The Effect of Monetary Policy & Macroprudential Policy and Their Interaction on Bank Risk-Taking in Indonesia

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Abstract

We use the Indonesian quarterly bank-level data from 2009Q1 to 2021Q1 to investigate the effect of monetary policy, macroprudential policy, and the interaction between both policies on bank risk-taking in Indonesia. Several important results emerge. Firstly, we find evidences of the existence of risk-taking channels of the monetary policy in Indonesia, and that both bank size and level of capital have a relatively significant negative impact on bank risk-taking. Secondly, macroprudential policy tightening lowers bank risk-taking. We also find that the interaction between macroprudential policy and monetary policy tightening lowers risk-taking.

Keywords: Monetary policy, Macroprudential policy, Bank risk-taking
JEL Classification: G21, G28, G32.

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I. Introduction

In the two decades before the 2008/2009 global financial crisis, central bank policies were emphasized on achieving price stability by means of short-term interest rate instruments through the implementation of Inflation Targeting Framework (ITF). These policies had supported relatively high economic growth with low inflation and interest rate. However, these policies were accompanied by an accumulation of risks and vulnerabilities in the financial system impacting the 2008/2009 global financial crisis (Warjiyo and Juhro (2016)). Borio and Zhu (2008) suggest that the effect of low policy interest rate on risk-taking is another channel of monetary transmission. They define a risk-taking channel as the impact of the changes in policy interest rate on either risk perception or risk tolerance, which in turn will affect the level of risk in the portfolio, asset pricing, as well as the prices and non-prices of the extension of funding.

The phenomenon of monetary policies influencing bank risk-taking also occurs in Indonesia. Lower policy interest rate increases bank risk-taking, while higher policy interest rate reduces bank risk-taking. These are reflected in the movement of the 1-day real interbank money market interest rate (PUAB) as the operational target of monetary policy, and the Z-score as a representation of bank risk-taking indicators in Indonesia (Figure 1).

In this study, we aim to investigate whether monetary and macroprudential policies, as well as the interaction between the two policies, affect bank risk-taking in Indonesia. In addition, we aim to find evidences of whether the individual characteristics of banks influence bank risk-taking. To understand the effect of monetary policy on bank risk-taking in Indonesia, we consider the characteristics of individual banks, which amount to 87 Commercial Banks and non-Foreign Bank Branch Offices (KCBA) in 2021, all with differing characteristics in terms of performance, including asset size. Among those banks, several banks with varying levels of bank capital and liquidity dominate the banking assets in Indonesia.

Our analysis uses Indonesian data for three reasons. Firstly, the country explicitly states that the role of its central bank (Bank Indonesia) is to maintain financial system stability. Secondly, Lee et al. (2016) mention that Indonesia is one of the countries that is quite active in implementing macroprudential policy instruments, particularly in implementing the Loan to Value (LTV) ratio and in maintaining price stability and contributing to the financial system stability, Bank Indonesia applies the policy mix (monetary policy and macroprudential policy) instrument. Lastly, the authorities face challenges from the relatively shallow characteristic of Indonesia's financial system, which is dominated by large banks.

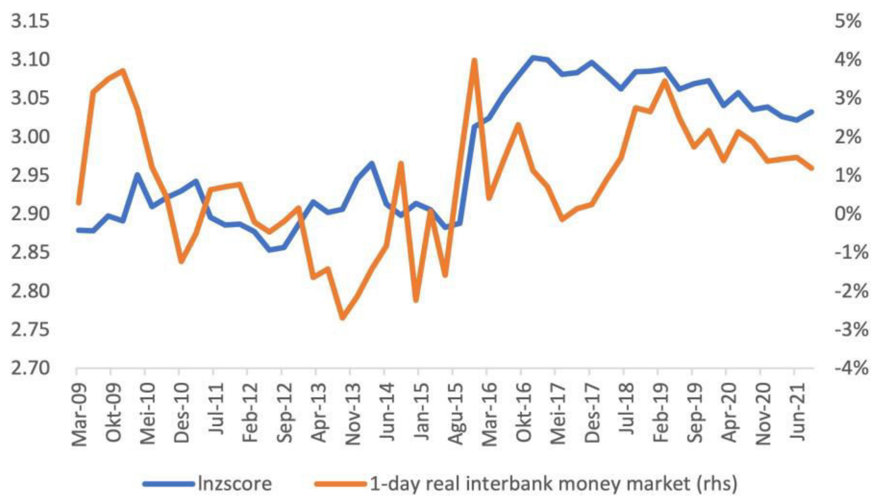

Figure 1. Bank Risk-taking and 1-day Real Interbank Money Market Interest Rate.
Note: Z-score is the average of 79 commercial banks calculated utilizing the full sample in natural logarithms. Source: CEIC and Bank Indonesia.

To answer the research question, we employ the quarterly bank-level data from 2009Q1-2021Q3 of 79 Indonesian banks to capture the dynamics of macroprudential policy, which is more active after the Global Financial Crisis in 2009. Several important findings emerge. Firstly, we obtain empirical evidences of the existence of risk-taking channels in the Indonesian monetary policy transmission mechanism. Secondly, in terms of the individual characteristics of banks, smaller banks with lower capital level tend to have a high level of risk-taking. Thirdly, we also find that tight macroprudential policies decrease bank risk-taking. Lastly, the interaction between monetary policy and macroprudential policy tightening lowers bank risk-taking. Our study also supports the findings of Lepetit and Strobel (2013) that the Z-score calculation utilizing the standard deviation of the ROA applying the entire observation sample period is the appropriate Z-score calculation for Indonesian banks.

Per our knowledge, this is the first study investigating the effect of monetary policy, macro-prudential policy, and especially the interaction between both policies, on bank risk-taking. Our study fills that practical-knowledge gap, particularly for countries implementing monetary and macro-prudential policy mixes. Furthermore, we apply various Z-score indicators as an indicator of bank risk-taking and utilize the macroprudential index as an indicator of macroprudential policy to better verify the results found in the literature empirically.

The rest of this paper will be organized as follows. Section 2 reviews the literatures on the effect of monetary policy, macroprudential policy, and the interaction between both policies on bank risk- taking. Section 3 discusses the data and methods utilized in the study, while Section 4 presents the empirical results and discussions. Lastly, Section 5 summarizes and discusses research limitations and implications.

II. Literature Review

The effects of interest rate on bank risk-taking have been widely studied (see: Gambacorta (2009), Delis and Kouretas (2011), Maddaloni and Peydró (2013), Altunbas et al. (2014), Paligorova and Santos (2017), and Neuenkirch and Nöckel (2018)). These studies confirm the existence of risk-taking channels in Europe and the United States. Recent studies venture out of the area and seek to find these channels in emerging markets. These studies include Montes and Peixoto (2014), Nguyen and Boateng (2015), and Sarkar and Sensarma (2019), each of which examines the existence of risk-taking channels of monetary policy transmission in Brazil, China, and India. In line with the findings in Europe and the US, these studies prove that risk-taking channels exist in the monetary policy transmission mechanism. Meanwhile, Huey et al. (2016) find few evidences regarding the relationship between interest rate policy and bank risk-taking in Malaysia.

Borio and Zhu (2008) explain how monetary policy influences bank risk-taking in three ways. First, through the influence of interest rates on valuation, income, and cash flow. For example, lowering interest rates will increase the value of assets and collateral along with incomes and profits, consecutively can reduce risk perception and or increasing risk tolerance. Second, through the relationship between interest rates and target returns, which are commonly used as benchmarks for measuring financial investment performance. Nominal yield targets tend to be sticky due to contracts with investment managers. Therefore, a decrease in interest rates interacts with a sticky yield target, affecting an increase in risk tolerance and encouraging investors to seek investment alternatives with higher yields (search of yield). The third and last way is through central bank policy communication and transparency. Transparency and communication, as well as clarity on the direction of central bank policy, can anchor the expectations of economic actors going forward, reduce financial premiums on financial markets and encourage business uncertainty – boosting the economy. On the other hand, this monetary stability can promote risky behavior of economic actors, mainly from speculative investors who seek higher profits from speculative investments and financial product innovation (Warjiyo and Juhro (2016)).

The characteristics of individual banks also influence bank risk-taking. Altunbas et al. (2014) find that banks that tend to take risks are small, less liquid, and under-capitalized. Jiang et al. (2019) find that bank size and the ratio of equity to assets have a relatively significant negative impact on risk-taking. In addition, Jiang et al. (2019) also find that bank liquidity ratio positively impact risk-taking. Meanwhile, macroprudential policy is defined as a policy designed to maintain financial system stability by strengthening financial system resilience, reducing systemic risk accumulation and contributing to the financial sector and sustainable economic growth (European Systemic Risk Board 2013). According to Galati and Moessner (2013), the objective of macroprudential policy is to prevent and limit systemic financial distress and to achieve financial stability. Caruana (2010) states that macroprudential policy aims to reduce systemic risk by overcoming interlinkages and common exposures between financial institutions and overcome the procyclical nature of the financial system. Based on the definition and objectives of the macroprudential policy above, macroprudential policy is a policy that influences bank risk-taking, reduces the accumulation of systemic risk and maintains financial system resilience.

The International Monetary Fund (2013) states that the implementation of monetary (macroprudential) policy instruments needs to consider the side effects of macroprudential (monetary) policy targets. If financial distortions vary exogenously, every policy can pursue its objectives without being disturbed by the side effects. Given these side effects, effective monetary and macroprudential policies complement each other and deliver better results than if we are to rely solely on each policy (Nier and Kang (2016)). Claessens (2013) states that, when the implementation of macroprudential policies is weak, monetary policies could respond to the buildup of financial risk with policies that counter the credit cycle, and implement expansionary policies in conditions of financial shocks. On the other hand, when monetary policies are limited, there will be a greater demand for the implementation of macroprudential policies. Agénor et al. (2014) states that the best economic results could be expected if the two policies are used complementarily.

Zhang et al. (2018) and Andrieş et al. (2018) find that tightening macroprudential policies reduces bank risk-taking significantly. Several studies have also tried to analyze how the interaction between monetary policy and macroprudential policy affect the behavior of banks in taking risks. Previous empirical research, such as Jiang et al. (2019) and Andrieş and Pleşcău (2020), show that the interaction between the two policies affects the risk-taking behavior of banks.

Empirical studies examining monetary policy and bank risk-taking in Indonesia are still limited. An empirical study related to this topic in Indonesia is one conducted by Satria and Juhro (2011). Satria and Juhro confirm the existence of a risk-taking channel in Indonesia. This study utilizes time-series data and ignores the varied characteristics of banks in Indonesia. Satria and Juhro recommend considering the banking characteristics and various alternative risk-taking indicators for further research. There are several studies on the interaction between monetary and macroprudential policies in Indonesia, including the one conducted by Wijayanti et al. (2020) and Dewati (2017). However, to the best of our knowledge, empirical research in Indonesia explicitly need to discuss the interaction between monetary and macroprudential policies in terms of bank risk-taking.

III. Data and Methodology

3.1 Data

This study utilizes the balanced panel data of Conventional Commercial Banks instead of Foreign Bank Branch Offices for 2009Q1-2021Q3. Among the banks operating during that period, there are 87 eligible banks. After eliminating the outliers, we pick 79 banks as the object of this research. The dependent variable in this study is bank risk-taking. The indicators of bank risk-taking in previous studies are varied. However, the most widely used bank risk-taking indicator is the Z-score (see. Nguyen and Boateng (2015), Zhang et al. (2018), and Andrieş and Pleşcău (2020)). Z-score measures risks that reflect the probability of bank bankruptcy. For this purpose, bank bankruptcy is generally defined as a state where ($EQTA + ROA$) ≥ 0, where EQTA is the ratio of equity to assets, and ROA is the return on assets. The Z-score calculation is as follows:

$$\text{Z-score} \equiv \frac{EQTA + \mu ROA}{\sigma ROA} > 0.$$

The above equation illustrates that, the higher the Z-score, the lower the risk-taking behavior of the banking sector will be. Meanwhile, lower Z-score reflects increased risk-taking behavior among banks. Considering the availability of data and the abundance of literatures using the Z-score, this study will utilize the Z-score as an indicator of bank risk-taking. However, there is yet to be a consensus on the best way to calculate the Z-score. In terms of its element's approach, we would need to decide whether to use a rolling time window or the entire sample period. As for the element combinations, we would need to decide whether to use a rolling average ROA (μ_{ROA}) or current values ROA (ROA_t). Furthermore, there needs to be a consensus on the best rolling period. The availability of these various options results in different Z-score values (Li et al. (2017)). Lepetit and Strobel (2013) suggest that, for Indonesian cases, to calculate the time-varying banking Z-score, the estimated standard deviation of ROA calculated over the full sample should be utilized in combination with the current value of the equity to asset ratio ($EQTA_t$) and return on assets (ROA_t).

Thus, this research will apply the Z-score calculation performed by utilizing the estimated standard deviation of ROA calculated over the full sample as suggested by Lepetit and Strobel (Z- score1), as well as the calculation of the ROA standard deviation for rolling 16 quarters (Z-score2) and rolling 12 quarters

(Z-score3). The Z-score correlation analysis utilizing the rolling average *ROA* and ROA_t shows a strong correlation. Thus, this study only applies the ROA_t position (current time) for Z-score calculation.

The variables of interest in this study are monetary policy and macroprudential policy. The monetary policy's proxy in this study is interest rate because it is the main instrument of Indonesia's monetary policy. In addition, various studies that are related to monetary policy in Indonesia use interest rate as a proxy for monetary policy, including Naiborhu (2020) and Wijayanti et al. (2020). However, dissimilar to the two studies mentioned, the interest rate utilized in this study is the real 1-day interbank rate. The reasons underlying the use of this interest rate are: i) interbank interest rate is the operational interest rate of the banking sector; ii) interbank rate is the operational target of monetary policy; and iii) according to Mishkin (2004), deciding real interest rate is the most important economic decision.

From the perspective of macroprudential policy proxies, this study will utilize a macroprudential index (MPI). The index comprises macroprudential policies stipulated by Bank Indonesia. The macroprudential policy instrument used in calculating the MPI is the Macroprudential Intermediation Ratio (RIM) and Loan to Value (LTV) ratio. Unlike the other policies, CCB has stayed the same, while PLM is a new policy implemented in 2018. Following the method of Paligorova and Santos (2017) and Naiborhu (2020), one variable will be used for each of the macroprudential policy instrument variables: LDR/LFR/RIM and LTV. Each variable gets a value of 1 during periods of tightening, -1 during periods of easing, and 0 for any other periods (Figure 2). The period of tightening and easing of each macroprudential instrument is summarized in Table A.1 in the Appendix.

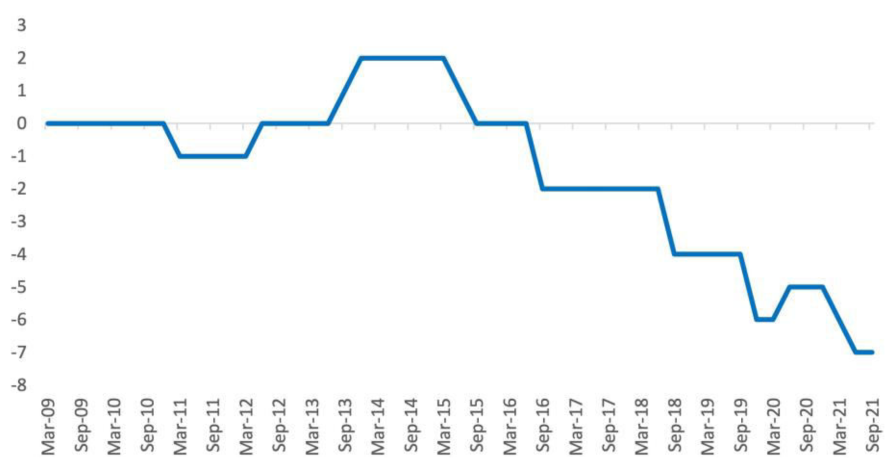

Figure 2. Macroprudential Index for Indonesia.

Source: Authors' calculation.

The bank characteristics and macroeconomic control variables utilized in this study are commonly used in research on bank risk-taking. For bank characteristics, the variables include the size of banking assets (ln *assets*), level of capital (*EQTA*), and liquidity (Loan to Deposit Ratio/LDR). Meanwhile, the macroeconomic control variables are economic growth (GDP) and the growth of average stock index (stocks) (see: Altunbas et al. (2014), Nguyen and Boateng (2015), Maddaloni and Peydrő (2013), and Jiang et al. (2019)). We obtain the interest rate and macroeconomic data from CEIC and International Financial Statistic (IFS) data from IMF, while the Z-score calculation data and individual characteristics of banks are acquired from the Commercial Bank Monthly Reports (LBU) reported by the banks to Bank Indonesia (BI) (Table A.3 in the Appendix)

3.2 Methodology

Generally, previous empirical research insert the lag variable of bank risk-taking into the regressor variables (dynamic panel), which is required because with high risk-taking behavior in the past are more likely to have increased risk-taking in the future. In other words, it is persistent. This study applies dynamic balanced panel data and adopt the estimation models from Jiang et al. (2019). In addition, following the footsteps of the previous literatures, such as Naiborhu (2020) and Andrieş and Pleşcău (2020), to address the possibility of an endogeneity problem when examining bank risk-taking and monetary policy, macroprudential policy, macroeconomic indicators, and bank characteristics, this study utilizes lag values for all interest and control variables.

To that end, we build a dynamic panel estimation model with three specifications. The first model is a baseline model that analyzes the effect of monetary policy on bank risk-taking:

$$\text{Z-score}_{i,t,q} = C + \beta_1 \text{Z-score}_{i,t,q-1} + \beta_2 rib_{t,q-1} + \beta_3 \ln(asset)_{i,t,q-1} + \beta_4 eqta_{i,t,q-1} + \beta_5 ldr_{i,t,q-1} + \ldots$$
$$\beta_6 grgdp_{i,t,q-1} + \beta_7 stock_{t,q-1} + \epsilon_{i,t,q}. \quad (1)$$

The second model, the extended baseline model, analyzes the effect of monetary policy and macro prudential policy on bank risk-taking:

$$\text{Z-score}_{i,t,q} = C + \beta_1 \text{Z-score}_{i,t,q-1} + \beta_2 rib_{t,q-1} + \beta_3 \ln(asset)_{i,t,q-1} + \beta_4 eqta_{i,t,q-1} + \beta_5 ldr_{i,t,q-1} + \ldots$$
$$\beta_6 grgdp_{i,t,q-1} + \beta_7 stock_{t,q-1} + \beta_8 mpi_{t,q-1} + \epsilon_{i,t,q}. \quad (2)$$

The third model, the second extended baseline model, analyzes the effect of monetary policy, macroprudential policy and the interaction between the two policies on bank risk-taking:

$$\text{Z-score}_{i,t,q} = C + \beta_1 \text{Z-score}_{i,t,q-1} + \beta_2 rib_{t,q-1} + \beta_3 \ln(asset)_{i,t,q-1} + \beta_4 eqta_{i,t,q-1} + \beta_5 ldr_{i,t,q-1} + \dots$$
$$\beta_6 grgdp_{i,t,q-1} + \beta_7 stock_{t,q-1} + \beta_8 mpi_{t,q-1} + \beta_9 rib_{t,q-1} \times mpi_{t,q-1} + \epsilon_{i,t,q}, \quad (3)$$

where $\text{Z-score}_{i,t,q}$ is the Z-score for bank i in year t and quarter q, and $\text{Z-score}_{i,t,q-1}$ is the Z-score for bank i in year t and previous quarter $q-1$. The two policy variables, $rib_{t,q-1}$ and $mpi_{t,q-1}$, represent the 1-day real interbank money market interest rate, and macroprudential indices year t and previous quarter $q - 1$. In terms of the individual characteristics of banks, total assets in natural logarithms, the ratio of equity to total assets and the ratio of credit to deposit for bank i, year t and previous quarter $q - 1$ are represented by $\ln(asset)_{i,t,q-1}$, $eqta_{i,t,q-1}$ and $ldr_{i,t,q-1}$, respectively. As for macroeconomy variables, real GDP growth (qtq) and average stock index growth (qtq) for year t and previous quarter $q-1$ are represented by $grgdp_{i,t,q-1}$ and $stock_{i,t,q-1}$, respectively.

In estimating the dynamic panels above, we acknowledge a potential endogeneity problem, which may cause inconsistency in the estimation method utilizing OLS and fixed effect estimation. Therefore, in the initial process, the estimation will use the first difference GMM introduced by Arellano and Bond (1991). However, the first difference GMM has some weaknesses. In dynamic panel data models where the autoregressive parameter values are pretty large and the number of time series observations is relatively small, the first difference GMM estimator may contain bias in limited samples, and this occurs when the instrument in the form of a lagged level in the first difference equation is a weak instrument, which in turn can cause the estimation results to face a downward bias. Blundell and Bond (1998) developed a System GMM estimator to provide greater efficiency than the first difference GMM. In addition, the System GMM estimator reduces potential bias in finite samples and the asymptotic imprecision associated with differentiable estimators.

In the GMM estimation method, several tests and assumptions must be performed and fulfilled so as to acquire valid estimation results. The tests are the Arellano Bond test and instrument test. The GMM method assumes that the error term does not contain autocorrelation. This assumption is critical in GMM because it utilizes lag as an instrument variable. Another important assumption regarding the validity of GMM that must be fulfilled is the assumption that the variables of the instrument are exogenous. To test the validity of the instruments utilized in estimating GMM, the Hansen Test is used. However, the Hansen test is prone to weakness because this test gets weaker with more moment conditions (Roodman (2009)). In addition, Roodman (2009) states that one of the downsides of the first difference GMM and System GMM is that they are complicated. Hence, GMM can easily produce invalid estimates.

Roodman (2009) and Bond (2002) state that this dynamic bias would be smaller if the research object utilize a long observation period. This study utilizes a long time series of observations with quarterly data collected over a period from the first quarter of 2009 to the third quarter of 2021. Therefore, the fixed effect is a better estimator in cases where the coefficient of the dependent lag variable estimated by the first difference GMM and System GMM is outside of the range of the OLS estimate and the fixed effect (Roodman (2009)). If the dependent lag estimation results in this study are outside of the range of the OLS estimation results and the fixed effect and cannot fulfill the assumptions of the GMM method, the estimation will utilize the fixed effect.

From the estimation results acquired utilizing the first difference GMM and System GMM on the three models for Z-score1, Z-score2 and Z-score3, we find that no estimation results are able to fulfill the specification test, and the dependent lag of the estimation results is within the range of the OLS and the fixed effect estimation results. Estimation results generally cannot fulfill the assumptions of exogenous instrument variables through the Hansen test. Therefore, the fixed effect model (FEM) is a better estimator.

IV. Empirical Results and Discussions

We will divide the estimation results and discussion into four parts. The first part is the first model estimation results, which uses the regression model in equation (2) as the baseline model. The second part is the model estimation results in equation (3) that incorporate macroprudential policies. The third part is the model estimation results in equation (3) that incorporate the interaction between monetary and macroprudential policies, while the last part will discuss the differences in the estimation results that utilize various Z-scores.

4.1 Baseline Model

The estimation results of the baseline model utilizing the FEM and the bank risk-taking proxied by Z-score1, as presented in Table 1 column 2, show that the 1-day real PUAB interest rate has a significant positive effect on Z-score1, namely declining bank risk-taking due to increasing interest rate. Meanwhile, the results of FEM that utilizes time effect show significant positive results with a larger coefficient value (Table 1 column 3). The estimation results utilizing the quarterly effect FEM to capture specified quarterly shocks, and the annual effect FEM to capture yearly specified shocks, as seen in Table 1 columns 4–5, show consistent results. This empirical evidences prove the existence of a risk-taking channel in the transmission of Indonesia's monetary policy as Borio and Zhu (2008) have stated.

The individual characteristics of banks affect bank risk-taking. The capital level of a bank has a significant positive effect on Z-score1 in all FEM estimation results, indicating that the higher the level of capital a bank has, the less risk-taking behavior it will display. This finding is in line with the results of Altunbas et al. (2014) and Jiang et al. (2019). Banks with higher capital in Indonesia are generally more prudent in lending and have better efficiency, as reflected by a better non-performing loan (NPL) ratio of operating cost on operating income (BOPO). Regarding bank asset size, the estimation results show that the bigger the bank, the lower its risk-taking will be. However, FEM is not significant when utilizing time effect. Government-owned banks and banks listed on the stock exchange generally comprise banks with high capital. This group of banks is generally more transparent, and is supervised by public and government institutions (on top of the financial services authority). In addition, banks with high assets also have better risk management and efficiency levels. In terms of liquidity, the estimation results show that the effect of LDR on Z-score1 has a significant negative relationship, namely banks with high LDR or low liquidity generally have high risk-taking behavizor. If we consider the LDR as a liquidity calculation, it is assumed that LDR calculates funds from depositors that are not channeled to debtors as credit. Meanwhile, banking funds can be obtained from sources such as issued securities, interbank loans, bank-owned capital and other sources. Therefore, LDR has a negative influence on Z-score. Banks that are aggressive in extending credit have high LDR, and therefore high risk-taking.

Regarding the macroeconomic control variables, the estimation results show that the better the economic growth, the lower the bank risk-taking will (besides, FEM is not significant when utilizing the time effect)– or, the better the economic growth, the lower the banking risk-taking, which is in line with Gambacorta (2009). In his research, Gambacorta finds that better economic condition (high GDP) means more profitable investments, thereby reducing bank credit risk. Similarly, in Indonesia, where economic growth is high, banking ROA is high, while NPLs are low. However, when the economy declines, banking ROA will drop, while banking NPLs will rise. Whenever both ROA and bank equity rise due to improving economy, the Z-score will also rise. Another macroeconomic control variable is the growth of the average stock index (qtq), which has a significant negative effect on bank risk-taking (besides, FEM is not significant when utilizing the time effect). The estimation results align with the research by Nguyen and Boateng (2015). Asset prices, which in this case are proxied by stock indexes, can amplify bank risk-taking behavior. An increase in asset prices will increase the value of the collateral and reduce credit risk, thus encourage bank risk-taking

	Model 1				Model 2				Model 3			
	FEM	Time Effect	Quarterly Effect	Year Effect	FEM	Time Effect	Quarterly Effect	Year Effect	FEM	Time Effect	Quarterly Effect	Year Effect
L.zscore1	0.828***	0.817***	0.831***	0.813***	0.828***	0.817***	0.831***	0.812***	0.828***	0.817***	0.831***	0.812***
	-0.027	-0.028	-0.026	-0.028	-0.027	-0.028	-0.026	-0.028	-0.027	-0.028	-0.026	-0.028
L.lnasset	0.136*	-0.183	0.151*	-0.134	0.218**	-0.183	0.212**	-0.142	0.243**	-0.183	0.242**	-0.154
	-0.076	-0.165	-0.077	-0.174	-0.094	-0.165	-0.093	-0.172	-0.099	-0.165	-0.098	-0.17
L.eqta	0.043**	0.041**	0.042**	0.044**	0.046***	0.041**	0.044***	0.044**	0.046***	0.041**	0.045***	0.044**
	-0.016	-0.017	-0.016	-0.017	-0.016	-0.017	-0.016	-0.017	-0.016	-0.017	-0.016	-0.017
L.ldr	-0.012***	-0.012***	-0.013***	-0.012***	-0.013***	-0.012***	-0.013***	-0.012***	-0.012***	-0.012***	-0.013***	-0.011***
	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003

L.grgdp	0.095***	-0.055	0.064**	0.075**	0.086***	-0.061	0.058**	0.070**	0.081***	0.059	0.050*	0.066**
	-0.03	-0.153	-0.028	-0.033	-0.03	-0.248	-0.027	-0.032	-0.03	-0.052	-0.027	-0.033
L.gstock	-0.025***	-0.011	-0.021***	-0.023***	-0.026***	-0.012	-0.021***	-0.021***	-0.026***	-0.002	-0.022***	-0.021***
	-0.005	-0.016	-0.005	-0.006	-0.005	-0.018	-0.005	-0.006	-0.005	-0.018	-0.005	-0.006
L.rib	0.099***	0.683**	0.076***	0.101***	0.126***	0.752	0.096***	0.077**	0.127***	-0.243	0.097***	0.064*
	-0.024	-0.332	-0.023	-0.036	-0.026	-1.085	-0.025	-0.036	-0.026	-1.002	-0.025	-0.037
L.mpi					0.044**	0.013	0.033*	-0.118	0.015	0.047	-0.001	-0.196**
					-0.019	-0.221	-0.019	-0.077	-0.02	-0.287	-0.019	-0.089
L.rib.L.mpi									0.025**	-0.155	0.029**	0.048**
									-0.012	-0.312	-0.011	-0.018
Constant	3.179***	3.619***	3.226***	3.890***	3.000***	3.609***	3.091***	3.917***	2.935***	3.708***	3.040***	3.945***
	-0.38	-0.563	-0.389	-0.49	-0.405	-0.536	-0.412	-0.488	-0.418	-0.577	-0.424	-0.488
Observations	3,950	3,950	3,950	3,950	3,950	3,950	3,950	3,950	3,950	3,950	3,950	3,950
Number of banks	79	79	79	79	79	79	79	79	79	79	79	79
R-squared	0.776	0.788	0.779	0.779	0.777	0.788	0.779	0.779	0.777	0.788	0.779	0.78

Table 1. The Estimation Results of the Fixed Effect Model (FEM) and Bank Risk-Taking that Utilizes Z-score
Note: standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.2 Model 2

The estimation results of model 2, which utilizes the FEM model and the dependent variable Z-score1, show that macroprudential policies effectively influence bank risk-taking (Table 1, columns 6 and 8). While the results of the estimation that utilizes time effect FEM and year effect FEM do not show significance (Table 2, columns 7 and 9), indicating that the tightening of macroprudential policies will result in increased Z-score, or reduced bank risk-taking. Meanwhile, the loosening of macroprudential policies will result in declining Z score, or increased bank risk-taking. These empirical evidences prove the effectiveness of macroprudential policies in influencing bank risk-taking behavior. The macroprudential policy represented through a macroprudential index can prevent risk accumulation and mitigate the risk of outbreaks from financial system interconnections.

In terms of bank characteristics, adding the macroprudential index variable to the model does not change the direction and significance of the influence of capital level, bank size and LDR on bank risk-taking. The same thing applies for macroeconomic control variables, GDP growth (qtq) and average stock index growth (qtq).

4.3 Model 3

The estimation results for model 3 show that the coordination/policy mix represented by the interaction variable between the 1-day real PUAB interest rate and the macroprudential index has a positive and significant effect on the Z-score1 (Table 1, columns 10, 12, and 13). The finding indicates that rising interest rate and tightening macroprudential policies boost bank Z-score or, in other words, lessen bank risk-taking. Meanwhile, dropping interest rate and loosening macroprudential policies will result in reduced bank Z-score or increased bank risk-taking. These empirical evidences show that, if the two policies are implemented simultaneously, they can effectively influence bank risk-taking. This finding is in line with the results of a study by Jiang et al. (2019), who obtained empirical evidences suggesting that monetary policy and macroprudential policy mutually support each other in influencing bank risk-taking in China. The estimation results are also in line with the view of Agénor et al. (2014), which states that monetary and macroprudential policies can achieve the desired goals if the two policies are implemented in the same direction. In line with Model 1 (baseline) and Model 2, the addition of the 1-day real PUAB interest rate interaction variable and the macroprudential index to the model does not change the direction and significance of bank characteristics and macroeconomic control. However, adding this variable changes the significance of the macroprudential index, and for the year effect, FEM changes the significance and direction.

V. Robustness Check and Sensitivity Analysis

We estimate the three models using different estimation methods and different Z-scores to check whether our estimation is robust in terms of Z-score measurement (Table A.4-A.6 in the Appendix). We find that the FEM estimation results with Z-score2 and Z-score3 are generally insignificant in explaining the effect of interest and control variables on bank risk-taking. The interest variables, monetary policy, macroprudential policy, and the interaction between both policies, as well as the control variables for economic growth (qtq) and average stock growth (qtq), do not significantly affect Z-score2 and Z-score3. This condition is affected by the high standard deviation of Z-score2 and Z-score3. The data distribution of Z-score2 and Z-score 3 is larger than Z-score 1. The Z-score2 and Z-score3 formulas have advantages in capturing changes in bank risk profiles, strategies, and loan patterns. However, the calculation of Z-score2 and Zscore 3 causes less stable Z-score values and reduces the observation period. In addition, the estimation with Z-score2 and Z-score3 shows that, in general, the result is robust against various variations of variables used in the estimation. Meanwhile, if we compare the results of the FEM estimation with FD-GMM, the direction of the coefficient of the interest variable generally shows consistent results. In addition, the estimation results with FEM have a higher significance and coefficient value than FD-GMM. For several interest variables, the ratio of equity to assets, bank size, and macroprudential policies have significant coefficient values in FEM compared to FD-GMM. However, the estimation results utilizing the FD-GMM indicate that the important assumptions regarding the validity of GMM are not fulfilled. The instrument variables are exogenous, and are reflected in the probability of the Hansen test results of below 0.1.

The estimation results utilizing the GMM System show that, generally, the direction and coefficient significance of both the interest and control variables are in line with FEM. However, the estimation results generated by the GMM System are indicated to be biased, as reflected in the lag value of the dependent variable of the GMM System being outside the range of the dependent lag estimated by OLS and FEM. The results of the Hansen test also show indications of non-fulfillment of exogenous instrument variables.

VI. Concluding Remarks

Based on the results of the analysis and discussion above, we conclude that the monetary policy in Indonesia, which is represented by 1-day real interbank interest rate, influences bank risk-taking. The empirical results provide evidences of the existence of a risk-taking channel transmission in the country's monetary policy transmission. Meanwhile, individual characteristics of banks influence bank risk-taking behavior. The smaller the bank, the higher the risk-taking behavior will be. Meanwhile, banks with low capital level tend to have a high risk-taking behavior. We also find that the macroprudential policy, which is represented by the macroprudential index, affects bank risk-taking, and the tightening of macroprudential policy reduces bank risk-taking. The mix/coordination represented by the interaction variable between the 1-day real interbank interest rate and the macroprudential index variable influences bank risk-taking. Empirical evidences show that if the two policies are implemented simultaneously, they can influence bank risk-taking. Considering that monetary policy, macroprudential policy and the interaction between the two policies influence risk-taking behavior, the authorities may use one of the policies and a combination of the two policies to influence bank risk-taking. In addition, the authorities need to consider the impact of policies on bank risk-taking in formulating monetary and macroprudential policies.

Aside from the empirical findings, our study finds the importance of selecting the Z-score variable calculation formula as a proxy for bank risk-taking. The calculation of the Z-score utilizing a combination of the standard deviation of ROA for all observation time samples with the ratio of equity to total assets and ROA for the current time is better than the Z-score utilizing therolling standard deviation in explaining bank risk-taking in Indonesia. This finding is also in line with the study by Lepetit and Strobel (2013) that provide recommendations related to the calculation the Z-score for Indonesian banking.

Our study comes with several caveats, specifically regarding the assumptions, usage of variables, and model specifications. The model assumes that monetary policy is only based on interest rate, and other monetary policies, such as the reserve requirements, are not included. We also assume that macroprudential policies only cover loans to value (LTV) and macroprudential intermediation ratios (RIM). Meanwhile, other macroprudential policies, such as the macroprudential liquidity buffer (PLM), are not included due to the implementation time. Furthermore, the estimation model has yet to capture how the effect of the policy mix/coordination in the presence of tight macroprudential policies interact with loose monetary policies on bank risk-taking. In other words, this model needs to explain whether the effect of low-interest rate policy on bank risk-taking can be reduced by implementing the tightening of macroprudential policies.

Reference

Age´nor, P. R., K. Alper, and L. A. P. Da Silva (2014): "Sudden Floods, Macroprudential Regulation and Stability in An Open Economy," *Journal of International Money and Finance*, 48, 68–100.

Altunbas, Y., L.Gambacorta, and D. Marques-Ibanez (2014): "Does Monetary Policy Affect Bank Risk?" *International Journal of Central Banking*, 10, 95–136.

Andrie¸s, A. M., F. Melnic, and S. Nistor (2018): "Effects of Macroprudential Policy on Systemic Risk and Bank Risk Taking," *Czech Journal of Economics and Finance*, 68, 202–244.

Andrie¸s, A. M., I. Ple¸scaˇu (2020): "the Risk-Taking Channel of Monetary Policy: Do Macroprudential Regulation and Central Bank Independence Influence the Transmission of Interest Rates?" *Romanian Journal for Economic Forecasting*, 23.

Arellano, M., S. Bond (1991): "Some Tests of Specification For Panel Data: Monte Carlo Evidence and an Application To Employment Equations," *The Review of Economic Studies*, 58, 277–297.

Blundell, R. and S. Bond (1998): "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models*," Journal of Econometrics*, 87, 115–143.

Bond, S. R. (2002): "Dynamic Panel Data Models: A Guide To Micro Data Methods and Practice," *Portuguese Economic Journal*, 1, 141–162.

Borio, C. and H. Zhu (2008): "Capital Regulation, Risk-Taking and Monetary Policy: A Missing Link In the Transmission Mechanism?" *Bank for International Settlements Working Papers*, 24– 25.

Caruana, J. (2010): "Macroprudential Policy: Working Towards A New Consensus. Speech Delivered At the High-Level Meeting on the Emerging Framework For Financial Regulation and Monetary Policy Jointly Organised by the Biss Financial Stability Institute and the IMF Institute Washington DC," *Bank for International Settlements, Basel, Switzerland.*

Claessens, S. (2013): "Interactions Between Monetary and Macroprudential Policies In An Interconnected World," in *Bank of Thailand-IMF Conference on Monetary Policy in An Interconnected World, Bangkok*, Vol. 31.

Delis, M. D. and G. P. Kouretas (2011): "Interest Rates and Bank Risk-Taking," *Journal of Banking & Finance*, 35, 840–855.

Dewati, W. (2017): "Interaksi Kebijakan Moneter Dan Makroprudensial, Studi Kasus: Giro Wajib Minimum (GWM) dan Loan To Value (LTV) di Indonesia," Ph.D. thesis, Universitas Gadjah Mada.

Galati, G. and R. Moessner (2013): "Macroprudential Policy–A Literature Review," *Journal of Economic Surveys*, 27, 846–878.

Gambacorta, L. (2009): "Monetary Policy and the Risk-Taking Channel," *BIS Quarterly Review December*.

Huey, T. T., D. C. S. Li, et al. (2016): "Measuring Bank Risk-Taking Behaviour: the Risk-Taking Channel of Monetary Policy In Malaysia," Tech. Rep., Bank For International Settlements.

International Monetary Fund (2013): "the Interaction of Monetary and Macroprudential Policies," *IMF Policy Papers.*

Jiang, Y., C. Li, J. Zhang, and X. Zhou (2019): "Financial Stability and Sustainability Under the Coordination of Monetary Policy and Macroprudential Policy: New Evidence from China," *Sustainability*, 11.

Lee, M., R. C. Asuncion, and J. Kim (2016): "Effectiveness of Macroprudential Policies in Developing Asia: an Empirical Analysis," Emerging Markets Finance and Trade, 52, 923–937.

Lepetit, L. and F. Strobel (2013): "Bank Insolvency Risk and Time-Varying Z-Score Measures," *Journal of International Financial Markets, Institutions and Money*, 25, 73–87

Li, X., D. W. Tripe, and C. B. Malone (2017):"Measuring Bank Risk: an Exploration of Z-Score," Available at ssrn: https://ssrn.com/Abstract=2823946 or http://dx.doi.org/10.2139/ssrn.2823946.

Maddaloni, A. and J. L. Peydro´ (2013): "Monetary Policy, Macroprudential Policy and Banking Stability: Evidence from the Euro Area," *International Journal of Central Banking*, 9, 121– 169.

Mishkin, F. S. (2004): *The Economics of Money, Banking, and Financial Markets*, the Addison-Wesley series in Economics.

Montes, G. C. and G. B. T. Peixoto (2014): "Risk-Taking Channel, Bank Lending Channel and the "Paradox of Credibility": Evidence from Brazil," *Economic Modelling*, 39, 82–94.

Naiborhu, E. D. (2020): "The Lending Channel of Monetary Policy In Indonesia," *Journal of Asian Economics,* 67.

Neuenkirch, M. and M. No¨ckel (2018): "The Risk-Taking Channel of Monetary Policy Transmission in the Euro Area," Journal of Banking & Finance, 93, 71–91.

Nguyen, V. H. T. and A. Boateng (2015): "An Analysis of Involuntary Excess Reserves, Monetary Policy and Risk-Taking Behaviour of Chinese Banks," *International Review of Financial Analysis*, 37, 63–72.

Nier, E. W. and H. Kang (2016): "Monetary and Macroprudential Policies–Exploring Interactions," Bank for International Settlements Paper.

Paligorova, T. and J. A. Santos (2017): "Monetary Policy and Bank Risk-Taking: Evidence from the Corporate Loan Market," *Journal of Financial Intermediation,* 30, 35–49.

Roodman, D. (2009): "How to Do Xtabond2: An Introduction To Difference and System GMM in Stata," *The stata Journal*, 9, 86–136.

Sarkar, S. and R. Sensarma (2019): "Risk-Taking Channel of Monetary Policy: Evidence from Indian Banking," *Margin: the Journal of Applied Economic Research*, 13, 1–20.

Satria, D. and S. M. Juhro (2011): "Risk Behavior in the Transmission Mechanism of Monetary Policy in Indonesia," *Buletin Ekonomi Moneter dan Perbankan*, 13, 243–270.

Warjiyo, P. and S. M. Juhro (2016): "Kebijakan Bank Sentral: Teori Dan Praktik," Rajawali Grafindo.

Wijayanti, R., N. M. A. P, and C. A. Harun (2020): "Effectiveness of Macroprudential Policies and their Interaction With Monetary Policy In Indonesia," BIS Paper No 110.

Zhang, X., F. Li, Z. Li, and Y. Xu (2018): "Macroprudential Policy, Credit Cycle, and Bank Risk-Taking," *Sustainability*, 10

Table **A.1**:
Macroprudential Policy Tightening and Easing Period.

Time	Instrument	Nature	Description
Mar-11	LDR	Easing	Implementation of Loan to Deposit Ratio (LDR) of 78%-100%
Jun-12	LTV	Tightening	Implementation of 70% LTV (only for housing credit (KPR) type $70m^2$, excluding shophouses and home offices)
Sep-13	LTV	Tightening	LTV regulation adjustment performed by including shophouses and home offices in the regulation. The regulation is also applicable to type $22\text{-}70m^2$ houses and houses $< 21m^2$.
Dec-13	LDR	Tightening	A change in LDR target range to 78%-92%
Jun-15	LTV	Easing	An increase in the KP-LTV ratio for banks with a total gross Non-Performing-Loan (NPL) ratio ¡ 5% and a gross property NPL ratio ¡ 5%.
Aug-15	LFR	Easing	Expansion of the calculation from LDR to LFR (Loan to Funding Ratio), where the calculation of bank funding sources includes the securities issued by banks.
Aug-16	LFR	Easing	LFR target range is changed to 80%-92%
Aug-16	LTV	Easing	The KP-LTV ratio of all facilities for banks that meet NPL requirements is increased.
Jul-18	RIM	Easing	Expansion of the calculation from LFR to RIM (Macroprudential Intermediation Ratio) by considering a broader type of bank intermediation, including securities held (issued by non-financial companies), as the numerator.
Aug-18	LTV	Easing	For banks that meet the NPL requirements, the KP-LTV ratio for the first facility is not regulated and submitted to the bank while still maintaining the prudential principle. Meanwhile, relaxation is imposed on the second facility and so on.
Oct-19	RIM	Easing	RIM target range is changed to 84%-94%
Dec-19	RIM	Easing	The loan component received by the bank is added as a component of funding source in the calculation of RIM. Meanwhile, RIM's target range remains at 84%-94%.
Dec-19	LTV	Easing	Relaxation of the maximum LTV ratio limit for KP, which amounts to LTV ratio + 5% (for the second facility and so on), compared to the previous regulation that is applicable to banks that meet NPL requirements.
May-20	RIM	Tightening	The lower disincentive parameters and upper disincentive parameters implemented in the RIM regulation are adjusted to 0 (zero).
Mar-21	LTV	Easing	The LTV ratio limit for KPs, both environmentally friendly and non-environmentally friendly, is loosened. For banks that meet NPL requirements, the maximum LTV ratio limit is 100% for all types of property as well as all KP facilities.
May-21	RIM	Loosening	The scope of securities owned by banks in the RIM calculation formula is expanded by adding a new component, i.e. export notes.

Table **A.2**: Data and Definition of Indicators.

	Variable	Description	Period	Source
		Bank Risk-Taking		
Zscore	$\frac{\text{Return on Assets (ROA)} + \text{Equity to Asset Ratio (ETA)}}{\sigma_{ROA}}$		2004Q1-2021Q3	BI-LBU
Zscore1	σ_{ROA} over the full sample			
Zscore2	σ_{ROA} for rolling 16 quarters			
Zscore3	σ_{ROA} for rolling 12 quarters			
		Monetary Policy		
rib	1-day real interbank money market interest rate (1-day interbank money market interest rate-inflation)	A proxy for monetary policy	2008Q1-2021Q3	CEIC
		Macroprudential Policy		
mpi	Macroprudential Index	Measures the tightening and loosening of macroprudential policies	2008Q1-2021Q3	BI
		Control Variables: Bank Level (BC)		
lnasset	Logarithm of total assets	Utilized to measure bank size	2008Q1-2021Q3	BI-LBU
ldr	Credit to deposit ratio	Utilized to measure the resilience of bank liquidity	2008Q1-2021Q3	BI-LBU
eqta	Equity to asset ratio	Utilized to measure the resilience of bank capital	2008Q1-2021Q3	BI-LBU
		Control Variables: Macro Level (ME)		
grgdp	Real GDP growth qtq	Utilized to measure macroeconomic development	2008Q1-2021Q3	CEIC
gstock	The average growth of the qtq stock index	Measures the growth of asset prices	2008Q1-2021Q3	CEIC

Table **A.3**: Descriptive Statistics.

Variable	Description	Obs	Mean	Std. Dev.	Min	Max
zscore1	Utilizes standard deviation ROA over the full sample	4,029	18.68	11.06	1.20	80.24
zscore2	Utilizes standard deviation ROA for rolling 16 quarters	4,029	35.42	25.93	0.66	225.36
zscore3	Utilizes standard deviation ROA for rolling 12 quarters	4,029	41.36	32.37	0.60	288.50
rib	1-day real interbank money market interest rate (%)	4,029	0.82	1.60	-2.70	3.98
mpi	Macroprudential Index	4,029	-1.45	2.49	-7.00	2.00
asset	In trillion IDR	4,029	64	163.70	0.09	1,538.52
lnasset	Natural logarithm of the banks' assets	4,029	2.73	1.65	-2.40	7.34
eqta	Equity to Asset Ratio (%)	4,029	15.46	7.89	5.91	95.15
ldr	Loan to Deposit Ratio (%)	4,029	86.48	25.07	4.61	321.37
grgdp	Real GDP Growth qtq (%)	4,029	1.13	1.24	-6.87	3.37
gstock	The average growth of the qtq stock index (%)	4,029	3.39	8.39	-16.18	35.63

Table **A.4**:
Model 1 Estimation Results with Different Z-scores and Various Estimation Methods. Note: standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	Z-score1					Z-s ore2					Z-score3				
	FD GMM	PLS	FEM Effect)	FEM (Time	System GMM	FD GMM	PLS	FEM	FEM (Time Effect)	System GMM	FD GMM	PLS	FEM FEM	(Time Effect)	System GMM
L.zscore	0.851***	0.987***	0.828***	0.817***	0.749***	0.943***	0.955***	0.917***	0.917***	0.980***	0.928***	0.929***	0.889***	0.889***	0.963***
	(0.055)	(0.004)	(0.027)	(0.028)	(0.056)	(0.020)	(0.011)	(0.011)	(0.011)	(0.019)	(0.016)	(0.015)	(0.009)	(0.009)	(0.014)
L.lnasset	0.107	0.037	0.136*	-0.183	0.511***	0.665*	0.180*	0.931***	-0.171	0.082	0.867**	0.322**	1.196***	-0.020	0.164
	(0.085)	(0.027)	(0.076)	(0.165)	(0.184)	(0.345)	(0.107)	(0.273)	(0.666)	(0.129)	(0.367)	(0.161)	(0.335)	(0.742)	(0.133)
L.eqta	0.024	-0.033***	0.043**	0.041**	0.081**	-0.093***	-0.020	-0.086***	-0.118***	-0.057***	-0.054	0.015	-0.056**	-0.093**	-0.026
	(0.033)	(0.008)	(0.016)	(0.017)	(0.033)	(0.028)	(0.015)	(0.023)	(0.039)	(0.019)	(0.033)	(0.025)	(0.026)	(0.038)	(0.024)
L.ldr	-0.012***	-0.005***	-0.012***	-0.012***	-0.013*	-0.018***	-0.008**	-0.020**	-0.017**	-0.011*	-0.017	-0.007	-0.014	-0.011	-0.011
	(0.003)	(0.002)	(0.003)	(0.003)	(0.007)	(0.007)	(0.004)	(0.008)	(0.007)	(0.006)	(0.011)	(0.007)	(0.011)	(0.010)	(0.008)
L.grgdp	0.093**	0.088***	0.095***	-0.055	0.099***	0.187	0.203*	0.196	-0.305	0.187	0.277	0.319*	0.302*	-1.228	0.265
	(0.036)	(0.029)	(0.030)	(0.153)	(0.036)	(0.123)	(0.117)	(0.122)	(0.421)	(0.126)	(0.185)	(0.171)	(0.181)	(0.800)	(0.191)
L.gstock	-0.022***	-0.019***	-0.025***	-0.011	-0.013*	-0.012	-0.018	-0.014	-0.053	-0.013	-0.025	-0.033	-0.026	-0.084	-0.026
	(0.005)	(0.005)	(0.005)	(0.016)	(0.008)	(0.016)	(0.018)	(0.017)	(0.033)	(0.016)	(0.020)	(0.021)	(0.021)	(0.051)	(0.018)
L.rib	0.094***	0.067***	0.099***	0.683**	0.073**	-0.028	-0.078	-0.020	1.787	-0.080	0.035	0.007	0.036	2.567	0.004
	(0.024)	(0.022)	(0.024)	(0.332)	(0.030)	(0.096)	(0.090)	(0.095)	(1.204)	(0.092)	(0.119)	(0.138)	(0.136)	(1.629)	(0.114)
Constant		1.018***	3.179***	3.619***	2.725***		2.365***	3.601***	5.748***	2.450***		2.548***	3.425**	6.009***	2.448***
		(0.171)	(0.380)	(0.563)	(0.853)		(0.489)	(1.237)	(1.653)	(0.774)		(0.744)	(1.393)	(1.974)	(0.774)
Observations	3,871	3,950	3,950	3,950	3,950	3,871	3,950	3,950	3,950	3,950	3,871	3,950	3,950	3,950	3,950
Number of Banks	79		79	79	79	79		79	79	79	79		79	79	79
Number of Instruments	55				57	55				57	55				57
AR(2)	0.712				0.645	0.179				0.188	0.046				0.047
Prob Hansen Test	0.043				0.049	0.081				0.089	0.098				0.079
R-squared		0.959	0.776	0.788			0.898	0.837	0.843			0.861	0.794	0.802	

Table **A.5**:
Model 2 Estimation Results with Different Z-scores and Various Estimation Methods. Note: standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	Z-score1					Z-score2					Z-score3				
	FD GMM	PLS	FEM Effect)	FEM (Time	System GMM	FD GMM	PLS	FEM	FEM (Time Effect)	System GMM	FD GMM	PLS	FEM FEM	(Time Effect)	System GMM
L.zscore	0.852***	0.987***	0.828***	0.817***	0.729***	0.955***	0.955***	0.917***	0.917***	0.980***	0.938***	0.929***	0.889***	0.889***	0.963***
	(0.055)	(0.004)	(0.027)	(0.028)	(0.063)	(0.017)	(0.011)	(0.011)	(0.011)	(0.014)	(0.015)	(0.015)	(0.009)	(0.009)	(0.014)
L.lnasset	0.150	0.052*	0.218**	-0.183	0.539**	0.579	0.184*	0.989***	-0.171	0.083	0.553	0.327**	1.278***	-0.020	0.157
	(0.100)	(0.027)	(0.094)	(0.165)	(0.218)	(0.367)	(0.108)	(0.340)	(0.666)	(0.117)	(0.462)	(0.166)	(0.432)	(0.742)	(0.135)
L.eqta	0.026	-0.031***	0.046***	0.041**	0.093**	-0.094***	-0.020	-0.083***	-0.118***	-0.057***	-0.069*	0.015	-0.053*	-0.093**	-0.026
	(0.031)	(0.008)	(0.016)	(0.017)	(0.039)	(0.031)	(0.015)	(0.024)	(0.039)	(0.019)	(0.038)	(0.025)	(0.027)	(0.038)	(0.025)
L.ldr	-0.012***	-0.005***	-0.013***	-0.012***	-0.012	-0.020***	-0.008**	-0.020**	-0.017**	-0.011*	-0.014	-0.007	-0.014	-0.011	-0.009
	(0.003)	(0.002)	(0.003)	(0.003)	(0.008)	(0.007)	(0.004)	(0.008)	(0.007)	(0.006)	(0.010)	(0.007)	(0.011)	(0.010)	(0.008)
L.grgdp	0.087**	0.078***	0.086***	-0.061	0.085**	0.174	0.200*	0.190	-0.427	0.181	0.259	0.315*	0.294	-1.577	0.274
	(0.035)	(0.029)	(0.030)	(0.248)	(0.037)	(0.128)	(0.118)	(0.122)	(0.677)	(0.128)	(0.180)	(0.174)	(0.183)	(1.349)	(0.190)
L.gstock	-0.023***	-0.022***	-0.026***	-0.012	-0.018**	-0.012	-0.019	-0.014	-0.062	-0.014	-0.023	-0.034	-0.027	-0.109*	-0.025
	(0.005)	(0.005)	(0.005)	(0.018)	(0.007)	(0.016)	(0.020)	(0.018)	(0.040)	(0.017)	(0.019)	(0.021)	(0.021)	(0.062)	(0.019)
L.rib	0.114***	0.106***	0.126***	0.752	0.128***	-0.034	-0.068	-0.001	3.099	-0.075	-0.046	0.021	0.063	6.339	-0.009
	(0.026)	(0.028)	(0.026)	(1.085)	(0.032)	(0.114)	(0.115)	(0.119)	(3.345)	(0.105)	(0.147)	(0.147)	(0.160)	(5.986)	(0.145)
L.mpi	0.029	0.053***	0.044**	0.013	0.072*	0.026	0.015	0.031	0.247	0.014	-0.092	0.019	0.044	0.709	-0.008
	(0.020)	(0.019)	(0.019)	(0.221)	(0.039)	(0.101)	(0.085)	(0.100)	(0.668)	(0.078)	(0.144)	(0.112)	(0.136)	(1.250)	(0.101)
Constant		1.017***	3.000***	3.609***	2.778***		2.363***	3.474***	5.557***	2.489***		2.546***	3.247**	5.460***	2.291***
		(0.171)	(0.405)	(0.536)	(0.891)		(0.490)	(1.267)	(1.686)	(0.753)		(0.745)	(1.438)	(1.802)	(0.766)
Observations	3,871	3,950	3,950	3,950	3,950	3,871	3,950	3,950	3,950	3,950	3,871	3,950	3,950	3,950	3,950
Number of Banks	79		79	79	79	79		79	79	79	79		79	79	79
Number of Instruments	56				58	56				58	56				58
AR(2)	0.724				0.693	0.180				0.189	0.045				0.047
Prob Hansen Test	0.068				0.080	0.072				0.086	0.162				0.085
R-squared		0.959	0.777	0.788			0.898	0.837	0.843			0.861	0.794	0.802	

Table **A.6**:

Model 3 Estimation Results with Different Z-scores and Various Estimation Methods. Note: standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	Z-score1					Z-score2					Z-score3				
	FD GMM	PLS	FEM Effect)	FEM (Time	System GMM	FD GMM	PLS	FEM	FEM (Time Effect)	System GMM	FD GMM	PLS	FEM FEM	(Time Effect)	System GMM
L.zscore	0.846***	0.987***	0.828***	0.817***	0.721***	0.955***	0.955***	0.917***	0.917***	0.981***	0.936***	0.929***	0.889***	0.889***	0.959***
	(0.056)	(0.004)	(0.027)	(0.028)	(0.064)	(0.016)	(0.011)	(0.011)	(0.011)	(0.015)	(0.015)	(0.015)	(0.009)	(0.009)	(0.013)
L.lnasset	0.176	0.055**	0.243**	-0.183	0.571**	0.605	0.184*	0.989***	-0.171	0.095	0.554	0.327**	1.258***	-0.020	0.188
	(0.108)	(0.027)	(0.099)	(0.165)	(0.224)	(0.388)	(0.107)	(0.356)	(0.666)	(0.117)	(0.452)	(0.164)	(0.441)	(0.742)	(0.135)
L.eqta	0.029	-0.031***	0.046***	0.041**	0.097**	-0.094***	-0.020	-0.083***	-0.118***	-0.055***	-0.071*	0.015	-0.053*	-0.093**	-0.025
	(0.032)	(0.008)	(0.016)	(0.017)	(0.041)	(0.032)	(0.015)	(0.025)	(0.039)	(0.021)	(0.037)	(0.025)	(0.027)	(0.038)	(0.025)
L.ldr	-0.011***	-0.005***	-0.012***	-0.012***	-0.012	-0.020***	-0.008**	-0.020**	-0.017**	-0.011**	-0.013	-0.007	-0.014	-0.011	-0.008
	(0.003)	(0.002)	(0.003)	(0.003)	(0.008)	(0.007)	(0.004)	(0.008)	(0.007)	(0.006)	(0.011)	(0.007)	(0.011)	(0.010)	(0.008)
L.grgdp	0.083**	0.072**	0.081***	0.059	0.079**	0.173	0.200*	0.190	0.249	0.179	0.261	0.316*	0.298	0.167	0.266
	(0.035)	(0.029)	(0.030)	(0.052)	(0.037)	(0.129)	(0.118)	(0.126)	(0.165)	(0.130)	(0.181)	(0.175)	(0.186)	(0.227)	(0.192)
L.gstock	-0.024***	-0.024***	-0.026***	-0.002	-0.020***	-0.014	-0.019	-0.014	-0.008	-0.017	-0.025	-0.034	-0.026	0.029	-0.028
	(0.005)	(0.005)	(0.005)	(0.018)	(0.007)	(0.017)	(0.020)	(0.018)	(0.046)	(0.017)	(0.019)	(0.022)	(0.021)	(0.082)	(0.020)
L.rib	0.115***	0.107***	0.127***	-0.243	0.130***	-0.033	-0.068	-0.001	-2.510	-0.069	-0.051	0.021	0.062	-8.140	-0.002
	(0.026)	(0.028)	(0.026)	(1.002)	(0.032)	(0.116)	(0.115)	(0.119)	(2.723)	(0.108)	(0.147)	(0.148)	(0.161)	(5.036)	(0.146)
L.mpi	0.003	0.012	0.015	0.047	0.028	0.006	0.012	0.031	0.439	-0.004	-0.165	0.028	0.070	1.206	-0.055
	(0.021)	(0.025)	(0.020)	(0.287)	(0.038)	(0.118)	(0.108)	(0.115)	(0.847)	(0.108)	(0.180)	(0.161)	(0.177)	(1.601)	(0.162)
L.rib.L.mpi	0.022*	0.031**	0.025**	-0.155	0.035***	0.015	0.002	0.000	-0.873	0.020	0.042	-0.007	-0.022	-2.254	0.034
	(0.012)	(0.013)	(0.012)	(0.312)	(0.013)	(0.064)	(0.056)	(0.064)	(0.855)	(0.061)	(0.085)	(0.084)	(0.094)	(1.641)	(0.088)
Constant		1.034***	2.935***	3.708***	2.816***		2.364***	3.474***	6.120***	2.477***		2.543***	3.305**	6.915***	2.315***
		(0.172)	(0.418)	(0.577)	(0.907)		(0.493)	(1.296)	(1.722)	(0.755)		(0.748)	(1.438)	(2.103)	(0.800)
Observations	3,871	3,950	3,950	3,950	3,950	3,871	3,950	3,950	3,950	3,950	3,871	3,950	3,950	3,950	3,950
Number of Banks	79		79	79	79	79		79	79	79	79		79	79	79
Number of Instruments	57				59	57				59	57				59
AR(2)	0.726				0.695	0.180				0.190	0.045				0.048
Prob Hansen Test	0.065				0.070	0.054				0.061	0.163				0.073
R-squared		0.959	0.777	0.788			0.898	0.837	0.843			0.861	0.794	0.802	

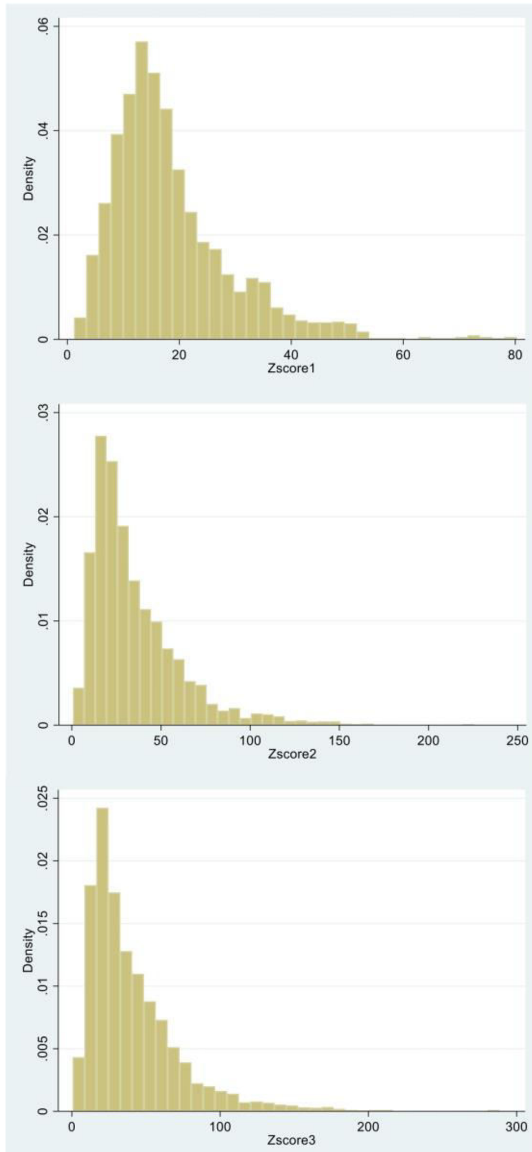

Figure **A.1**: Histogram of Various Z-score Calculations. Source: authors' calculations.