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Monetary policy, macroprudential policy, and bank risk-taking behaviour in the Indonesian banking industry

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ABSTRACT

There is a growing consensus on the translation of monetary policy actions into changes in credit demand on account of changes in interest rates. The study investigates monetary policy, macroprudential policy, bank-specific and macroeconomic determinants of bank risk-taking from 2010–2022 in Indonesia. The study aims to address a gap in the literature because most previous studies have focused on advanced markets. First, three POLS and fixed effect models are estimated. However, the Durbin Wu-Hausman test indicated endogeneity issues with the estimated models. The second stage uses a system GMM estimation to investigate the impact of central bank rates and macroprudential policy on bank risk-taking. Dynamic-GMM estimations find that, partially the central bank rate and macroprudential policy have a positive impact on bank Z-Score. Furthermore, when central bank rate and macroprudential policy are included in a model, we still find a positive impact of both policies on bank Z-Score.

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1. Introduction

The central bank set monetary policy by controlling the interest rate for the purpose to achieve price and financial stability (Anwar et al., 2023). However, prolonged periods of low interest rates can also raise financial stability issues, by inducing banks should pursue additional valuable assets outside credit, in line with taking risks (Caselli & Figueira, 2023). Easy monetary conditions are a classic element of a financial crisis (Queralto, 2020). Low rate of interest affect the perception and assessment of bank risk, which increases credit supply (Dang, 2020). The concern over this excessive supply of loans is related to the amount of loans disbursed resulting into higher risk levels for these loans. According to Wang et al. (2022), the risk-taking channel is the effect of changes in interest rates on risk tolerance and risk perception, which in turn triggers changes in credit supply.

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Banks are the predominant players and are central to the financial systems of most economies, including in Indonesia (Anwar, 2021). The intermediary function of banks is regarded as the mechanism that drives economic performance. Therefore, it is considered that the stability of the financial sector is a prerequisite for economic stability. According to Cruz-García et al. (2020) and Yang (2019), there are two factors that influence the financial system, the first is endogenous factors including financial risk, operational risk, legal risk, reputation risk, strategic risk, capital concentration risk and capital risk. Second are exogenous factors including domestic macroeconomic disturbances and risks unavoidable such as natural disasters and others.

Because of their dynamic structure and the complicated nature of the economic environment in which they operate, banks face several risks. There are several types of risks inhibiting the financial system that can pose a risk of a banking crisis, based on the size of the market. Risk-taking behaviour includes both systematic and non-systematic risks (Chen et al., 2017; Paule-Vianez et al., 2020). The Z-score is one measure of bank risk appetite based on the returns on assets. The higher the Z-Score, the farther the distance from the default value, and the less risk. The Z-score therefore provides a good indicator for analysis of the risk appetite of banks that are listed in the stock market.

In recent years, scholars and policymakers have paid increased focus to the link between bank risk-taking and monetary policy. The priority for monetary policy focus has been on these twin pillars of price stability and business cycle management. Banks are central to the transmission of monetary policy through their role in setting the lending rates in response to monetary policy action. However, a rapidly growing line of research indicates that monetary policy attitudes can have an impact on bank perceptions or tolerance of risk, cause excessive risk-taking, and consequently undermine financial sector stability. A monetary policy with accommodative, which prolonged too-low interest rates, is thought to be the main factor underlying financial institutions' excess risk-taking (Altavilla et al., 2018). The widespread and prolonged policy of low-interest rates coupled with asset purchase program in most countries in response to impact of the global financial crisis of 2007–2009 raised concerns whether central banks should “lean against the wind” by tightening monetary policy in periods with excess liquidity in the financial sector to curb bank risk-taking incentives (Kashyap & Stein, 2023). The global financial crisis emphasized not just the need for price stability but also prudential regulation and policies to mitigate contagion effect of risk in one industry on the financial system. However, risk taking continues to characterise the integrated financial system.

Along with financial crisis that affects the economy, central banks are increasingly recognising systemic risk mitigation initiatives (Jackson & Pernoud, 2021). Bank Indonesia (Central Bank of Indonesia), as a financial authority for macroprudential policy, develops macroprudential policies and carries out macroprudential supervisory operations with the main objective of reducing systemic risk (Suhendra & Anwar, 2021). This involve both micro-prudential and macroprudential assessment of financial institutions on their vulnerability to risk. The experience of the crisis brought to light the idea that central banks should focus on both the objective of price stability and financial sector stability to achieve sustained macroeconomic stability. Therefore, the transmissions of monetary policy is considered to include both interest rates, and balance policies (or non-traditional policies) including macroprudential policies when assessing the potential

impact of shocks on the banking system (Revelo et al., 2020). Macroprudential policies are designed to complement monetary policy to achieve price and financial stability objectives (Anwar et al., 2023).

The experience of 2008 global financial crisis where risk spread from the real estate credit markets through banks to insurance companies, macroprudential policy have become crucial part of macroeconomic stabilization policies. The crisis begun in subprime mortgage market segment in 2008 and rapidly spreading to the rest of the economy creating credit defaults and financial failures. The crisis revealed the levels of integration and contagion effects, which accelerated the establishment of macroprudential regulation (Zhang et al., 2021). The macroprudential policy seeks to ensure stability in the financial system as whole by identifying and addressing areas of vulnerability. They are designed to promote sustained economic growth and stability through credits but recognizing the interconnectedness of the entities involved, which enable the central bank monitor the stability of the financial system (Nakatani, 2020). The objective is to reduce the likelihood of financial system disruption from systemic failures.

Currently, study on macroprudential policy primarily focuses on the policy's subject, its instruments, its efficacy, and how macroprudential policy and monetary policy interact within an economy. The coordination between macroprudential policy and monetary policy is a critical issue, and is the main focus of this study. The argument is that since, both monetary and macroprudential policies directly affect real economic variables, they should be coordinated (Jiang et al., 2019). Reliance solely on macroprudential policy is likely to make the execution of policy expensive, it should therefore supplement monetary policy in macroeconomic stabilization (González, 2022). In booms periods of business cycle, monetary policy tends to be expansionary such that financial imbalances start to build up, policy should “lean against the wind” in coordination with macroprudential policy to guide the reversal of imbalances during recessions. The idea that macroprudential policy and monetary policy should be conducted in parallel is largely acknowledged in the literature and in practice. Therefore the issue of policy coordination among the two approaches to ensure sustained macroeconomic stability has emerged as an important policy direction.

This research contributes the empirical debates on macroeconomic policies and the risk-taking of financial institutions, especially banks. The focus on Indonesian listed banks is motivated by the consideration of the pace of economic growth and financial transition that this economy has experienced including frequent banking crises in recent decades (Anwar & Suhendra, 2023). Until experience of the global financial crises, monetary policy was central for addressing macroeconomic instability through management of aggregate demand and expectations thereof. The objectives of monetary policy included limiting inflation, promoting economic growth and stabilising exchange rates. However, the trade-off between financial stability and price stability was largely ignored (Anwar et al., 2023). Commercial banks dominated the financial system as the primary source of financing but its linkages to insurance and stock markets continued to expand (Anwar & Suhendra, 2020). This suggests that countries with a lower reliance on banks may be more vulnerable to the negative impacts of excessive bank risk taking (Dahir et al., 2018). In such

circumstances, the optimal policy design, long-term stability, and economic growth all depend critically on knowledge of nexus between macroeconomic policies and bank risk taking.

2. Literature review

According to Bauer et al. (2023), risk-taking channel indicates that low interest rates influence risk tolerance via valuation, income, and cash flow. This is similar to the arguments of Bernanke et al. (1999) financial accelerator. Lower interest rates improve valuation and an agent's net worth, notably their collateral value and assets. As a result, a rise in the value of collateral following a policy rate decrease reduces the agent's likelihood of default, prompting the bank to respond by making additional loans. Through its communication strategies, monetary policy impacts channel risk-taking. A high degree of predictability in policymakers' future actions can minimize market uncertainty and lead banks to adopt riskier positions. Poor economic outcomes, for example, might impact agents' perceptions of central banks loosening monetary policy and mitigating the economic consequences of inactivity. As a result of anticipating this insurance impact, the bank assumes greater risk (Bernanke, 2020).

The impact of monetary policy on bank risk taking has been investigated by Wang et al. (2022), Ayomi et al. (2021), Dang (2020), Bounboua (2020), Brana et al. (2019), and Chen et al. (2017). Wang et al. (2022) investigate the influence of bank liquidity on Chinese banks' risk-taking behaviour and present evidence for a risk-taking channel of monetary policy working through bank liquidity. They discovered that institutions with reduced liquidity risk are incentivized to take more risks. Furthermore, loose monetary policy encourages more aggressive risk-taking by lowering bank liquidity risk, implying a liquidity risk-taking channel of monetary policy. Ayomi et al. (2021) examine the effect of monetary policy on credit defaults. Ayomi et al. (2021) reveal that monetary policy, as measured by a rise in the benchmark interest rate, has a negative impact on the chance of default demonstrating that monetary intervention improves banking stability.

Dang (2020) examines the connection between monetary policy and bank risk-taking in Vietnam from 2007 to 2018 under a multiple-tool system. Dang (2020) demonstrates using static and dynamic panel models that the liquidity injection brought on by the central bank's asset purchases encourages banks to assume more risks, as measured by the Z-score. However, monetary policy easing through lower interest rates is advantageous to banks' loan portfolios and financial stability, posing a challenge to the channel for bank risk-taking. Bounboua (2020) using a Difference-in-Differences estimator to analyse the effects of negative interest rates on bank risk-taking. Bounboua (2020) discovers that banks' risk-taking is lower in nations where negative interest rates have been adopted. This influence is determined by the features of a country's banking system, specifically its capitalization and size. Brana et al. (2019) examined the impact of monetary policy on bank risk-taking behaviour in Europe from 2000 to 2015. They established that relaxing monetary policy (through low interest rates and increased central bank liquidity) reduces bank risk, proving the existence of the risk-taking channel. Chen et al. (2017) investigated the effect of monetary policy on bank risk-taking in the emerging economies. They found that monetary policy have a positive significant on bank risk taking.

The effect of macro-prudential policy on the banking sector was analysed by Anwar et al. (2023), González (2022), Nakatani (2020), Ali and Iness (2020), and Zhang et al. (2018). Anwar et al. (2023) investigated how macroprudential regulation might help enhance financial system stability by addressing the lending gap in 20 emerging economies from 2000 to 2021. The findings revealed that stringent macroprudential policies increased banking sector financial stability. González (2022) investigates the impact on bank competitiveness and stability of modifications in eight types of bank-oriented macroprudential policy. He finds that tightening bank-oriented macroprudential regulations boosts bank stability on average. Using data from 65 countries from 2000 to 2016, Nakatani (2020) empirically explores the influence of macroprudential regulation on the likelihood of a banking crisis. Nakatani (2020) suggests that macroprudential policy can reduce the likelihood of a banking crisis via a credit channel. Ali and Iness (2020) argue that differences in the financial stability of individual institutions between countries can be explained. Using 85 developing countries from 2000 to 2014, they identify macroprudential policies as instruments for promoting the financial stability of banks. Zhang et al. (2018) analyse the impact of macroprudential policies on the risk-taking of banks. They collect data from 231 commercial banks in China in order to test empirically whether macroprudential instruments influence bank risk-taking behaviour. The results provide additional evidence of the significance of macroprudential policies in maintaining financial stability, which helps to reduce vulnerabilities in the financial system. With the improvement of macroprudential supervision, banks will take on less risk.

Moreover, the effectiveness coordination between macroprudential and monetary policies on bank risk taking have been studies by Jiang et al. (2019). They examine the effects of monetary policy and macroprudential policy coordination on bank risk-taking in the banking sector of China. They concluded that countercyclical regulation should be carried out concurrently by monetary policy and macroprudential policy.

The effect of COVID-19 on bank's systemic risk has been investigated by Susanti et al. (2023), Yarovaya et al. (2022), Çolak and Öztekin (2021), Mateev et al. (2021), Elnahass et al. (2021), and Barua and Barua (2021). They reached the conclusion that risk taking in the banking industry and COVID-19 had a negative correlation.

3. Data and methodology

3.1. Data

3.1.1. Bank risk taking

The study uses Z-score as a proxy for bank risk-taking – computed using ROA for each of the banks in the sample

$$Z - score_{i,t} = \frac{ROA_{i,t} - E_i(ROA)}{\sigma_i(ROA)} \quad (1)$$

where ROA is computed as the profits after tax/total assets $E_i(ROA)$ denotes the average ROA for the i bank of the sample period, and $\sigma_i(ROA)$ represents the standard deviation for each institution.

The identification method employed is as follows: the risk-taking channel suggests that bank risk-taking rises as its Z-score falls probably driven by expansionary monetary

policy. This is on the assumption that a unit change in the Z-score mostly translates into the bank's risk-taking behavior after adjusting for macroeconomic shocks and the influence of some bank-specific variables.

3.1.2. Monetary and macroprudential policies

3.1.2.1. Monetary policy. Monetary policy in most countries has transitioned from quantity management to the base interest rates settings (pricing) approach. The central bank of Indonesia changed its monetary policy framework to inflation targeting with interest rates as the instrument of policy, drawing on the successful experience in countries such as New Zealand, UK, Canada, etc. As a result, the variable for monetary policy is the central bank policy interest rate, denoted as CB Rate.

3.1.2.2. Macroprudential policy (MAPP). The macroprudential index created by Cerutti et al. (2017) is used as the variable for macroprudential policy, expressed as MAPP, to examine the overall impact of macroprudential policy. The MAPP index is built using Cerutti et al. (2017)'s 12 Global Macroprudential Indicators (GMPI). The coincident indicator approach established by Stock and Watson (1989) and Garratt and Hall (1996) likewise yields a new index. Following that, the 12 GMPI instruments are influenced by a common component, which is represented by an unobserved variable that prioritises one of the model's advantages. Anwar et al. (2023) used dynamic factor model to transform the 12 MAPP instruments into an index between 0 and 1.

3.1.3. Macroeconomic variables

It is critical to incorporate macroeconomic variables to account for the structure of the economy. Banks are the primary source of credits to businesses and control the largest share of financial assets in Indonesia. We can control for the influence of business on bank soundness by using money supply. That is, money supply captures the portion of the change in the Z-score due to credit extensions. The analysis follow the approach of Chen et al. (2017) and Dang (2020) to examine the effect of money supply on bank risk-taking. Through their decision-making, inflation can influence banks' risk-taking behaviours. As a result, we include the change in consumer price index to capture the change in price to bank soundness. Previous research such as Bongiovanni et al. (2021), and Zhang et al. (2018) show that inflation has a negative effect on bank risk-taking. Then, exchange rate is included as a determinant of bank risk-taking. The impact of exchange rates has been examined by Wang and Luo (2019), Boungou (2020), and Kabundi and De Simone (2020), which show that exchange rate has a negative effect on bank risk taking.

3.1.4. Bank specific variables

We account for several bank characteristics that can influence risk taking such as: profitability, asset size, and efficiency. In terms of profits, López-Penabad et al. (2022), Abbas and Ali (2022), and Bui et al. (2021) show that it reduces bank risk-taking. The justification for each bank's size follows Moudud-Ul-Huq (2021). In addition, we account for large bank referred to as, "too big to fail" that must be supported by the government when it faces financial difficulties (Bhagat et al., 2015).

Turning to bank's operational efficiency, we assume that each entity pursue competitive strategies that reduces cost per-unit. As a result, temporary changes in margins do

not actually put banks in monetary trouble or drives an institution into bankruptcy. The efficiency is determined by the BOPO ratio, which is the ratio of total operating expenditures to operating income at the bank. The benchmark is an important characteristic of banks trying to understand the input-output relationship of their operations that facilitate risk management. We follow Fang et al. (2019), and Zhang et al. (2021) who found that bank riskiness decreases with efficiency.

3.1.5. COVID-19

We add COVID-19 as a control variable. In the Indonesian banking sector, COVID-19 influences bank risk-taking behaviour as well as macroprudential and monetary policy. Furthermore, The Financial Services Authority (OJK) offered incentives to banks to restructure loans for borrowers who were affected by the pandemic. This means that lenders are exempt from having to set aside funds for soured loans, which will help avert an increase non-performing loan (NPL) ratio in banking sector in Indonesia. According to Susanti et al. (2023), Yarovaya et al. (2022), Çolak and Öztekin (2021), Mateev et al. (2021), Elnahass et al. (2021), and Barua and Barua (2021) concluded that there is a negative relationship between COVID-19 and risk taking in banking sector.

3.2. Econometrics methodology

This study uses both macro and micro-level data to examine the effect of monetary and macroprudential policies on bank risk-taking, creating a panel dataset for Indonesia. The panel dataset cover the period 2010–2022 for 41 commercial banks whose equity stocks are listed on the Jakarta stock exchange. The study employs panel approaches to examine the effect of monetary and macroprudential policies on banks' risk-taking. Since the individual bank characteristics are likely to be non-random and may affect outcome variables, we need to control for them in our panel regression model. In such specification, the effects of the outcome will not influence those individual bank fixed characteristics. The general specification of the fixed effect model is:

$$Y_{i,t} = \alpha_0 + \alpha_i X_{i,t} + \mu_t + \varepsilon_{it} \quad (2)$$

Where $Y_{i,t}$ denotes the outcome variable for bank i at time, $X_{i,t}$ is a vector of predictors, the parameters α_0 is an unknown intercept for each entity while α_i are the coefficient on each independent variables in the vector $X_{i,t}$. Then, μ_t is the within banking entity error term and $\varepsilon_{i,t}$ is the over all error term.

The estimation follow the approach of Wang et al. (2022) and Ayomi et al. (2021) to estimate the effect of monetary policy on bank risk-taking in model in Equation 3. In Equation 4, we investigate the effect of macroprudential policy on bank risk-taking following González (2022), and Ali and Iness (2020). Finally, Equation 5 is employed to estimate the individual effects to both monetary policy and macroprudential policy on bank risk taking consistent with Jiang et al. (2019). In addition to the key variables, the models incorporate money supply, inflation, exchange rate, bank size, efficiency, and COVID-19 as control variables that affect banks' risk-taking.

In the general model, since period t Z-score is also influenced by $t-1$, we make the model dynamic that helps with addressing endogeneity issues in the estimation:

$$Z - Score_{it} = \alpha_0 + \alpha_1 Z - Score_{it-1} + \alpha_2 CB Rate_{it} + \alpha_3 MS_{it} + \alpha_4 INF_{it} + \alpha_5 ER_{it} + \alpha_6 SIZE_{it} + \alpha_7 EFF_{it} + \alpha_8 COV_{it} + \varepsilon_{it} \quad (3)$$

$$Z - Score_{it} = \alpha_0 + \alpha_1 Z - Score_{it-1} + \alpha_2 MAPP_{it} + \alpha_3 MS_{it} + \alpha_4 INF_{it} + \alpha_5 ER_{it} + \alpha_6 SIZE_{it} + \alpha_7 EFF_{it} + \alpha_8 COV_{it} + \varepsilon_{it} \quad (4)$$

$$Z - Score_{it} = \alpha_0 + \alpha_1 Z - Score_{it-1} + \alpha_2 CB Rate_{it} + \alpha_3 MAPP_{it} + \alpha_4 MS_{it} + \alpha_5 INF_{it} + \alpha_6 ER_{it} + \alpha_7 SIZE_{it} + \alpha_8 EFF_{it} + \alpha_9 COV_{it} + \varepsilon_{it} \quad (5)$$

Where Z-Score is a proxy of bank risk taking, CB rate is the central bank policy rate as a proxy of monetary policy. MAPP is macroprudential policy index. MS, INF, ER, SIZE, EFF, and COV are money supply, inflation, exchange rate, size, efficiency, and covid-19. *i* is bank cross section. *t* is period.

The rising body of empirical research on bank risk-taking, however, provides weight to several arguments in favour of a dynamic model. Although the coefficient of the lagged dependent variable are not of interest, allowing for dynamics enables to the model to recover consistent estimates of other parameters. In addition, the dynamic model facilitate addressing any possible endogeneity issue that the relationship between risk-taking and the stabilization policies could experience. According to Brana et al. (2019), two main problems are underscored:

- (1) Omitted variables: Interest rates and bank risk may be endogenous to the regional macroeconomic environment.
- (2) Reverse causality: Possible future higher risk could be related to recent monetary expansion.

A test for endogeneity was conducted to evaluate the consistency of the panel ordinary least square (POLS) models' results using Durbin-Wu-Hausman test. The best solution for endogeneity problem in the models is performing dynamic panel data estimation developed by Arellano and Bond (1991), and Blundell and Bond (1998). We perform Stata software for econometrics estimations such as POLS estimation, fixed effect estimation, Endogeneity test, and system GMM estimation.

4. Results

4.1. Basic POLS estimation

Table 1 reveals the output of the POLS estimation and shows that a lag 1 of Z-score has a positive significance on Z-score. The CB rate and MAPP were not significant effect on Z-score. Similarly, money supply, inflation, exchange rate, and COVID-19 were not significant impact on Z-score. However, Size and efficiency have a significant positive effect, on Z-Score. This implies that risk taking improves the banks efficiency and size probability through expanding credit assets in their balance sheets.

Table 1. POLS estimation results.

Variable	Dependent Variable: Z-Score		
	Model 1	Model 2	Model 3
Z-Score (–1)	0.5525*** (0.0380)	0.5524*** (0.0379)	0.5524*** (0.0380)
CB Rate	0.0219 (0.0392)		0.0094 (0.0403)
MAPP		1.9233 (1.3486)	1.8479 (1.3881)
Money Supply	0.0304 (0.0301)	0.0711 (0.0431)	0.0730 (0.0439)
Inflation	–0.0232 (0.0314)	–0.0410 (0.0269)	–0.0465 (0.0369)
Exchange Rate	–0.4510** (0.2220)	–0.2345 (0.4752)	–0.1858 (0.5273)
Size	0.0108** (0.0046)	0.0109** (0.0046)	0.0109** (0.0046)
Efficiency	0.0015* (0.0008)	0.0015* (0.0008)	0.0015* (0.0008)
Covid-19	–0.1701 (0.1886)	–0.4435 (0.2804)	–0.4486 (0.2815)
R ²	0.3288	0.3312	0.3313
No. of Cross-section	41	41	41
No. of Observation	492	492	492

Note: Symbols * is Prob. <10%, ** is Prob. <5%, and *** is Prob. <1%.

Table 2. Fixed effect estimation results.

Variable	Dependent Variable: Z-Score		
	Model 1	Model 2	Model 3
Z-Score (–1)	0.1631*** (0.0438)	0.1635*** (0.0438)	0.1634*** (0.0438)
CB Rate	0.0365 (0.0338)		0.0260 (0.0347)
MAPP		1.7504 (1.1604)	1.5408 (1.1941)
Money Supply	0.0432* (0.0259)	0.0735** (0.0371)	0.0788** (0.0378)
Inflation	–0.0183 (0.0269)	–0.0224 (0.0232)	–0.0377 (0.0309)
Exchange Rate	–0.5824*** (0.1915)	–0.0969 (0.4091)	–0.0508 (0.4542)
Size	0.0021 (0.0051)	0.0022 (0.0052)	0.0023 (0.0052)
Efficiency	0.0076*** (0.0011)	0.0075*** (0.0011)	0.0076*** (0.0011)
Covid-19	–0.2162 (0.1626)	–0.4352 (0.2419)	–0.4487* (0.2426)
R ²	0.1304	0.1326	0.1337
No. of Cross-section	41	41	41
No. of Observation	492	492	492

Note: Symbols *** is Prob. < 1.

4.2. Fixed effect estimation

The individual bank fixed effect estimation results are presented in Table 2, and reveal that lag 1 of n Z-score, money supply, and efficiency have a positive significance on Z-score. The CB rate, MaPP, and size positively affect the Z-score but

Table 3. Endogeneity test.

Variable	Model 1	Model 2	Model 3
Durbin-Wu-HausmanTest	6.86** (0.0088)	14.21** (0.0002)	13.78** (0.0002)
No of Cross-Section	41	41	41
No of Observation	451	451	451

Note: Symbols ** is Prob. < 5%.

were insignificant. Meanwhile, inflation, exchange rate, and COVID-19 negatively affect Z-score.

4.3. Endogeneity test

The Durbin Wu- Hausman test results presented in Table 3. The conclusion from the panel data test indicates that there exists an endogeneity problem in all the three estimated models. To address this issue of endogeneity in the model we estimate a generalized methods of moment model.

4.4. GMM estimation

The results of the panel system GMM estimation are presented in Table 4. The results

Table 4. Panel system GMM estimator.

Variable	Dependent Variable : Z-Score		
	Model 1	Model 2	Model 3
Z-Score (−1)	0.3041*** (0.0078)	0.2679*** (0.0097)	0.3008*** (0.0084)
CB Rate	0.0497*** (0.0073)		0.0464*** (0.0077)
MAPP		1.2189*** (0.3887)	0.9682*** (0.2347)
Money Supply	0.0414*** (0.0080)	0.0768*** (0.0095)	0.0721*** (0.0083)
Inflation	−0.0252*** (0.0046)	−0.0136*** (0.0052)	−0.0408*** (0.0053)
Exchange Rate	−0.5800*** (0.0399)	−0.5343*** (0.1585)	−0.2846*** (0.1057)
Size	0.0014 (0.0013)	0.0073 (0.0061)	0.0019 (0.0013)
Efficiency	0.0063*** (0.0003)	0.0053*** (0.0003)	0.0065*** (0.0003)
Covid-19	−0.1739*** (0.0537)	−0.4451*** (0.0604)	−0.3707*** (0.0540)
AR (1) (p-value)	0.0000	0.0001	0.0000
AR (2) (p-value)	0.1807	0.3236	0.1878
Sargan Test (p-value)	0.5003	0.1885	0.6726
No. of Cross-section	41	41	41
No. of Observation	451	451	451

Note: Symbols * is Prob. < 10%, ** is Prob. < 5%, and *** is Prob. < 1%.

show that the previous period of risk-taking has a significant positive effect on the

current period, confirming the pro-cyclicality of finance and demonstrating the continuity of banks' risk-taking behaviour. Central bank rate positively and significantly affects Z-score. This implies that an increase in central bank policy rate leads to increase banks' Z-score. Macroprudential policy has a significant positive effect on Z-score. This implies that an increase in macroprudential policy leads to an increase in Z-score. Furthermore, money supply and efficiency have a significant positive effect on Z-score. The inflation, exchange rate, and COVID-19 have a significant negative effect on Z-score. Size has a positive effect on Z-score but insignificant.

5. Discussion

Table 4 shows that the Central bank rate has a positive impact on Z-score implying that tight monetary policy improves banking stability and loose monetary policy leads to a higher bank risk taking. This finding is essential since it proves the existence of bank risk taking channel of monetary policy in Indonesia. The reduction in interest rate suggests that banks offer loans with a higher credit risk, resulting in an increase in bank risk-taking, which suggests that monetary policy influences the composition of bank loans in the economy (Boungou, 2020). During a period of low interest rates, banks modify their lending criteria. In the short term, low interest rate would reduce hazardous loan portfolios by reducing refinancing costs and NPLs, but would also reduce banks' revenues. Banks prefer to lend more to high-risk borrowers with high probability default since bank might get high income. This result is consistent with findings of Chen et al. (2017), Zhang et al. (2018), where expansionary monetary policy established to encourage banks to take more risks. The relationship between interest rate and risk taking is when monetary policy interest rates are loose, increase risk taking, depending on the health conditions of the banking system. Borio and Zhu (2012) explained that the risk taking channel, a low interest rates increases the perception of asset prices and potential returns, thus, strengthen the illusion of assets holding money, it is known as sticky rate returns.

Furthermore, we also find a positive effect of macroprudential policy on Z-score. This implies that the more prudent the central bank leads to the more stabilize in banking system. The reason cited for macroprudential policy increase on banks' Z-Score is that macroprudential policy minimises the risk-sharing impact by requiring capital adequacy ratios, the leverage effect by requiring leverage ratios, and the pro-cyclical effect by requiring counter-cyclical capital buffers. This finding is in line with Anwar et al. (2023), González (2022), Nakatani (2020), Ali and Iness (2020), and Zhang et al. (2018) which found that macroprudential policy strengthen financial and banking stability.

We find that when both monetary and macroprudential policies are included in the model, the effect of both policies on bank risk-taking is positive and significant. Counter-cyclical regulation should be implemented concurrently by monetary and macroprudential policy in order to decrease bank risk taking. Monetary policy and macroprudential policy influence bank risk-taking via credit channel and the balance sheet channel. This finding in line with the work of Jiang et al. (2019).

Booming economies boost financial stability, evidenced by our result of a positive effect of money supply on Z-score. This finding implies that the increase in money supply

increases market liquidity leads to the more stabilize in banking system. A potential explanation is that an increase in money supply increases the borrowers' ability to pay the credit, and resulting high profitability of banks. This finding is in accordance with the prior studies of Dang (2020) with the results that the money supply has a positive effect on bank risk, meaning that the higher of money supply, the banks reduce taking the risk actions.

The impact of inflation on financial stability is shown consistently negative in all models, in line with the hypothesis of Bongiovanni et al. (2021), and Zhang et al. (2018). The inflation rate is due to excess currency in circulation outside the banking system is likely to cause banks to take large amount of risks (Mayer & Schnabl, 2021). The rationale is that a rise in inflation reduces the profitability of banks when interest rates remain unchanged, causing them to seek yield (Chen et al., 2017). We also find that the estimated coefficient of exchange rate on Z-Score is negative. An appreciation in the exchange reflects in better economic performance and lead banks to behave more prudently. A better economic performance creates banks' higher revenue that can be used to increase bank equity. The results show that the exchange rate has a negative and significant effect on the Z-Score. Our findings are in line with Wang and Luo (2019), Bounougou (2020), and Kabundi and De Simone (2020) which states that the exchange rate variable turns out to have a negative effect on risk-taking, which means that the results of the analysis carried out in this study explain that when the exchange rate is high, bank risk-taking will take will be high. The relationship that occurs between the exchange rate and risk-taking due to a weakening exchange rate can cause uncertainty in the future, this will disrupt monetary stability and create risk.

We also discover some intriguing findings in terms of other bank risk factors. Although this influence of size is just slightly minor, large banks appear to take greater risks than their smaller counterparts. This result is different with a study of Moudud-Ul-Huq (2021), Srairi (2019), and Chen et al. (2017) where bank size creates higher bank Z-Score. In all models, the bank efficiency coefficient is consistently and statistically significant, suggesting that efficiency reduces bank risk. This is consistent with the research of Fang et al. (2019), Haque (2019), and Zhang et al. (2021).

We find that COVID-19 has a negative effect on bank risk taking. This implies that COVID-19 reduces the bank Z-score. The effect of COVID-19 on bank risk taking has been investigated by Susanti et al. (2023), Yarovaya et al. (2022), Çolak and Öztekin (2021), Mateev et al. (2021), Elnahass et al. (2021), and Barua and Barua (2021). They reached the conclusion that systemic risk in the banking industry and COVID-19 had a negative correlation.

6. Conclusion

The study examines the impact of monetary and macroprudential policies on listed banks' risk-taking using the Z-score. It contributes to the literature resource gap through analysis of the effects of monetary and macroprudential policies using data from Indonesian banks listed on the Indonesia stock exchange. It utilizes three panel data models on a rich bank-level micro-dataset. First, three POLS and fixed effect models are estimated. The results reveal that monetary rate and macroprudential policies have no

significant negative effect on bank risk taking. However, the Durbin Wu-Hausman test indicated endogeneity issues with the estimated models – suggesting the need to perform instrumental variable estimation. The second stage uses a system GMM estimation, which indicate that monetary rate and macroprudential policies have a positive impact on Indonesian banks' risk-taking. In particular the result show that money supply, inflation, and exchange positively affect banks' Z-score. Turing to bank characteristics, the results indicate that profitability and efficiency have a positive effect on bank Z-score.

The findings provide policy insights for emerging economies whose stock markets tend to exhibit higher volatility compared to the industrialized economies. Given the significance of the nexus, central banks should be cognizant banks' risk-taking behaviours in response to monetary and macroprudential policies shocks. In addition, there is need to closely examine performance listed banks with respect to bank profitability and stock price movements to ensure compliance capital adequacy requirements.

This is an area of growing research interest with several options for extensions. First, the implications of stabilization policies on banks' performance and risk-taking in other countries/regions. This will espouse information on similarities and differences across countries allowing from comparison of countries under different policy frameworks and levels of development of financial markets. The cross-country panel approach enables one to overcome the limitation of small sample size to derive broad conclusions. The other approach is to investigate the argument bank risk-taking is driven by credit demand from riskier borrowers. This justification provides a fascinating approach to separate the two components of bank risk, which calls for loan-level data in addition to overall bank data. Second, the future research use other methods to calculate the risk taking by using Altman Z-score or Conan-Holder model.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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