70)	(2.50)	(2.49)
InAsset	0.127***	0.184**	0.128***	0.037	0.013	0.020
	(0.02)	(0.09)	(0.03)	(0.05)	(0.13)	(0.09)
CPI	-2.490***	-3.075***	-2.671***	-2.880***	-2.725***	-2.786***
	(0.20)	(0.29)	(0.21)	(0.51)	(0.55)	(0.50)
gdp	-0.061***	-0.084***	-0.072***	-0.010	-0.040**	-0.032*
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
quality	-0.005	-0.000	-0.002	-0.039***	-0.019***	-0.024***
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
capital	0.001	0.015***	0.005	0.009**	0.008	0.006
	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
MAPPs	-0.063***	-0.066***	-0.065***	-0.034**	-0.059***	-0.055***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
N	1889	1889	1889	658	658	658
r2	0.225	0.192		0.163	0.128	
r2_a	0.222	0.122		0.155	0.043	
F	90.849***	68.702***		21.139***	14.635***	
BP-LM	chibar2(01) = 51.39***			chibar2(01) = 180.74***		
chi2			489.162***			93.794***
Hausman	chi2(6) = 33.73***			chi2(6) = 40.49***		
	Low-income					
_cons	0.765	2.393**	1.145	0.396	-6.283***	-0.350
	(0.68)	(0.98)	(0.71)	(1.14)	(2.35)	(1.30)
InAsset	0.165***	0.083	0.169***	-0.105	0.280*	-0.062
	(0.03)	(0.09)	(0.03)	(0.07)	(0.16)	(0.08)
CPI	-1.213***	-1.277***	-1.287***	-0.525***	-0.297***	-0.495***
	(0.11)	(0.15)	(0.11)	(0.08)	(0.10)	(0.09)
gdp	-0.010	-0.056***	-0.029**	0.018	-0.013	0.014
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
quality	0.004	-0.004	0.001	-0.002	-0.004	-0.003
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
capital	0.008**	0.014***	0.009***	0.016***	0.043***	0.019***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
MAPPs	-0.060***	-0.069***	-0.064***	-0.026	-0.070***	-0.040*
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
N	2072	2072	2072	546	546	546
r2	0.086	0.082		0.122	0.093	
r2_a	0.083	0.003		0.113	-0.002	
F	32.262***	28.260***		12.541***	8.451***	
BP-LM	chibar2(01) =50.35***			chibar2(01) = 7.05***		
chi2			186.867***			60.651***
Hausman	chi2(6) = 39.18***			chi2(6) = 37.77***		

*Note: Standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01.*

4.4. Moderating effect of country governance

Table 6 shows the regression results with the CG interaction term to examine the role of governance in the *MAPPs* efficiency in terms of CBs and IBs. It can be concluded that CG strengthens the negative relationship between *MAPPs* and CBs' efficiency. The negative moderating effect of CG can be explained by the following, since political stability, rule of law, and control of corruption are subindexes of GG.

First, a more stable government can amplify the negative effect of *MAPPs* on bank efficiency. Good governance provides a sense of predictability and consistency in policymaking (Ouattara, 1999). In politically stable countries, the consistent implementation of such measures tends to have a more negative impact.

Second, the rule of law is also significant. Tightening macroprudential measures combined with an excessively strict judiciary system leads to an increase in the cost of intermediation, heightened

risk-taking, and restrictions on bank activities (Kamarudin et al., 2022). These factors collectively contribute to a further decline in bank efficiency.

Finally, control of corruption is equally crucial in the banks' operating environment. A strong control of corruption will promote public officers' own private interests rather than concentrate on addressing market failure (Beck et al., 2013). The implementation of macroprudential tools is compliant with regulators' interests. Therefore, as policies become more targeted and efficient, the negative impact of MAPP would be amplified.

Table 6. The moderating effect of governance in conventional banks and Islamic banks

Variable	*CB*			*IB*		
	OLS	***FE***	***RE***	***OLS***	***FE***	***RE***
_cons	2.195***	3.137***	2.428***	-0.334	-1.716	-0.589
	(0.53)	(0.86)	(0.55)	(0.79)	(1.58)	(1.17)
MAPPs	-0.077***	-0.090***	-0.084***	-0.033***	-0.067***	-0.060***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
CG	-0.263***	-0.480*	-0.251***	0.611***	0.331	0.641***
	(0.07)	(0.25)	(0.09)	(0.11)	(0.50)	(0.18)
Interact	-0.023**	-0.037***	-0.030***	0.006	-0.000	-0.001
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
InAsset	0.178***	0.068	0.177***	-0.012	0.061	0.005
	(0.02)	(0.06)	(0.02)	(0.04)	(0.10)	(0.07)
capital	0.007***	0.011***	0.008***	0.015***	0.023***	0.017***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
quality	-0.001	-0.003	-0.002	-0.028***	-0.018***	-0.021***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
gdp	-0.030***	-0.056***	-0.042***	-0.002	-0.009	-0.004
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
CPI	-1.540***	-1.411***	-1.575***	-0.437***	-0.412***	-0.448***
	(0.09)	(0.13)	(0.09)	(0.08)	(0.08)	(0.08)
N	3961	3961	3961	1204	1204	1204
r2	0.147	0.124		0.166	0.084	
r2_a	0.145	0.049		0.161	-0.006	
F	84.891***	64.486***		29.768***	12.522***	
BP-LM	chibar2(01) = 94.56***			chibar2(01) = 163.18***		
chi2			616.831***			129.647***
Hausman	chi2(8) = 53.61***			chi2(8) = 19.65**		

*Note: Standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01.*

4.5. Robust test

In this section, four robustness tests were performed on the key discoveries. Following the previous study of Chen et al. (2022), two new variables, namely *mappt3* and *mappl3,* were created. The former is the proxy of tightening policies, while the latter is the proxy of easing. We summed all the instances of "1" and "-1" in the data of Alam et al. (2019), which means tightening-oriented and loosen-oriented in that month. In addition, the data was converted to a yearly variable, and *mappt3* (*mappl3*) was generated using a three-year rolling window, like the independent variable. Next, *mappt3* and *mappl3* were used in place of the original macroprudential indicator, and the results are reported in Table 7. The coefficients for *mappt3* and *mappl3* were found to be negative and statistically significant, which was similar to the basic regression model. This step adds to the evidence that *MAPPs* have a symmetric impact on banks' efficiency. This means that the impact of *MAPPs* is the same, regardless of whether it is a loose or tight policy. The symmetric influence of *MAPPs* is similar to the result of Chen et al. (2022).

Second, according to the Islamic Financial Services Board (2023) report, countries whose share of Islamic banking assets in their total domestic banking sector assets is over 15% can be divided into system important countries. The system's important countries were excluded to examine the impact of *MAPPs* on bank efficiency in Table 8. The positive and significant relationship can be found in the table, but only for CBs.

Third, following the previous study of Chen et al. (2022), a five-year spanning window was used by aggregating the macroprudential tools (*marp5*). The results are reported in Table 9. The regression results showed that the basic regression remained robust.

Fourth, following the method of Mehmood and De Luca (2023), this study considered COVID-19 as a dummy variable, which equalled 1 if the years belonged to the COVID-19 pandemic (2020–2021). The negative coefficient in terms of the two types of banks reported in Table 10 indicated that when the level of *MAPPs* increased, the efficiency of the two types of banks decreased.

Table 7. Robust test 1

Variable	***mappt3***					
	CB			***IB***		
	OLS	***FE***	***RE***	***OLS***	***FE***	***RE***
_cons	1.754***	3.019***	2.065***	-1.704**	-3.440**	-2.536**
	(0.56)	(0.79)	(0.58)	(0.77)	(1.54)	(1.11)
InAsset	0.153***	0.071	0.155***	0.108***	0.170*	0.134**
	(0.02)	(0.06)	(0.02)	(0.04)	(0.10)	(0.06)
CPI	-1.351***	-1.319***	-1.398***	-0.606***	-0.375***	-0.475***
	(0.10)	(0.13)	(0.10)	(0.07)	(0.08)	(0.08)
gdp	-0.037***	-0.083***	-0.056***	-0.005	-0.025*	-0.015
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
quality	0.004	-0.001	0.002	-0.025***	-0.015***	-0.018***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
capital	0.004*	0.011***	0.006**	0.019***	0.023***	0.018***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
mappt3	-0.038***	-0.065***	-0.048***	0.020	-0.068***	-0.039***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
mappl3						
N	3961	3961	3961	1204	1204	1204
r2	0.110	0.094		0.138	0.067	
r2_a	0.108	0.017		0.134	-0.022	
F	81.314***	63.216***		32.035***	13.226***	
BP-LM	chibar2(01) = 109.49***			chibar2(01) = 146.51***		
chi2			443.610***			92.554***
Hausman	chi2(6) = 83.31***			chi2(6) = 25.31***		
	mappl3					
_cons	5.120***	8.816***	5.949***	-1.758**	-0.512	-1.608
	(0.57)	(0.76)	(0.59)	(0.76)	(1.56)	(1.11)
InAsset	0.113***	-0.137**	0.102***	0.097***	-0.047	0.049
	(0.02)	(0.06)	(0.02)	(0.04)	(0.10)	(0.06)
CPI	-2.020***	-2.046***	-2.157***	-0.587***	-0.440***	-0.496***
	(0.10)	(0.13)	(0.10)	(0.07)	(0.08)	(0.08)
gdp	-0.013	-0.033***	-0.023**	0.010	-0.003	0.003
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
quality	0.007**	-0.004	0.004	-0.026***	-0.019***	-0.021***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
capital	0.001	0.006*	0.002	0.020***	0.022***	0.019***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
mappt3						
mappl3	-0.103***	-0.128***	-0.112***	-0.090***	-0.095***	-0.092***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
N	3961	3961	3961	1204	1204	1204
r2	0.127	0.110		0.156	0.075	
r2_a	0.126	0.035		0.152	-0.014	
F	95.779***	75.379***		36.853***	14.783***	
BP-LM	chibar2(01) = 100.69***			chibar2(01) = 162.05***		
chi2			520.761***			115.042***
Hausman	chi2(6) = 77.65***			chi2(6) = 14.69**		

*Note: Standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01.*

Table 8. Robust test 2

Variable	***CB***			***IB***		
	OLS	***FE***	***RE***	***OLS***	***FE***	***RE***
_cons	2.656***	4.738***	3.161***	4.310	3.767	4.224
	(0.86)	(1.10)	(0.88)	(3.87)	(4.66)	(3.98)
InAsset	0.209***	0.149*	0.210***	0.078	-0.134	0.074
	(0.02)	(0.09)	(0.03)	(0.13)	(0.30)	(0.14)
CPI	-1.664***	-1.908***	-1.764***	-1.891**	-1.081	-1.846**
	(0.16)	(0.21)	(0.16)	(0.73)	(0.97)	(0.76)
gdp	-0.065***	-0.101***	-0.077***	-0.085	-0.151***	-0.095*
	(0.01)	(0.01)	(0.01)	(0.05)	(0.06)	(0.05)
quality	-0.014***	0.003	-0.010*	0.003	0.006	0.005
	(0.00)	(0.01)	(0.01)	(0.02)	(0.03)	(0.02)
capital	0.011***	0.014***	0.012***	0.049***	0.047**	0.049***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.02)	(0.01)
MAPPs	-0.113***	-0.123***	-0.115***	-0.034	-0.133***	-0.048
	(0.01)	(0.01)	(0.01)	(0.03)	(0.04)	(0.03)
N	2157	2157	2157	195	195	195
r2	0.167	0.159		0.193	0.170	
r2_a	0.164	0.084		0.167	0.063	
F	71.596***	62.456***		7.495***	5.852***	
BP-LM	chibar2(01) = 41.43***			chibar2(01) = 0.13		
chi2			412.970***			39.457***
Hausman	chi2(6) = 47.02***			chi2(6) = 20.24***		

*Note: Standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01.*

Table 9. Robust test 3

Variable	*CB*			*IB*		
	OLS	***FE***	***RE***	***OLS***	***FE***	***RE***
_cons	1.638***	2.944***	1.974***	-1.481*	-3.067**	-2.484**
	(0.54)	(0.74)	(0.56)	(0.77)	(1.50)	(1.09)
InAsset	0.158***	0.082	0.160***	0.108***	0.142	0.133**
	(0.02)	(0.06)	(0.02)	(0.04)	(0.10)	(0.06)
CPI	-1.331***	-1.342***	-1.389***	-0.625***	-0.371***	-0.470***
	(0.09)	(0.13)	(0.10)	(0.07)	(0.08)	(0.08)
gdp	-0.031***	-0.068***	-0.047***	0.002	-0.013	-0.004
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
quality	0.003	-0.003	0.001	-0.026***	-0.017***	-0.020***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
capital	0.005**	0.012***	0.007***	0.018***	0.022***	0.017***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
marp5	-0.053***	-0.072***	-0.061***	-0.009	-0.071***	-0.056***
	(0.00)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
N	3961	3961	3961	1204	1204	1204
r2	0.128	0.117		0.137	0.092	
r2_a	0.127	0.042		0.133	0.005	
F	97.031***	80.700***		31.743***	18.530***	
BP-LM	chibar2(01) = 127.44***			chibar2(01) = 179.51***		
chi2			547.439***			119.184***
Hausman	chi2(6) = 82.05***			chi2(6) = 34.42***		

*Note: Standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01.*

Table 10. Robust test 4

Variable	*CB*			*IB*		
	OLS	***FE***	***RE***	***OLS***	***FE***	***RE***
_cons	5.653***	9.973***	6.564***	-0.266	3.279**	0.973
	(0.56)	(0.78)	(0.58)	(0.76)	(1.64)	(1.12)
InAsset	0.122***	-0.176***	0.109***	0.053	-0.210**	-0.039
	(0.01)	(0.06)	(0.02)	(0.04)	(0.10)	(0.06)
CPI	-2.174***	-2.189***	-2.320***	-0.786***	-0.738***	-0.769***
	(0.10)	(0.13)	(0.10)	(0.07)	(0.09)	(0.08)
gdp	0.034***	0.015	0.023**	0.024*	0.025*	0.028**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
capital	0.002	0.008**	0.003	0.019***	0.017***	0.015***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
quality	0.003	-0.010***	-0.001	-0.026***	-0.022***	-0.023***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
MAPPs	-0.039***	-0.026***	-0.037***	0.021*	-0.010	-0.003
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
COVID-19	1.245***	1.454***	1.287***	1.429***	1.403***	1.380***
	(0.08)	(0.09)	(0.08)	(0.17)	(0.19)	(0.17)
N	3961	3961	3961	1204	1204	1204
r2	0.184	0.179		0.188	0.127	
r2_a	0.183	0.109		0.183	0.043	
F	127.340***	113.583***		39.521***	22.772***	
BP-LM	chibar2(01) = 127.65***			chibar2(01) = 179.41***		
chi2			851.629***			185.838***
Hausman	chi2(7) = 90.06 ***			chi2(7) = 36.98***		

*Note: Standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01.*

5. CONCLUSION

As regulators attempt to optimise their financial systems from MAPPs, these policies have become a hot issue. This study examined the moderating effect of CG on the MAPPs and bank efficiency nexus for the period of 2006–2021 among 14 countries whose share of Islamic banking assets in their total domestic banking sector assets was over 1%.

The basic regression models in this study showed that MAPPs were negatively and significantly correlated with both types of banks' efficiency. This can be explained by the fact that macroprudential tools make banks comply with additional regulations, and bank lending operations may be constrained by some macroprudential instruments. What is more, the coefficient of IBs was greater than that of CBs. This may be explained by the unique financing method of IBs. Moreover, MAPPs had a stronger effect on both types of banks' efficiency in low-income countries than in high-income countries. This result signified that financial systems in low-income countries may be less diversified compared to high-income countries, so banks in low-income countries would find it harder to adjust their operations under stricter regulatory requirements. CG strengthens the negative impact of MAPP on the efficiency of two types of banks, even though the coefficient is not significant in terms of IBs.

The results of this study have important policy ramifications. First, policymakers should carefully assess the impact of MAPPs on both IBs and CBs' efficiency. While these policies may help mitigate risks and enhance financial stability, they could also impose constraints on bank lending operations. Striking a balance between financial stability and banks' efficiency is crucial to ensure sustainable economic growth. The stronger impact of MAPPs on bank efficiency in low-income countries highlights the need for more targeted and supportive measures. Second, policymakers should consider the less diversified financial systems in these countries and provide necessary support to help banks adapt to stricter regulations while promoting

financial inclusion. Third, the moderating effects of CG indicate that policymakers should tailor policies to the environment connected to each country's governance level.

This study is subject to several limitations. First, it focuses only on a specific set of countries, which may restrict the generalisability of the findings to other contexts. Second, bank efficiency was measured solely using the DEA approach, whereas alternative methods might capture additional factors. Third, the analysis considers only the moderating role of CG, leaving other potential moderators unexplored. Future research can explore the moderating role of bank regulatory (Barth, Lin, et al., 2013) on the MAPPs-bank efficiency nexus.

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APPENDIX

Table A.1. Data envelopment analysis inputs and outputs

Inputs and outputs	*Variable*	*Definition*
Inputs 1	*Deposits*	Deposits and short-term funding
Inputs 2	*Physical capital*	Fixed assets
Outputs 1	*Loan*	Gross loans
Outputs 2	*Investment*	Total financial assets: securities

Table A.2. Variable explanations

Variable		*Symbol*	*Description*	*Source*
Dependent variable	*Efficiency score*	*Inte*	Measure the efficiency of the bank (log)	Calculated by the authors
Independent variable	*Macroprudential policies*	*MAPPs*	Measure the level of macroprudential policies	The Macroprudential Policy Survey database (https://www.elibrary-areaer.imf.org/Macroprudential/Pages/Home.aspx)
Bank-level control variables	*Size*	*InAsset*	Bank's total assets (log)	BankFocus
	Credit risk	*quality*	$\frac{Loan\ loss\ reserves}{Gross\ loans}$	BankFocus
	Capitalization	*capital*	$\frac{Equity}{Total\ assets}$	BankFocus
Country-level control variables	*GDP*	*gdp*	GDP growth (annual %)	WDI
	CPI	*CPI*	Consumer price index (2010 = 100) (log)	WDI
Moderating variable	*Country governance*	*CG*	The average of six dimensions of country governance	WGI