**Migration Letters**

Volume: 20, No: S7(2023), pp. 1160-1177

ISSN: 1741-8984 (Print) ISSN: 1741-8992 (Online)
www.migrationletters.com

# The Analysis of Efficiency for The Bank's Monetary Macroprudential Policy During and After the Covid-19 Outbreak Using the DSGE Model in Indonesia

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**Abstract**

*This research aims to develop a small-scale New Keynesian DSGE model from the relative performance of various monetary and macroprudential policy combinations when the Indonesian economy is affected by Covid-19 outbreak shocks and the projection after Covid-19 pandemic. Besides that, this study will also analyze the impulse-responses to orthogonalized shock in technology, inflation, domestic price, capital flow, and some policies related monetary and macroprudential policy shocks. This study uses the Bayesian Estimation method approach in estimating the DSGE Model in the Indonesian. The data used in this study is national economic and banking data in Indonesia in the period 2009.Q3 to 2022.Q4 using 16 variables and 5 macroprudential policy.*

*We found that the technological shock was the shock that most influenced the mix of monetary and macroprudential policy during the Covid-19 pandemic. On the other hand, capital flow management shocks do not have a significant impact on policy implementation. During the Covid-19 period, only a mixture of monetary policy with Capital Adequacy Ratio, Countercyclical Buffer, Macroprudential Intermediation Ratio, and Macroprudential Liquidity Buffer was able to maintain the stability of the financial system that was proven by improved relative well-being during the observation period. Meanwhile, the LTV ratio policy does not make a better contribution than simply using monetary policy (MP) alone in tackling the financial friction during the Covid-19 outbreak.*

***Keywords:*** *DSGE Model, Macroprudential Policy, Monetary Policy, Bayesian Estimation.*

## INTRODUCTION

The Covid-19 pandemic, which has been going on for about 3 years, had a significant impact on Indonesian real financial an economy activity and all countries in the world. There was a shock from the supply side which was very significant because of the impact of countries around the world implementing various kinds of restrictions on export-import activities as an effort to fulfill domestic needs as well as large-scale social restrictions which ultimately disrupted the supply chain cycle in the world. Meanwhile, from the demand side, households and companies have made sharp reductions in their consumption and investment expenditures to contain existing operating expenses due to declining income and increasing uncertainty. Responding to this situation, stakeholders and policy makers around the world have attempted various methods and strategies to

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achieve macroeconomic stability. Bank Indonesia as the central bank in Indonesia, for example, has formulated and implemented monetary policy instrument including lowering rate of interest, implementing macroprudential regulations, and intervening in exchange rates. Without any efforts being made, the economic downturn is unavoidable.

Despite the existence of various policy package options that have been formulated and can be used as alternative policies for Bank Indonesia, it is still unclear whether the policy mix can increase the stability of national economic conditions when compared to conventional policies that are often carried out by Bank Indonesia. Instead of supporting the monetary policies undertaken by Bank Indonesia in managing surges and uncertainties in the financial and business cycles, macroprudential policies (or predetermined policy interventions) can increase the intensity of these fluctuations.

During the 2008 financial crisis, the stability of the financial system became a concern. It was determined that existing macroeconomic policies were not adequate to forestall the occurrence of financial crises. During the global financial crisis that began in 2008, the banking industry did its part to cushion the blow of demand shocks while simultaneously contributing to an increase in supply shocks. After the Global Financial Crisis (GFC), the deployment of the framework provided Bank Indonesia with a reliable framework for accomplishing domestic policy objectives notwithstanding the volatility of capital flows. As Indonesia navigates the economic slowdown caused by the epidemic, the Integrated Policy Framework (ITF) is an essential instrument for the Bank ofIndonesia to assist the economy and preserve sustainable growth (Basu et al., 2020).

Considering the Covid-19 outbreak, this research investigates how various configurations of Indonesia's monetary policy and macroprudential regulations fared in the face of the Covid-19 outbreak in Indonesia economy. As a result of this, we build and estimate a dynamic stochastic general equilibrium (DSGE) model for a small open economy of medium size, subject to a wide variety of frictions and shocks, including banking and financial frictions, using real data from Indonesia economy. The model is intended for a small open economy of medium size. The academic field of new open economy macroeconomics, abbreviated as NOEM, has devoted a significant amount of attention to the issue of exchange rate pass-through, with a particular focus on models of dynamic stochastic general equilibrium, abbreviated as DSGE (Luo et al., 2021). Academic institutions as well as organizations concerned with policy, such as central banks, are discovering that DSGE models are useful instruments for doing policy analysis(Luo et al., 2021). Lucas (1976) criticism suggested that the likelihood of parameter stability of coefficients in conventional data-based econometrics decreases with the emergence of new policy regimes. The rise in popularity of these models may be traced back in part to an attempt to address the Lucas (1976) criticism. For example, forward- looking agents in a model have their current activities influenced by how they anticipatefuture policy shifts, and these shifts might influence the model.

When using a DSGE model, it is possible to accurately express the activities of economic players as well as the interaction that occurs between them. The DSGE model is sensitive to the influence that something has on people's well-being in addition to evaluating the effect that something has on GDP. The DSGE model will build around 5 agents: the households, the firms, the government, and the monetary authorities, the fiscal authorities, and external agent. This model is a helpful addition to the DSGE models thatare currently being used by the Bank of Indonesia for the purpose of assessing simulations of monetary policy, macroprudential policy, and the combination of monetary and macroprudential policy. Since The Bayesian estimate encompasses the entire inflation- targeting era in Indonesia up to the Covid-19 period, we can determine the composition of the Covid-19 shocks suggested by the data and model restrictions. This is possible because the Covid-19 period spans the entire inflation-targeting era in Indonesia (2009.Q3- 2022.Q4). Our primary concentration is on the following five macroprudential regulations that are often used by policymakers: Macroprudential Liquidity Buffer (MPLB), Capital Adequacy

Ratio (CAR), and Macroprudential Intermediate Ratio (MIR), Countercyclical Liquidity Buffer (CCB) and Loan to Value Ratio (LTV). The first three rules dictate the restrictions that are imposed on the amount of credit that may be made available to the economy. The fifth rule restricts the amount of credit that customers are allowed to borrow. The model operates under the assumption that monetary policy is decided according to a Taylor-type rule.

## LITERATURE REVIEW

Fiscal and Monetary Policy during Covid-19 Outbreak

The NK-DSGE model was used by Zhang et al. (2021) in order to investigate how the Covid-19 pandemic would influence China's long-term economic growth, public debt, and income inequality. According to the findings, the impact that the Covid-19 pandemic has had on aggregate demand and labor demand poses a significant risk to the expansion of the economic gap between wealthy and poor over the long run, as well as to the development of the economy overall. The findings of the study led the researchers to the conclusion that monetary policy should place an emphasis on maintaining price stability notwithstanding the impact the epidemic would have on aggregate demand.

Using Friedman's (1968) arguments as a starting point, Bhar and Malliaris (2021) developed a Markov transition econometric model with monthly data from 2002 to 2015 to analyze the impact of non-conventional monetary policy on unemployment during the Great Recession. The findings indicate that unconventional monetary policy, such as quantitative easing and targeting tools, has had an influence on lowering the unemployment rate, the findings indicate. Eichenbaum et al. (2021) investigated the relation between economic policy and the spread of disease by employing the epidemiological model in their research. People should reduce on both their consumption and employment, as suggested by the findings of Eichenbaum et al. (2021), in order to lower their likelihood of becoming infected. These initiatives mitigate the impact of the epidemic, but they exacerbate the magnitudeof the recession that is connected with it.

Fiscal and Monetary Policy and Technological Shocks

Juhro et al. (2021) based on their research in Indonesia economy found that technology shock are the primary drivers of business cycle changes in Indonesia during the entirety of the inflation-targeting era as well as in the present, ongoing COVID-19 phase. This suggests that the policy that must be taken by the central bank in dealing with the economic contraction caused by the pandemic is to combine monetary policy with countercyclical macroprudential policies which can directly and significantly affects credit supply. These policies can take the form of capital requirements, reserves requirement, or liquidity buffer regulations. These are all examples of policies that directly affect the availability of credit.

Barrie and Jacskon (2022) on their research in Sierra Leone found that the effect of technological shock on the economy of Sierra Leone is more persistent on output, capital stock, and consumption than that of interest rates. Long-term economic expansion can be fueled by technological advances; to put it another way, technological innovation is essential to Sierra Leone's prospects for sustained economic development. With the expansion of model blocs, the Monetary Policy Authority (also known as the BSL) and the overall financial mechanism have a role to play in stabilizing the aftereffects of technological shock-induced high income and consumption.

Fiscal and Monetary Policy and Preference Shocks

Arabi (2021) in his research on the economy in Sudan found that Sudan's central bank (CBS) is implementing fewer radical changes in monetary policy, and it is making minor progress in reducing rate of inflation and fostering growth in the economy condition. The

nominal interest rate and the general price level have the same impact on monetary policy terms. Inflation and real marginal cost have a weak relationship. Preference shock has the greatest effect on endogenous variables, followed by shocks to consumer preferences,real money supply, and finally shock to general price level.

Using Bayesian inference techniques, Takyi and Gonzales (2020) estimated the model's parameters by collecting time series data on 4 Sub Saharan Africa economies condition starting from 1985 to 2016. The percentage of families (households) in these economies that are excluded from financial participation is relatively low, according to Bayesian estimates, ranging between 35% until 42%. Furthermore, the Bayesian impulseresponse in this study reveals that inflation and productivity were substantially reduced due to a positive monetary policy shock. This was the case even though a sizeablesegment of the households cannot get their hands on enough money resources.

Conceptual Framework

Juhro et al. (2021) created the DSGE model, which includes the banking sectors and is widely employed in various central banks to simulate macroprudential policies. The developed model is the DSGE model of a closed economy that includes both monopolistically competitive banking and credit market friction in the form of borrowing restraints. Lenders (patient households) and borrowers (impatient households and entrepreneurs) both play roles in the DSGE model.

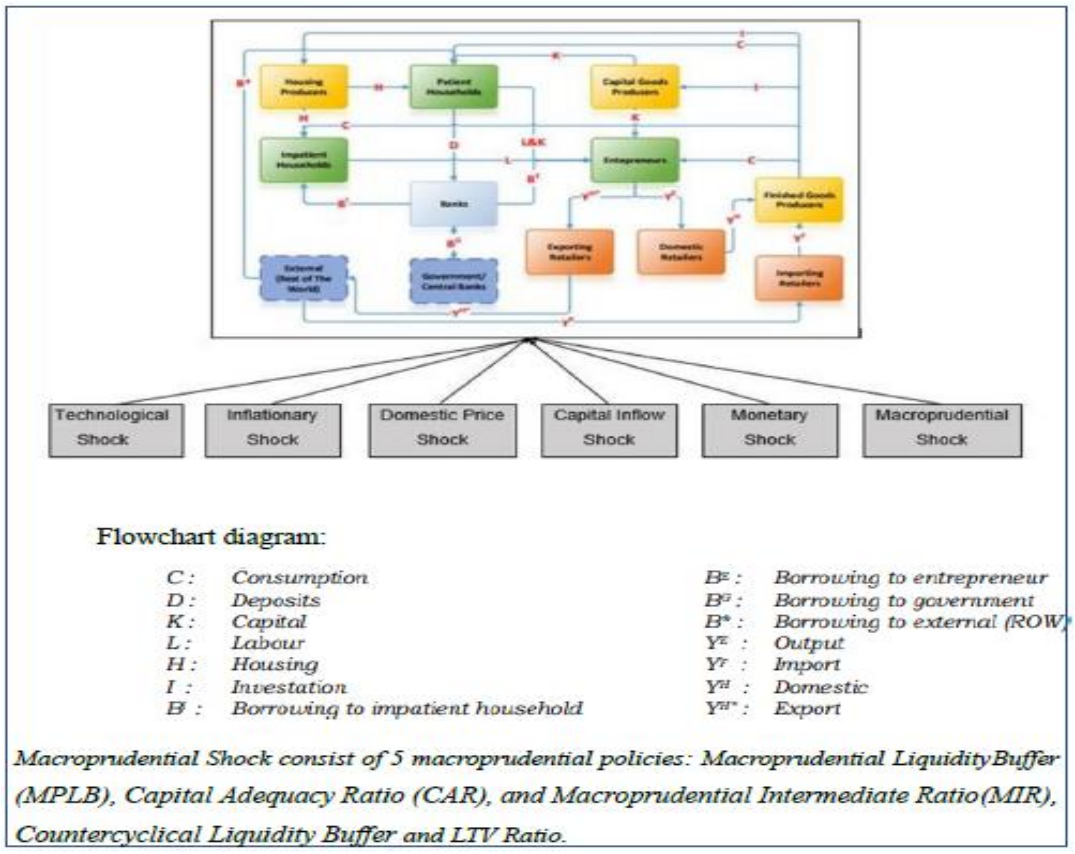


Figure 1: New Keynesian Conceptual Research Model

## METHODOLOGY

The Bayesian methodology is used to make predictions about the parameters of the underlying structural model. This method also enables us to recognize fundamental economic shocks that impacted the Indonesian economy during the research's sample period, including shocks that occurred during the Covid-19 Pandemic. This condition

corresponds to the time period of observations made from 2009-Q3 to 2022-Q4 which makes 54 quarterly observations for each variable, after The Global Financial Crisis in 2008 and Covid-19 hit all the world during 2019-Q4 to 2022-Q4.

The variables used in this study consist of 13 variables of observation of Indonesian domestic time series data, and 3 foreign time series data. This study uses data such as Indonesia's GDP which is used to measure Indonesia's economic growth rate, real investment, real government expenditure, real government bonds, export to GDP ratio, import to GDP ratio, mortgage lending rate, lending rate, deposit rate, exchange rates, Non-Performing Loans (NPL), Bank Indonesia rate (BI rate) / annual interest rate, dan Inflation rate. In addition, there are 3 (three) international data that are used as references, namely the foreign time series proxied by US real Gross Domestic Product (in terms of log difference), the inflation rate/ Consumer Price Index (in terms of log difference in Gross Domestic Product deflator), and LIBOR.

The New-Keynesian (NK) paradigm model and the Real Business Cycle (RBC) framework are both incorporated into the basic structure of the vast majority of DSGE models that can be found in academic literature. The benchmark of DSGE model is a fully micro-founded model that can either be applied to an open or closed economy. Inthis part, some examples are provided to clarify the fundamental components of DSGE approach by employing the formula that is common among economists. Despite their apparent lack of complexity, these models offer a comprehensive empirical description of the development of certain economic variables in Indonesia, including outcome, consumer price index, the nominal interest rate, and others.

The DSGE model was developed by Juhro et al. (2021), and it incorporates the banking sector. This model is commonly utilized by a variety of central banks in order to simulate macroprudential policies. The model that was developed is the dynamic stochastic general equilibrium (DSGE) model for a closed economy with friction in the form of borrowing limits on the credit market and a banking sector that operates in a monopolistic competitive environment.

Household

There are two different varieties of homes: those that are impatient (type I), and those that are patient (type P). Any (typical) type-P household, in general, strives to maximize:

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \beta_P^t \left[ \left(1 - a^P\right) \frac{\varepsilon_{z,t} \left(c_t^P(i) - a^P c_{t-1}^P\right)^{1-\sigma}}{1-\sigma} + \varepsilon_{h,t} \log h_t^P(i) - \frac{n_t^P(i)^{1+\phi}}{1+\phi} \right]$$

(1)

where the household's choice of consumptions amount, housing demand, labor hours, aggregate consumption preference shock, and housing-demand shock are denoted by $c^P t(i)$, $h^P t(i)$, $n^P t(i)$, $\varepsilon_{z,t}$, $\varepsilon_{h,t}$ , respectively. The following is an example of the predicted utility for households that are impatient (type I):

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \beta_I^t \left[ \left(1 - a^I\right) \frac{\varepsilon_{z,t} \left(c_t^I(i) - a^I c_{t-1}^I\right)^{1-\sigma}}{1-\sigma} + \varepsilon_{h,t} \log h_t^I(i) - \frac{n_t^I(i)^{1+\phi}}{1+\phi} \right]$$

(2)

Entrepreneurs and Domestic Wholesale Goods Production

Entrepreneurs in the model are responsible for creating domestic wholesale items, intermediate goods, and $y^E$ using the production function, as stated by Gerali et al. (2010):

$$y_t^E(i) = \varepsilon_t^a \left(k_{t-1}^E(i)\right)^{\alpha} \left(n_t^E(i)\right)^{1-\alpha}$$

(3)

where $\varepsilon^a t$ represents the exogenous aggregate level of technology (total factor productivity), $k_{t-1}^E(i)$ represents the physical capital input, and $n_t^E(i)$ represents

thecomposite labor input, which is comprised of labor inputs from type-P households, $n^{E,P}$ (i), and type-I households, $n^{E,I}$ (i).

Domestic Final Good Retailers

To calculate the total demand for any given variety j, first designate $P_{H,t}(j)$ as the nominal price of the good or variety j, and then designate $P_{H,t}$ as the aggregate domestic producer(retailer) price index. This will give you the total demand:

$$y_{H,t}(j) = \left[\frac{P_{H,t}(j)}{P_{H,t}}\right]^{-\varepsilon^y} y_{H,t} \quad (4)$$

Importers

Retailers of import products source unique items made elsewhere and bring them into the country for sale on the local market. At these ports, we are going to assume that the law of one price governs the pricing of these items. Importers, on the other hand, are presumedto have some market strength (monopolistically competitive), and as a result, they are able to demand a markup on the price at which the item was initially purchased.

$$y_{F,t}(j) = \left[\frac{P_{F,t}(j)}{P_{F,t}}\right]^{-\varepsilon^y} y_{F,t} \quad (5)$$

where $P_{F,t}(j)$ is the nominal price of import products in domestic currency j and $y_{F,t} \equiv c^P_{F,t} + c^I_{F,t} + c^E_{F,t}$ represents the aggregate demand for these commodities from households$(c_{PF,t} + c_{IF,t})$ and entrepreneurs $(c_{EF,t})$.

Banks and Banking Friction

Only the resulting (log-linearized) optimal retail deposit rate ($\widehat{r_t^d}$) and retail loan rates here ($\hat{r}^{bs}_t$, $s \in \{H,E\}$) are presented in this section; the specifics of the difficulties involving the retail units' attempts to maximize their profits are presented as:

$$\hat{r}^{bs}_t = \left(\frac{k_{bs}}{\varepsilon^{bs}-1+(1+\beta_P)k_{bs}}\right)\hat{r}^{bs}_{t-1} + \left(\frac{\beta_P k_{bs}}{\varepsilon^{bs}-1+(1+\beta_P)k_{bs}}\right)E_t\hat{r}^{bs}_{t+1} + \left(\frac{\varepsilon^{bs}-1}{\varepsilon^{bs}-1+(1+\beta_P)k_{bs}}\right)\hat{R}^b_t \quad (6)$$

$$y_t = v_t^{-\eta}\left[(1-\omega)c_t + q_t^{\eta}y_t^*\right] + i_t + g_t + \delta^b\frac{K^b_{t-1}}{\pi_t} + Adj_t \quad (7)$$

Aggregations, Market Clearing, and Other Equilibrium Conditions

When resources are pooled among all of the economy's participants, the following equation describes the aggregate resource constraint:

$$1 = (1-\omega)v_t^{1-\eta} + \omega(q_t\psi_{F,t}^{-1})^{1-\eta} \quad (8)$$

Fiscal, Monetary and Macroprudential Policies

When executing monetary policy, the central bank is supposed to adhere to a Taylor rule.

$$(1+r_t) = (1+\bar{r})^{1-\phi_R}(1+r_{t-1})^{\phi_R}\left(\left(\frac{\pi_t}{\bar{\pi}}\right)^{\phi_\pi}\left(\frac{y_t}{\bar{y}}\right)^{\phi_y}\left(\frac{y_t}{y_{t-1}}\right)^{\phi_{\Delta y}}\left(\frac{e_t}{e_{t-1}}\right)^{\phi_e}\right)^{1-\phi_R}\varepsilon_t^r \quad (9)$$

Here, $\phi_R$ represents the degree of interest-rate smoothing and $\phi_\pi$, $\phi_y$, $\phi_{\Delta y}$, and $\phi_e$ represents the feedback-coefficients on inflation deviation from the target ($\frac{\pi_t}{\bar{\pi}}$), output level deviation ($\frac{y_t}{\bar{y}}$), output growth rate ($\frac{y_t}{y_{t-1}}$), and nominal exchange-rate depreciation), respectively.

Table 1 below are the parameters used in the calibration process. These parameters are used as a policy mix analysis tool during the Covid-19 outbreak in Indonesia. By using these parameters, this research was conducted to analyze whether the policies that had been implemented were effective or not and were able to determine which policy mix was more effective in dealing with the COVID-19 pandemic in Indonesia during the 2019 to 2022 period. At coincide with the interest rate (from Bank Indonesia) and the general inflation rate,the discount factor P for Patient households has been calibrated to 0.9942. In the utility function for patient households, the second and third discount factors, $\beta^I$ and $\beta^E$, as wellas the labor income share and housing weight, are set according to Purwanto et al (2018). Investment adjustment cost parameter is performed in the same manner as that of Auray et al. (2018). Labor elasticity parameter was declared based on Purwanto et al. (2018).

We focused on computing the habit parameter for patient and impatient households,and for entrepreneurs, ignore the habit parameter and assume zero habit formation ($\alpha^E = 0$). The weight of housing in utility function $\varepsilon^h$ are frequent that appear often in the literature. Additionally, we decided to use a Taylor rule smoothing parameter of $\rho^i = 0.75$, which agrees with the Indonesian economy's posterior mean from Juhro et al. (2021)and is close to the value proposed by Dutu (2016), which is about 0.8. Both the top bound of Bank Indonesia's inflation objective for 2023 (5.28% year on year) and our sample's average debt-to-output ratio are consistent with the steady-state inflation rate. Based on scientific literature, these priors are generally common and standard. The investment, deposit, and loan rates priors, as well as the parameters for bank leverage adjustment cost,are identical to those used by Harmanta et al. (2014) and Budiman et al. (2022). For the remaining structural parameters, we use identical priors as were used in Juhro et al. (2021), Purwanto et al. (2018), Auray et al. (2018), Xiao et al. (2018) and Liu et al. (2020). In the case of exogenous processes, Beta and Inverse-Gamma prior distributions are assumed for autoregressive coefficients and standard errors.

Table 1: Parameters and Values Prior Distributions During Covid-19

| Description | Parameter | Value | Source |
|---|---|---|---|
| Patient HHs' subjective discount factor | βP | 0.994 | Juhro et al. (2021) |
| Impatient HHs' subjective discount factor | βI | 0.960 | Purwanto et al. (2018) |
| Entrepreneurs' subjective discount factor | βE | 0.967 | |
| Labor elasticity parameter | μ | 0.01 | |
| Investment adjustment cost | ij | 1.728 | Auray et al. (2018) |
| Weight on housing in utility function | εh | 0.10 | Budiman et al. (2022) |
| Share between factor productivity | α | 0.72 | |
| Persistence coefficient on NPL | EN | 0.75 | |
| LTV ratio requirement | mI | 0.75 | |
| Substitution elasticity between intermediate products | σ | 6 | Xiao et al. (2018) |
| The reciprocal of Frisch labor supply elast. | φ | 2 | Liu et al. (2020) |
| Importer's profit margin | ω | 0.03 | Harmanta et al. (2014) |
| Exporter's profit margin | η | 0.026 | |
| Risk-premium scale parameter | χ | 0.11 | |

| | | | |
|---|---|---|---|
| Deposit rate | εd | 0.045 | |
| Loan rate | εbH | 0.1498 | |
| Entrepreneurs' habit | aE | 0 | Juhro et al. (2021) |
| Taylor rule's interest rate smoothing | φR | 0.75 | |
| Steady-state quarterly net inflation rate | $\pi^-$ | 1% | |
| Steady-state govt. debt-to-output ratio | $b/^-y^-$ | 0.44 | Jin and Xiong (2021) |

## RESULT AND DISCUSSION

Prior and Posterior Distribution of Estimated Structural Parameters

Posterior Mean Forecast Error Variance Decompositions of Key Endogenous Variables before and during Covid-19 (from 2019 to 2022) with focus on technology, preference, domestic price, and capital flow shocks using Matlab. The Covid-19 pandemic, which emerged in 2019 and persisted until 2022, had a profound impact on the global economy, including Indonesia. In this analysis, we utilize Matlab to conduct a posterior mean forecast error variance decomposition of key endogenous variables, namely output (GDP) growth, inflation, the monetary policy interest rate (BI rate), and lending facility rate growth, across different horizons during this period. The goal is to understand the relative contributions of macroeconomic shocks, technology shock, preference shock, domestic price shock, and capital flow management shock in driving fluctuations in output growth.

Below is a hypothetical table showcasing the prior and posterior distribution of estimated structural parameters in a Dynamic Stochastic General Equilibrium (DSGE) model for Indonesia with banking and financial frictions. The table provides the parameter names, prior mean and standard deviation (SD), posterior mean, and 95% Credible Interval (CI) obtained through Bayesian estimation. Here is a table that presents the comparison of prior and posterior distribution of estimated structural parameters.

Table 2: Prior and Posterior Distribution of Estimated Structural Parameters

| Description | Distr. | Prior Distribution | | Posterior Distribution | |
|---|---|---|---|---|---|
| | | Mean | St. Dev | Mean | 95% Prob. Int |
| Patient Household Coefficient | Beta | 0.5 | 0.25 | 0.32 | [0.04, 0.27] |
| Calvo Parameter for Domestic Goods | Beta | 0.6 | 0.05 | 0.49 | [0.69, 0.54] |
| Calvo Parameter for Export Goods | Beta | 0.4 | 0.05 | 0.81 | [0.45, 0.85] |
| Calvo Parameter for Import Goods | Beta | 0.7 | 0.05 | 0.65 | [0.71, 0.67] |
| Inverse of Frisch of labor supply elasticity | Beta | 2.0 | 0.20 | 4.18 | [3.46, 5.85] |
| Inverse of intertemporal elasticity of substitution for housing | Beta | 4.0 | 0.20 | 4.27 | [5.78, 6.89] |
| Inverse of intertemporal elasticity of substitution for consumption | Beta | 2.0 | 0.20 | 2.15 | [2.34, 3.12] |

Taylor rule coefficient:

| | | | | | |
|---|---|---|---|---|---|
| inflation | Gamma | 2.50 | 0.20 | 1.71 | [1.34, 2.73] |
| output | Gamma | 0.30 | 0.15 | 0.27 | [0.19, 0.43] |
| output growth | Gamma | 0.30 | 0.15 | 0.13 | [0.07, 0.23] |
| exchange rate | Gamma | 0.30 | 0.15 | 0.12 | [0.11, 0.30] |
| Adjustment cost: | | | | | |
| Investment | Gamma | 4.50 | 1.00 | 5.78 | [5.45,7.23] |
| Mortgage lending rate | Gamma | 11.00 | 3.00 | 12.37 | [6.79, 15.45] |
| Lending facility rate | Gamma | 9.50 | 3.00 | 8.56 | [12.78,10.22] |
| BI Rate | Gamma | 5.00 | 3.00 | 5.75 | [4.73, 8.33] |
| Deposit Rate | Gamma | 4.00 | 3.00 | 3.88 | [2.82, 5.13] |

| Description | Dist. | Prior Distribution | | Posterior Distribution | |
|---|---|---|---|---|---|
| | | Mean | St. Dev | Mean | 95% Prob. Int. |
| Exogenous Process: | | | | | |
| Technology | Beta | 0.80 | 0.30 | 0.91 | [0.86, 1.02] |
| Preference | Beta | 0.80 | 0.30 | 0.72 | [0.54, 0.82] |
| Domestic Price | Beta | 0.50 | 0.25 | 0.22 | [0.23, 0.45] |
| Capital Management | Beta | 0.80 | 0.30 | 0.56 | [0.88, 0.74] |
| Govt. Spending | Beta | 0.80 | 0.30 | 0.73 | [0.67, 0.85] |
| Govt. Bond | Beta | 0.80 | 0.30 | 0.53 | [0.33, 0.56] |
| Export Cost Push | Beta | 0.80 | 0.30 | 0.67 | [0.23, 0.85] |
| Import Cost Push | Beta | 0.80 | 0.30 | 0.53 | [0.76, 0.94] |

Note: (1) The values in the table represent the percentage contributions of each shock to the forecast error variance of the respective endogenous variables at different horizons; (2) "Residual" represents the unexplained variance, which captures the impact of other factors not explicitly modelled in the DSGE framework; (3) The sample period considered in the analysis spans from the third quarter of 2009 (2009.Q3) to the fourth quarter of 2022 (2022.Q4).

Implications of Policy Mixes Strategies before and after Covid-19

In this section, we analyse and investigate the macroprudential policies mixed issued by the Bank of Indonesia during the period before and after the Covid-19 pandemic hit Indonesia as a whole. This analysis aims to identify which policy mix is capable of improving the stability of macroeconomic conditions in Indonesia and is able to improve the prosperity/level of economic stability during the observation period. This section will show you which policy mix comparisons are more appropriate during the period, that is, the period before and after the onset of Covid-19. The study will use 6 (six) mixed macroprudential policy scenarios. As for the six scenarios used in this observation are:

(1)Monetary policy only (BI rate) (MP); (2) Policy mixes between monetary policy and macroprudential liquidity buffer (MP + MPLB); (3) Policy mixes between monetary policy and capital adequacy ratio (MP + CAR); (4) Policy mixes between monetary policy and macroprudential intermediation ratio (MP + MIR); (5) Policy mixes between

monetary policy and counter-cyclical buffer (MP+CCB); and (6) Policy mixes between monetary policy and LTV/ FTV ratio (MP+LTV)

In carrying out this analysis, we use the policy approach that has been established by the Bank of Indonesia, where the five available macro-prudential policies are countercyclical policies that have been legally and are contained in the Indonesian Bank Regulations specifically where such policies are constantly changing in accordance with the national and global economic conditions that occurs.

Table 3: Standard Deviations of Observable Variables under Policy Mixes

| Policy Mixes | Output Growth | Inflation | Interest Rate | Credit / Lending Growth Rate |
|---|---|---|---|---|
| MP only | 0.0796 | 0.0340 | 0.0379 | 0.0249 |
| MP + CAR | 0.0947 | 0.0491 | 0.0530 | 0.0400 |
| MP + CC | 0.0661 | 0.0205 | 0.0245 | 0.0114 |
| MP + MPLB | 0.0736 | 0.0281 | 0.0320 | 0.0190 |
| MP+ MIR | 0.0661 | 0.0205 | 0.0245 | 0.0114 |
| MP + LTV | 0.1796 | 0.1341 | 0.1380 | 0.1250 |

Notes: (1) all values in percent (%); (2) entries value for five macroprudential policy mixes are simulated using 10,000 periods under the estimated standard deviation of the exogenous shocks; (3) entries value for LTV policy are generated under average LTV that happened during the observation period.

Table 3 above presents the standard deviation values of four key variables namely: the deviation standard over GDP Growth, the deviations standard over the rate of inflation, the variance standard over nominal interest rate policy applied by the Bank of Indonesia, and the credit/credit interest rate deviation standards applied to the 6 mixture of macroprudential policies which are the policy options of Bank Indonesia as stipulated in the Regulations of the Bank. To obtain that value, we used a simulation with 10,000 period simulation, with shocks drawn based on the matrix of the posterior variance-covariance averages.

Table 3 indicates that when compared to the MP only strategy, the mixed policy strategies MP+CC, MP+MPLB, and MP + MIR have lower standard deviation values than MP only policies for the four observed variables. Thus, the three policy mixes (MP+CC, MP+MPLB, and MP+ MIR) are able to control the fluctuations and frictions that occur both in the financial cycle (especially credit growth and credit interest rates) and also in the business cycle in general (output). The policy conditions below these three policy mixtures are capable of producing more subtle fluctuations so that in a pandemic situation, the economic shock does not occur more sharply.

However, when compared between MP only policies with MP+CAR and MP+LTV, the standard deviation values of both are higher compared to MP for the four key variables used. This indicates that in the circumstances of a dangerous financial cycle, then the Bank of Indonesia will implement the policy by setting a banking health rate for the entire bank in Indonesia. As far as the policy is concerned, the Bank of Indonesia needs to raise the capital adequacy ratio (CAR) to ensure that the bank has an adequate capital sufficiency ratio while the bank is experiencing internal and external shocks that

jeopardize the bank's financial condition such as credit crashes and large-scale and massive withdrawals of customer funds. Based on existing regulations, the Bank of Indonesia currently applies a CAR rate of > 8% and in fact, the average banking has met that requirement by having a CAR above 20%. This condition really reflects that banks in Indonesia have CARs far above the requirements of the Bank of Indonesia.

The study also performed a comparative analysis of the relative welfare losses that occurred at a time when central banks implemented one of the strategies of a mix of macroprudential policies that could be used. As far as the loss is concerned, it is done with the formula of the approach according to Woodford (2002) as Juhro et al. (2021) did in his research.

Table 4: Relative Welfare Losses of Various Policy Mixes

| | MP | MP +CAR | MP + CC | MP +MPLB | MP+MIR | MP +LTV |
|---|---|---|---|---|---|---|
| $\lambda_{cr}$ = 0.00 | | | | | | |
| $\lambda_y$ = 0.05 | 1 | 0.9547 | 0.9737 | 0.9924 | 0.9953 | 1.3591 |
| $\lambda_y$ = 0.5 | 1 | 0.9541 | 0.9734 | 0.9918 | 0.9947 | 1.3595 |
| $\lambda_y$ = 1 | 1 | 0.9532 | 0.9731 | 0.9916 | 0.9946 | 1.3597 |
| $\lambda_{cr}$ = 0.20 | | | | | | |
| $\lambda_y$ = 0,05 | 1 | 0.9533 | 0.9731 | 0.9996 | 1.0021 | 1.3590 |
| $\lambda_y$ = 0,5 | 1 | 0.9530 | 0.9728 | 0.9993 | 1.0017 | 1.3594 |
| $\lambda_y$ = 1 | 1 | 0.9525 | 0.9727 | 0.9993 | 1.0018 | 1.3598 |

Notes: (1) all values in percent (%); (2) entries value for five macroprudential policy mixes are simulated using 10,000 periods under the estimated standard deviation of the exogenous shocks; (3) entries value for LTV policy are generated under average LTV that happened during the observation period.

Table 4 presents the results of simulations carried out against five mixed macro-prudential policies over the 2009.Q3 until 2022.Q4. The simulation is done using the various shocks that exist within the business cycle and the financial cycle within a specified time frame. Based on the results of the above simulation, information was obtained that the four macroprudential policy mixtures MP+CAR, MP+CC, MP + MPLB, and MP+ MIR experienced improved well-being when compared with the implementation of MP only as a policy baseline (relative welfare loss < 1). But at a time of high credit growth fluctuations where λcr = 0.20 MP+MIR policy mix has a loss/degradation of well-being where the relative welfare loss value is >1. Meanwhile, for all simulations at both λcr = 0 and λcr = 0.20, the MP+LTV macroprudential policy mix has experienced a decrease/ loss of well-being given the relative welfare loss value >1. In this context, regardless of the relative weights, the welfare losses exhibit a 35% increase in comparison to those observed in the baseline MP only scenario. This is in line with the function that LTV policy is used for several purposes including: reducing housing credit and reducing the boom in real estate prices, reducing default probability at a time of decline in the housing market, and reducing losses at the time of default so that during

this observation period, this policy is not too extreme to have a significant influence in suppressing the fluctuations of financial conditions that occur.

Based on these projected shocks, we are able to draw the conclusions stated above regarding whether or not a certain macroprudential policy is supporting or weakening the central bank's monetary policy stance in the process of managing the variations of the business cycle and maximizing the welfare of economic agents. The conclusion that the MP+LTV policy mix is unconditionally welfare-reducing and, as a result, should not be implemented by central banks is, for instance, incorrect. This is due to the fact that there are exceptions to this rule. This conclusion probably is dependent on the particular shocks that are currently affecting the economy.

An analysis of the relative welfare losses could also be done using a specific shocks simulation used in this study. Suppose that the relative welfare losses simulation is done using the formula used by Woodford (2002) as used in the Juhro et al. (2021) study simulation, where it is simulated against four chosen shocks: technology, preference, domestic price, and capital flow management shocks, while other shocks are assumed to have variance values equal to zero. The table below presents values that represent the degree of likely relative welfare losses that will occur between a mixture of macroprudential policies issued by the central bank in this case regulated by the Bank of Indonesia with certain shocks that have been identified in this study.

Table 5: Relative Welfare Losses of Various Policy Mixes under 5 Shocks

| | MP | MP +CAR | MP + CC | MP +MPLB | MP+MIR | MP +LTV |
|---|---|---|---|---|---|---|
| Technology shock | | | | | | |
| $\lambda_y$ = 0,05 | 1 | 0.8452 | 0.9422 | 0.9715 | 0.9928 | 1.2672 |
| $\lambda_y$ = 0,5 | 1 | 0.8413 | 0.9102 | 0.9713 | 0.9973 | 1.2676 |
| $\lambda_y$ = 1 | 1 | 0.8385 | 0.9715 | 0.9712 | 0.9982 | 1.2678 |
| Preference shocks | | | | | | |
| $\lambda_y$ = 0,05 | 1 | 1.5383 | 1.1299 | 1.0571 | 1.0071 | 1.2867 |
| $\lambda_y$ = 0,5 | 1 | 1.3432 | 1.1693 | 1.0486 | 1.0058 | 1.2535 |
| $\lambda_y$ = 1 | 1 | 1.3354 | 1.1478 | 1.0398 | 1.0047 | 1.2383 |
| Domestic Price Shocks | | | | | | |
| $\lambda_y$ = 0,05 | 1 | 1.1773 | 1.0070 | 1.0254 | 1.0639 | 1.2558 |
| $\lambda_y$ = 0,5 | 1 | 1.1404 | 1.0070 | 1.0250 | 1.0678 | 1.2274 |
| $\lambda_y$ = 1 | 1 | 1.1501 | 1.0067 | 1.0247 | 1.0688 | 1.1486 |
| Capital Flow Management Shocks | | | | | | |
| $\lambda_y$ = 0,05 | 1 | 0.7429 | 0.9865 | 0.9970 | 1.1271 | 1.6651 |
| $\lambda_y$ = 0,5 | 1 | 0.7491 | 0.9707 | 0.9967 | 1.1289 | 1.6723 |

| | | | | | | |
|---|---|---|---|---|---|---|
| $\lambda_y$ = 1 | 1 | 0.7548 | 0.9127 | 0.9933 | 1.1295 | 1.6973 |

Notes: (1) The welfare loss function based on Woodford (2002) function when the $\lambda_r$ = 0.05 and $\lambda_{cr}$ = 0 in all selective shocks; (2) the values above based on the estimated posterior mean standard deviations and other shocks are assumed to be equal to zero.

Table 5 above describes the relative welfare losses against shocks of choice such as technological shocks, preference shock, domestic price shocks and capital flow management shocks. When only technological shock is included in the simulation, then four mixed macro-prudential policies exclude MP+LTV experience improved well-being when compared to MP as the baseline. The lowest rate of decline in welfare if the central bank applies the MP+CAR macro-prudential policy mix and the greatest decrease in well-being occurs when the central Bank applies MP+MIR policy when the MP only policy becomes the policy baseline. Nevertheless, both MP+CAR, MP+CC, MP+MPLB, and MP+MIR are still experiencing an improvement in prosperity compared to when the central bank applies monetary policy only (MP only).

Furthermore, when a mixture of macroprudential policies is simulated with the influence of inflation rates, then the five mixed macro-prudent policies experience a higher decrease in well-being compared to the MP only policy as the baseline. Simulating five policy mixes with the influence of domestic price shocks, the same results were obtained where for the five macroprudential policy mixtures MP+CAR, MP+CC, MP+MPLB, MP+MIR, and MP+LTV there was a decline in prosperity when the five policies were implemented during the period 2009-2022. The last simulation was conducted using the capital flow management shock, where the macroprudential policy mix MP+CAR, MP+CC, and MP+MPLB experienced improved well-being where MP+ CAR had the highest improvement in well - being among the other policy mix. The interesting thing is that the MP+LTV policy mix does not experience an improvement in social welfare for the entire simulation of the shocks that exist even if the shock analysis is done simultaneously or one-on-one Nevertheless, when we consider the MP + LTV mix, the only financial shock that occurs is the chock to the bank balance sheet. Because this shock predominantly (and immediately) affects the supply of credit, a countercyclical credit demand-side policy, such as an LTV regulation, may in fact intensify the financial cycle, and by extension, the economic cycle.

Impulse Response Function (IRF)

Figure 2 illustrates the impulse responses of key economic variables—Output, Consumption, Inflation, and Policy Instrument—to a negative 1% technology shock. Such a shock represents a sudden adverse change in technological advancements that affects the economy. The figure provides a visual representation of how these variables respond to the shock over a specific period. A negative technology shock could lead to a decrease in productivity and innovation, which might result in reduced economic activity and GDP (Output). Consumer sentiment could be impacted, leading to decreased spending and Consumption. The Inflation curve might exhibit mixed effects, as reduced productivity could counteract potential demand-pull inflation. Policymakers may respond to the shock by adjusting the Policy Instrument (e.g., interest rates) to support economic activity, which might be observed through changes in the Policy Instrument curve. Overall, Figure 2 offers insights into the dynamic interactions and adjustments of these variables in response to a negative technology shock, aiding in the understanding of the potential economic repercussions and guiding policymakers in formulating effective strategies to manage such shocks.

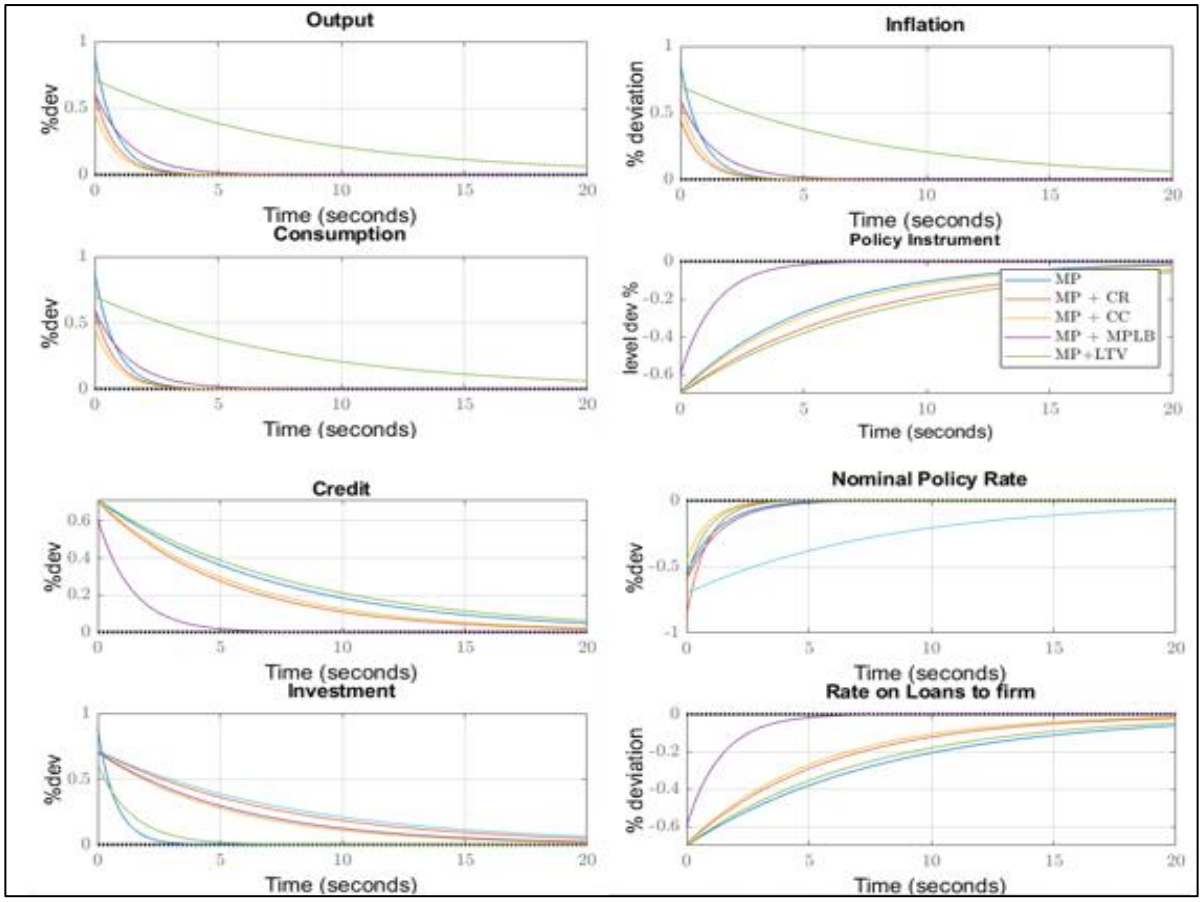


Figure 2: Impulse Responses to a negative 1% Technological Shock

In response, the Bank of Indonesia will surely react by raising the nominal interest rate. This is, of course, also driven by the credit development that is taking place within the society, which leads to the occurrence of qualitative disparities. When referring to the impulse response chart below, with the presence of a technological shock, resulting in huge contractions throughout the business cycle including output, consumption, and investment levels. The biggest shock and contraction occurred when the central bank implemented the MP+LTV macro-prudential policy which yielded the greatest welfare loss, followed by the MP only baseline. In addition, the macroprudential policy mix MP+CAR, MP+CC, MP+MPLB, MP+MIR are able to suppress a smoother output contraction so that the shock is not too big and still can have an impact on the improved well-being of macroeconomies at the time of the policy being implemented where the MP+CAR policy provides the highest welfare compared to the other policy mix or the MP policy used as the policy baseline.

Figure 3 illustrates the impulse responses of key economic variables—Output, Consumption, Inflation, and Policy Instrument—to a negative 1% preference shock. A preference shock typically represents a sudden change in consumer preferences or behaviour that affects the economy. The figure visually demonstrates how these variables react to the shock over a certain time horizon.

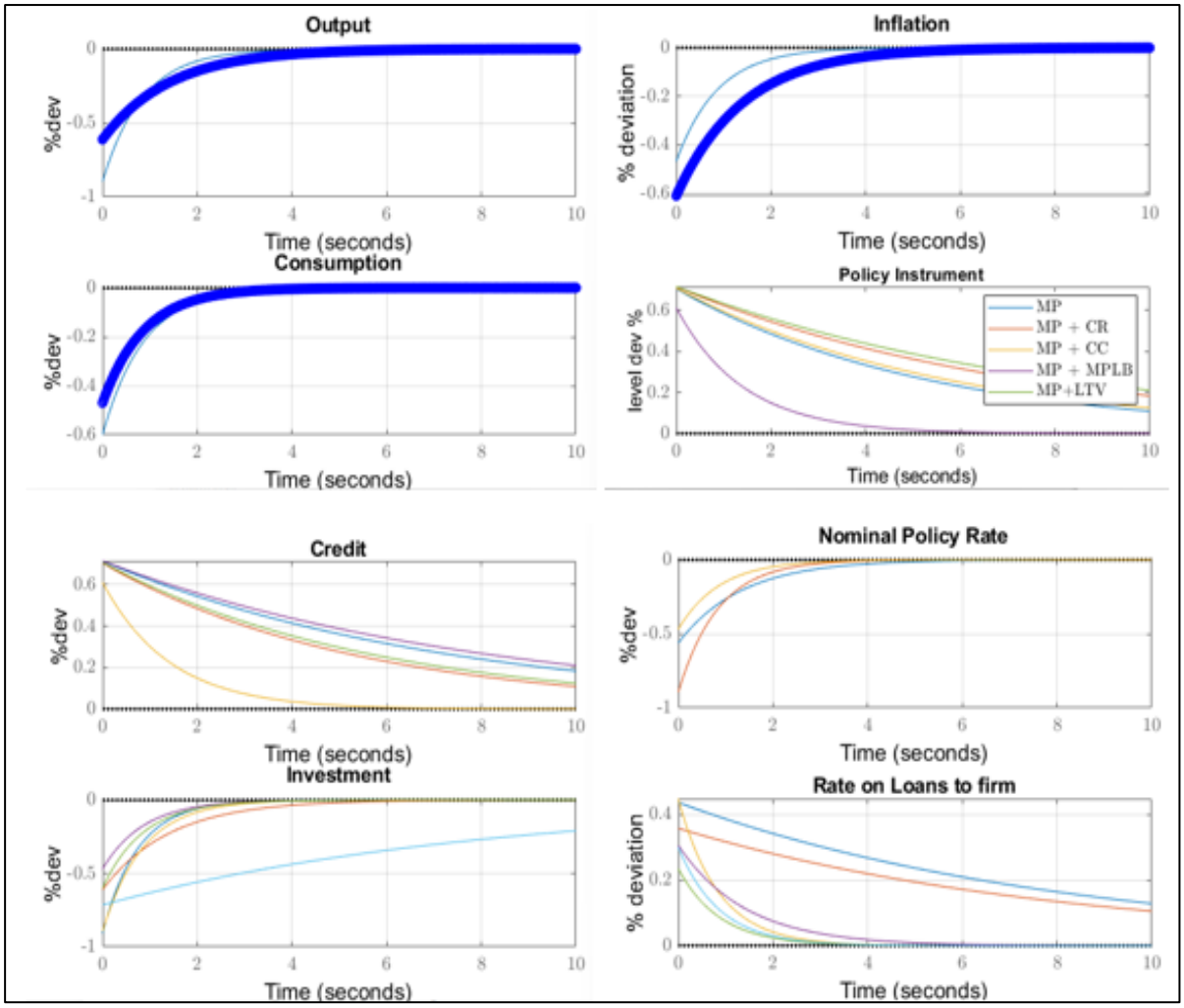


Figure 3: Impulse Responses to a negative 1% Preference Shock

A negative preference shock might lead to a decrease in consumer demand and spending, causing a reduction in Output (economic activity) and subsequently impacting Consumption. These curves might exhibit a downward trend, indicating a short-term contraction in economic output and consumption levels. The shock's effect on Inflation depends on various factors. A decrease in consumer spending might lead to reduced demand-pull inflation. However, supply-side factors could counterbalance this effect. The Inflation curve might show a mixed response, reflecting the interplay of demand and supply dynamics.

In response to the negative preference shock, policymakers may adjust a Policy Instrument (such as interest rates) to mitigate its impact. The figure likely displays how the central bank's policy rate, or another relevant instrument is altered over time to counteract the shock's negative effects. An increase in the Policy Instrument could be observed as the central bank seeks to stimulate economic activity. The impulse responses in Figure 3 provide insights into the short-term adjustments and interactions among these variables following the preference shock. Such analyses help economists and policymakers understand the potential outcomes of various shocks on the economy, guiding them in formulating appropriate responses to stabilize and support economic conditions. According to Figure 3, the total amount of credit (loans) in the economy increases both after the impact of the policy mix and in the period that follows it in any of the six possible scenarios. This increase in credit availability is largely the result of lower interest rates for households and loans, which were driven by a fall in the policy rate. The

extent to which the interest rates on loans were lowered, on the other hand, varies according on the policy mixtures.

As can be seen in the bottom right panel of Figure 3, the interest rate on loans to firms reduces the greatest under the MP+LTV mix strategy. More crucially, it decreases by a greater amount than it does in the baseline MP case, and this holds true throughout all time periods. The same pattern is seen with the rate of interest on loans made to households, which is not reflected here. Although the interest rates on loans fall when considering both the MP+CAR, MP+CC and the MP+MIR mix strategy, the magnitude of the drop is smaller than when using the MP scenario as the baseline. Although upon closer inspection, the extent of the decline is slightly less in the former, the reactions of the loan rates for the MP+MPLB mix are practically indistinguishable from the responses under the baseline MP case. This is because the MP+MPLB mix contains both the MP and the MPLB. Considering the impact that each of the macroprudential policies has on the credit market is necessary in order to comprehend this response pattern.

## CONCLUSION AND RECOMMENDATIONS

The study aims to build a mixed model of macro-prudential policy that is appropriate for the period of the Covid-19 pandemic and attempts to make appropriate policy estimates in the period after the Covid-19 declaration is completed in Indonesia. The study uses the Bayesian method in estimating the DSGE model within the scope of the small economy model in Indonesia. We simulated six mixed macro-prudential policies in line with the policies of the Bank of Indonesia by trying to apply a variety of shocks such as technology, preference, domestic price, and capital management shocks in two different time frames, before and after the Covid-19 pandemic.

Using the DSGE model, this study tries to find the best performance mixture of macroprudential policies capable of being policy solutions during the Covid-19 pandemic attack, and at the same time there are several shocks simulated together and simultaneously. After doing such a simulation, we found several conclusions. First, during Covid-19 pandemic in Indonesia, the only policy instrument capable of improving welfares was a mixture of MP+CAR, MP+CC,MP+MPLB, and MP+MIR policies, while the MP+LTV policy mix did not demonstrate its effectiveness in managing the macro-economic and financial conditions in Indonesia during the Covid-19 epidemic because it provided greater relative welfare losses compared to MP only policies. Second, the implementation of a mixture of monetary and macro-prudential policies has been a good performance compared to if the Bank of Indonesia had only implemented monetary policy in order to create stability in Indonesia's financial system at a time of technological shock and preference shock during the observation time period. Third, our analysis reveals that technological shocks have emerged as the primary drivers of business-cycle changes in Indonesia, encompassing both the whole inflation-targeting phase and the continuing Covid-19 period. The implementation of countercyclical credit demand-channel macroprudential policies, such as regulations on loan-to-value ratios, has the potential to exacerbate aggregate variations.

Overall, the results of the model simulation also showed that the implementation of a mixture of monetary and macroprudential policies has better performance in achieving macroeconomic and financial system stability compared to merely implementing monetary policy in the face of technology shocks. However, there is a trade-off between achieving inflationary stability, the financial system (banks), interest rates, and GDP (output) with the achievement of stability in output and commodity prices when the economy is in a technology shock. The central bank needs to consider the trade-offs in order to be able to choose the optimal policy to implement.

. In this study simulated a mixture of optimal policies in the face of technology chock, preference shock, domestic price shock and capital flow management shock. There are several research recommendations that can be done as further research. First, developing a DSGE model that is capable of accommodating broad policy applications not only covering monetary policy and macroprudential policy, but also can perform projections of macroeconomic variables associated with the condition of banking balance sheets and non-financial banking factors within the banking sector as an independent company. Second, in addition to the other qualitative variable of macroprudential policy, which is short-term liquidity assistance, the central bank is able to elaborate quantitative and qualitatively in determining the appropriate policy in the specified period of time. Lastly, using other variable shocks such as the kind of shock associated with the increased inclusion and financial literacy sector that is developing in Indonesia.

Acknowledgement

The research for this paper was supported by the Graduate School Chiang Mai University, Thailand under the CMU Presidential Scholarship. Besides, we thank the anonymous reviewers for their valuable comments that have important significance to our research.

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