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Interaction between Monetary and Macroprudential Policy to Enhance Financial Stability: Evidence from Indonesia

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Abstract

This study aimed to evaluate the interaction between monetary and macroprudential policy through the function of the central bank's objectives, namely the plain vanilla taylor rule, lean against the wind taylor rule, independent macroprudential policy rule and lean against the wind taylor rule with macroprudential policy. The parameter value used was based on the previous empirical study. The numerical optimizer csminwel of Chris Sims was used to solve the quadratic linear problems. The optimum coefficient calculation applied dynare optimal simple rule routine using the application of dynare 4.5.7 and matlab software. The result shows the macroprudential instruments, known as a buffer in monetary policy, we're able to optimally minimize the loss function of the central bank. The central bank carried out both monetary and macroprudential policy in a comprehensive way to achieve two purposes as stated in the tinbergen principle. The interest rate policy is intended for reaching inflation and output stability, while the macroprudential policy is for credit growth. Macroeconomic stability with the addition of macroprudential policy is significant. This advantage is intended to cover greater volatility both in the policy rate and the inflation rate.

Keywords
monetary policy; macroprudential policy; loss function

I. Introduction

The dynamics of the increasingly rapid and integrated world economy have important implications on the economic constellation of each country including the dynamics of the financial sector. The rapid financial sector is marked by the presence of financial derivative products that are in line with the development of information technology. On the other hand, the increasingly massive mobility of financial products between countries can be a fairly rapid transmission of vulnerability to the risk of financial system instability and the global economic crisis.

The global financial crisis in 2008 had an impact on the contraction of the world economy ever since the great depression, as well as raised various inquiries about the efficacy of policies, especially monetary policy, in achieving inflation and in balancing the output. The global financial crisis shows that monetary policy is inadequate in maintaining overall financial stability. Two aspects of low inflation and output volatility drive low economic players' expectations of risk, making the financial system more vulnerable to crisis.

According to Taylor (2009) that the crisis occurred because of too low-interest rates as regulated in the policy of the central bank, accompanied by low levels of inflation for a long period before the crisis. Also, the risks in the banking and financial sectors were not taken into account in the monetary policy reaction function. The results of the same study showed that in the case of "leaning against the wind" using interest rate instruments in achieving price and output stabilization has implications for the emergence of risks to credit growth and asset prices (Bernanke, 2010; Beau et al., 2012; Turner, 2013). Blanchard (2013) stated that the central bank must counter to "leaning against the wind" in the financial sector by using interest rate instruments more than needed in inflation stability and output gaps when credit growth is rapid enough and responds to the pace increase in asset prices.

Chakraborty and Banerjee (2009) stated that the policy of increasing interest rates when asset prices escalate above the threshold and reducing interest rates when asset prices plummet below the threshold tends to offset the effects on output and inflation. While Kent and Lowe (1997) emphasized the importance of the use of prudential regulations, namely macroprudential policies to acknowledge the asset price bubbles through financial system stability, namely ensuring a healthy banking system and not experiencing excessive risk associated with asset prices. In carrying out policies, the central bank’s objective function was in a loss function form and in minimizing the social loss function. The central bank's objective function shows the amount of the squares of the actual inflation deviations from the target, the deviation of output from its potential value (output gap), and the deviation of the interest rate from the previous period’s interest rates. Until now, what many central banks have implemented is the loss function of monetary policy and there is no consensus on the loss function in macroprudential policy. However, given the importance of financial system stability, macroprudential policy is essential in a loss function. The study of Angelini et al. (2011) builds a loss function by including variants of the loan to output ratio and the variability of macroprudential policies.

Beau et al. (2012) analyzed the interactions between monetary and macroprudential policies with coordinative interactions by using the DSGE model and included financial friction, heterogeneous agents, and housing in the Euro area during the 1985-2010 period. The instrument used is the short-term interest rate with a leaning against the credit growth model. The study results show that the occurrence of conflict in achieving the final target is determined by the amount of shock to the economy. During the observation period, the shock factor of housing credit requires a macroprudential policy instrument to reduce the dynamics of inflation.

In Indonesia, the main instrument of monetary policy implemented by Bank Indonesia is the BI Rate. Following the ARIMBI model Harmanta et al. (2011) that has been used in the operational preparation of monetary policy recommendations at Bank Indonesia, the behavior of interest rate instruments refers to the standard mechanism, namely the Taylor-type rule, where policy rates react to the forecasted-inflation deviation from the target and the deviation of GDP growth from potential (output gap). Furthermore, in this study, the macroprudential policy was applied in the form of a loan to value ratio (LTV ratio) instrument that regulates the maximum amount of the loan to the collateral value of the customer. Moreover, the maximum customer value can be made only if positive influence of marketing and individual environment association does exist (Kusumadewi, 2019). The quality of products that are in great demand by consumers can be seen from several factors including packaging, price, quality, and benefits obtained by consumers (Romdonny, 2019).

The study is purposed to calculate the loss function of the central bank's policy reaction function on four policy models namely (1)the plain vanilla Taylor rule, (2)lean against the wind policy rule, (3)lean against the wind with macroprudential policy rule, and (4)independent macroprudential policy rule in Indonesia.

II. Research Methods

Research methods are the sciences/methods used to obtain the truth using a search with certain procedures in finding the truth, depending on the reality being studied (Asyraini et al., 2022; Octiva, 2018). Methodology consists of structured ways to acquire knowledge. The purpose of the research methods are theoretically an attempt made to find out one thing. Knowledge obtained from theoretical research is often referred to as basic research, because it cannot be used directly (Pandiangan et al., 2018). Method is a systematic method or process used to carry out an activity so that the desired goal can be achieved Pandiangan (2015). In other words, the method serves as a tool to achieve a goal, or how to do or make something (Octiva et al., 2018). According to Pandiangan et al. (2021), a method is used as a reference for activities because in it there is an orderly sequence of steps so that the process of achieving goals becomes more efficient. In relation to scientific efforts, the method is a way of working to be able to understand the object that is the target of the science concerned (Pandia et al., 2018). The implementation method is a method that describes the mastery of systematic work completion from start to finish covering the main work stages and job descriptions of each type of main work activity that can be technically accounted for (Octiva et al., 2021). In compiling the implementation method, it should be in accordance with the requirements in the document where the method of carrying out the work made must meet the substantive requirements specified in the selection document and describe mastery in completing the work (Pandiangan, 2018). Stages of work from beginning to end in outline and job descriptions of each main type of work, namely the suitability of work methods (Pandiangan et al., 2022). The main equipment offered in the execution of work and the suitability of work methods with the required job specifications (Pandiangan, 2022; Tobing et al., 2018).

Behavioral parameters are used to identify the model dynamics in conditions leading to steady-state (i.e. long-term equilibrium). The parameters used for estimation purposes were obtained through a calibration approach based on the previous study's results. The calculation of the optimal coefficient uses the dynare optimal simple rule routine using the dynare 4.5.7 and matlab software. The basic problem in the quadratic linear model is to select a subset of parameters to reduce the weight (co) - variance of endogenous variables to law of linear motion at first order conditions. The linear quadratic problem was solved by employing the csminwel numerical optimizer of Chris Sims.

The rule of optimal simple policy for linear-quadratic problems was as follows:

$$\min_{\gamma} E(y_t^l W_{y_t})$$

And subject to:

$$A_1 E_t y_{t+1} + A_2 y_t + A_3 y_{t-1} + C e_t = 0$$

Where:

1. E is the operator's unconditional expectations.
2. γ represent a parameter to be optimized and has a matrix element, A_1, A_2, A_3 as a parameter in params-commands and included in the equation block.
3. y are endogenous variables, i.e. in the var-command and (co) - variance included in the loss function.
4. e represents exogenous stochastic shocks, i.e. in var_exo-command.
5. W is the matrix's weight.

As previously described above on the central bank objective function, following is the function of policy losses and modelling constraints.

$$L = \gamma_{\pi}\sigma_{\pi}^2 + \gamma_y\sigma_y^2 + \gamma_{RB}\sigma_{RB}^2 + \gamma_s\sigma_s^2 + \gamma_{LB}\sigma_{LB}^2$$

Where, L represents a loss function of the central bank consisting of fluctuations in inflation (σ_{π}^{2}), output (σ_{y}^{2}), interest rates (σ_{RB}^{2}), exchange rates (σ_{s}^{2}) and credit (σ_{RB}^{2}). The parameter of γ represents the weight of each variable with an amount equal to 1 (one).

Some basic models of household, entrepreneurial and bank financial institution behaviour adopt the new keynesian model from (Harmanta et al., 2011). Modelling constraints are as follows:

(Ricardian Household Lagrangian)

$$\tilde{\pi}W_t = \beta E_t \tilde{\pi}W_{t+1} + \left[\frac{(1-\theta_w)(1-\beta\theta w)}{\theta w}\right]\left[\varphi\tilde{L}_{R,t} - \tilde{\lambda}_{R,t} + \left(\frac{\tau_{ss}^{l}}{1-\tau_{ss}^{l}}\right)\tilde{\tau}_t^{l}\right]$$

(Phillipis Equation for the Ricardian Household)

$$\tilde{\pi}w,t = \tilde{W}_t - \tilde{W}_{t-1}$$

(Gross Wage Inflation Rate)

$$P_{ss}C_{R,ss}\left[(\tilde{P}_t + \tilde{C}_{R,t})(1+\tau_{ss}^{c}) + \tau_{ss}^{c}\tilde{\tau}_t^{c}\right] + P_{ss}I_{ss}^{P}\left[(\tilde{P}_t + \tilde{C}_{R,t})(1+\tau_{ss}^{c}) + \tau_{ss}^{c}\tilde{\tau}_t^{c}\right] + \frac{B_{ss}}{R_{ss}^{B}}\left(\tilde{B}_{t+1} - \tilde{R}_t^{B}\right)$$

$$= W_{ss}L_{R,ss}\left[(\tilde{W}_t + \tilde{L}_{R,t})(1-\tau_{ss}^{l} - \tau_{ss}^{l}\tilde{\tau}_t^{l}\right] + R_{ss}K_{ss}^{P}\left[\left(\tilde{R}_t + \tilde{K}_t^{k}\right)(1-\tau_{ss}^{kl}) - \tau_{ss}^{k}\tilde{\tau}_t^{k}\right] + B_{ss}\tilde{B}_t + \omega_R\overline{TRANS_t}$$

(Ricardian Household Budget constraint)

$$\left(\frac{Q_{ss}}{\beta}\right)\tilde{Q}_t = E_t\left\{\begin{matrix}(1-\delta)Q_{ss}\tilde{Q}_{t+1} + \lambda_{R,ss}R_{ss}U_{ss}(1-\tau_{ss}^{k})\left[\tilde{\lambda}_{R,t+1} + \tilde{R}_{t+1} + \tilde{U}_{t+1} - \left(\frac{\tau_{ss}^{k}}{1-\tau_{ss}^{k}}\right)\tilde{\tau}_{t+1s}^{k}\right] \\ -\lambda_{R,ss}P_{ss}\psi_1 U_{ss}\tilde{U}_{t+1}\end{matrix}\right\}$$

(Tobin's Q)

$$(1-\tau_{ss}^{k})\frac{R_{ss}}{P_{ss}}\left[\tilde{R}_t - \tilde{P}_t - \left(\frac{\tau_{ss}^{k}}{1-\tau_{ss}^{k}}\right)\tilde{\tau}_t^{k}\right] = \psi_2 U_{ss}\tilde{U}_t$$

(Demand for Installed Capacity)

$$(1-\tau_{ss}^{k})\lambda_{R,ss}P_{ss}\left[\lambda_{R,t} + \tilde{P}_t + \left(\frac{\tau_{ss}^{k}}{1-\tau_{ss}^{k}}\right)\tilde{\tau}_t^{c}\right] - Q_{ss}\tilde{Q}_t + \chi Q_{ss}(\tilde{I}_t^{P} - \tilde{I}_{t-1}^{P}) = \chi\beta Q_{ss}(E_t\tilde{I}_{t+1}^{P} - \tilde{I}_t^{P})$$

(Demand for Investments)

$$\tilde{K}_{t+1}^{P} = (1-\delta)\tilde{K}_t^{P} + \delta\tilde{I}_t^{P}$$

(Law of Motion of Private Capital)

$$\tilde{\lambda}_{R,t} - \tilde{R}_t^{R} = \tilde{\lambda}_{R,t+1}$$

(Euler Equation Public Bond)

$$\tilde{\lambda}_{NR,t} + \tilde{P}_t + \left(\frac{\tau_{ss}^{c}}{1+\tau_{ss}^{c}}\right)\tilde{\tau}_t^{c} = \left[\frac{\sigma}{(1-\phi_c\beta)(1-\phi_c)}\right]\left[\phi_c\beta(E_t\tilde{C}_{NR,t+1} - \phi_c\tilde{C}_{NR,t}) - (\tilde{C}_{NR,t} - \phi_c\tilde{C}_{NR,t-1})\right]$$ (Non-

(Non-Ricardian Household Lagrangian)

$$\tilde{\pi}\tilde{W}_t = \beta E_t\tilde{\pi}\tilde{W}_{t+1} + \left[\frac{(1-\theta w)(1-\beta\theta w)}{\theta w}\right]\left[\varphi\tilde{L}_{NR,t} - \tilde{\lambda}_{NR,t} + \left(\frac{\tau_{ss}^{l}}{1-\tau_{ss}^{l}}\right)\tilde{\tau}_t^{l}\right]$$

(Phillips Equation for Non-Ricardian Household Wage)

$$C_{ss}\tilde{C}_t = \omega_R L_{R,ss}\tilde{L}_{R,ss} + (1-\omega_R)C_{NR,ss}$$

(Aggregate Consumption)

$$L_{ss}\tilde{L}_t = \omega_R L_{R,ss}\tilde{L}_{R,ss} + (1-\omega_R)L_{NR,ss}\tilde{L}_{NR,ss}$$

(Aggregate Labor)

$$\tilde{Y}_t = \tilde{A}_t + \alpha_1(\tilde{U}_t + \tilde{K}_t^k) + \alpha_2\tilde{L}_t + \alpha_3\tilde{K}_t^K$$

(Production Function)

$$\tilde{L}_t - \tilde{U}_t - \tilde{K}_t^P = \tilde{R}_t\tilde{W}_t$$

(Problem of the Firm Trade-Off, MRS=Relative price)

$$\overline{MC}_t = \alpha_2\tilde{W}_t + \alpha_2\tilde{R}_t - \tilde{A}_t - \alpha_3 K_t^G$$

(Marginal Cost)

$$\tilde{\pi}_t = \beta E_t\tilde{\pi}_{t+1} + \left[\frac{(1-\theta w)(1-\beta\theta w)}{\theta w}\right](\overline{MC}_t - \tilde{P}_t)$$

(Phillipis Equation)

$$\tilde{\pi}_t = \tilde{P}_t - \ddot{P}_{t-1}$$

(Gross Inflation Rate)

$$\frac{B_{ss}}{R_{ss}^B}(\tilde{B}_{t+1} - \tilde{R}_t^B) - B_{ss}\tilde{B}_t + T_{ss}\tilde{T}_t = P_{ss}G_{ss}(\tilde{G}_t\tilde{P}_t) + P_{ss}I_{ss}^G(\tilde{P}_t + \tilde{I}_t^G) + P_{ss}TRANS_{ss}(\tilde{P}_t + \overline{TRANS}_{ss})$$ (G

overnment Budget Constraint)

$$T_{ss}\tilde{T}_t = \tau^c P_{ss}\left[C_{ss}(\tilde{C}_t + \tilde{P}_t) + I_{ss}^P(\tilde{I}_s^P + \tilde{P}_t)\right] + \tau^l W_{ss}L_{ss}(\tilde{W}_t + \tilde{L}_t) + \tau^k K_{ss}^P\left[R_{ss}(\tilde{R}_t + \tilde{K}_t^P\right]$$

(Government Tax Revenues)

$$RLB = \frac{RP + \Omega + \rho_B(1-\pi)}{1-\rho_B}$$

(Interest Rate Equation)

$$RP - RF = \theta_f + S$$

$$\theta^f = \theta * \theta_{t-1}^f + \varepsilon_\theta$$

(The Spread of Lending and Deposit Rates)

$$RD = RP * (1 - 0{,}02)$$

(Deposit Rates Equation)

$$RP - RF = \theta^f + S$$

$$S = \Phi * S_{t-1} + \varepsilon_s$$

(The Spread of Domestic and Foreign Interest Rates)

$$RR = \kappa * RR_{t-1} + \kappa_2 LB + \varepsilon_{RR}$$

$$LB = \kappa_1 Y + \varepsilon_{LB}$$

(The Reserve Requirement Equation)

$$\tilde{K}_{t+1}^G = (1-\delta_G)\tilde{K}_t^G + \tilde{\delta}_t^G$$ (Law of Motion of Public Capital)

$$\tilde{Z}_t = \gamma_z\tilde{Z}_{t-1} + (1-\gamma_{Z)}\phi_Z(\tilde{B}_t - \tilde{Y}_{t-1} - \tilde{P}_{t-1}) + \tilde{S}_t^Z$$ (Fiscal Policy Rule)

$$\tilde{R}_t^B = \gamma_R\tilde{R}_{t-1}^B + (1-\gamma_R)(\gamma_\pi\tilde{\pi}_t + \gamma_y\tilde{Y}_t) + \tilde{S}_t^m$$ (Taylor Rule)

$$Y_{ss}\tilde{Y}_t = C_{ss}\tilde{C}_t + I_{ss}^P\tilde{I}_t^P + I_{ss}^G\tilde{I}_t^G + G_{ss}\tilde{G}_t$$ (Equilibrium Condition)

$$\tilde{A}_t = \rho_A\tilde{A}_{t-1} + \varepsilon_t$$ (Production Shock)

$$\tilde{S}_t^Z = \rho_Z\tilde{S}_{t-1}^Z + \varepsilon_{Z,t}$$ (Fiscal Policy)

$$\tilde{S}_t^m = \rho_m\tilde{S}_{t-1}^m + \varepsilon_{m,t}$$ (Monetary Policy Shock)

Where, b_t are government securities, l_t are domestic loans, l_t^f foreign loans, ρ_B are default risk of loans, θ_t^f foreign risk premiums, R_t^f are foreign interest rates, R_t^d are deposit rates, R_t^l are loan interest rates, R_t^P are policy interest rates, s_t exchange rates, RR reserve requirement, LB is the amount of credit.

The modeling used in policy simulation through policy instruments uses four scenarios, namely plain vanilla taylor rule, lean against the wind taylor rule, lean against the wind taylor rule with macroprudential policy and independent macroprudential policy.

The following are the general forms of the policy rule:

$$\tilde{R}_t^P = \gamma_R \tilde{R}_{t-1}^P + (1-\gamma_R)(\gamma_\pi \tilde{\pi}_t + \gamma_y \tilde{Y}_t + \gamma_S \tilde{S}) + \tilde{S}_t^m$$

Where γy and γπ are the sensitivity of the base interest rate in relation to output and the inflation rate, respectively, and γR is the interest rate smoothing parameter. S_t^m is a shock of monetary policy.

1. The Plain Vanilla Taylor Rule
$$\tilde{R}_t^B = \gamma_R \tilde{R}_{t-1}^B + (1-\gamma_R)(\gamma_\pi \tilde{\pi}_t + \gamma_\gamma \tilde{Y}_t + \gamma_S \tilde{S}_t) + \tilde{S}_t^m$$
2. Lean Against the Wind Taylor Rule
$$\tilde{R}_t^B = \gamma_R \tilde{R}_{t-1}^B + (1-\gamma_R)(\gamma_\pi \tilde{\pi}_t + \gamma_\gamma \tilde{Y}_t + \gamma_S \tilde{S}_t + \gamma_{LB} L\tilde{B}_t) + \tilde{S}_t^m$$
3. Lean Against the Wind Taylor Rule with Independent Macro-Prudential Policy
$$\tilde{R}_t^B = \gamma_R \tilde{R}_{t-1}^B + (1-\gamma_R)(\gamma_\pi \tilde{\pi}_t + \gamma_\gamma \tilde{Y}_t + \gamma_S \tilde{S}_t + \gamma_{LB} L\tilde{B}_t) + \tilde{S}_t^m$$
$$RR = \kappa * RR_{t-1} + \kappa_2 LB + \varepsilon_{RR}$$
4. Independent Macro-Prudential Policy
$$\tilde{R}_t^B = \gamma_R \tilde{R}_{t-1}^B + (1-\gamma_R)(\gamma_\pi \tilde{\pi}_t + \gamma_\gamma \tilde{Y}_t + \gamma_S \tilde{S}_t) + \tilde{S}_t^m$$
$$RR = \kappa * RR_{t-1} + \kappa_2 LB + \varepsilon_{RR}$$

III. Discussion

3.1 The Dynamic of Monetary Policy Rule

Macroprudential policy has a role that supports the objectives of monetary policy in maintaining price and output stability. Macroprudential policy aims to ensure the resilience of the whole financial system and to prevent the boom-bust cycle of credit supply and liquidity. Macroprudential policy is counter-cyclical in synergy with the objective of monetary policy in reducing economic fluctuations. Macroprudential policy also tightens the requirements over capital and liquidity, especially when the economy is on an upswing that may encourage banks to reduce credit growth and to maintain bank resilience going forward when the economy worsens.

The interaction between monetary and macroprudential policies is very important in minimizing the impact of systemic risk on the economy. The social loss function approach is used by the central bank in the interaction model of monetary and macroprudential policies in providing maximum social welfare for the economy.

The dynamics of the relationship pattern of integration of monetary and macroprudential policies are distinguished in the simulation of four loss function models, namely (1)plain vanilla taylor rule; (2)lean against the wind taylor rule; (3)independent macroprudential policy rule; and (4)lean againts the wind plus macroprudential policy rule.

a. Plain Vanilla Taylor Rule

The plain vanilla taylor rule model is a function model of monetary policy reaction with a standard taylor rule where the objective of monetary policy is to minimize losses from inflation, output and exchange rate deviations in the open economic system by using interest rate instruments as short-term instruments in achieving the ultimate goal of monetary policy. The results of the impulse response analysis indicated that the shock of monetary policy had an impact on several related macroeconomic indicators, as follows:

1. Monetary policy shock was responded positively by output (Y) with the highest deviation of 0.02. This which means that an increase in monetary policy in this case the use of policy interest rates cause an increase in output at the beginning of the period and continue to decline although the value was still positive until a state of equilibrium is reached.
2. Inflation (PI) positively responds to an increase in interest rates with deviations that are still lower than output and declines towards equilibrium. This indicates that the policy of interest rate in the design of this policy reaction is quite effective in controlling price stability compared to output stabilization.
3. The same response pattern with output is shown by bank credit (LB) which shows a positive pattern and decreases towards balance (Figure 1). This shows that an increase in interest rates at the beginning period was corresponded to an increase in credit. However, after the 10th period a decreased trend was observed, which indicating that an increase in interest rates causes a decrease in credit to the balance. There is an interaction of the business cycle pattern with the financial cycle and the procyclicality pattern between output and credit, although at the beginning of the period an increase in interest rates did not reduce credit demand during the interval of less than 10 initial periods.

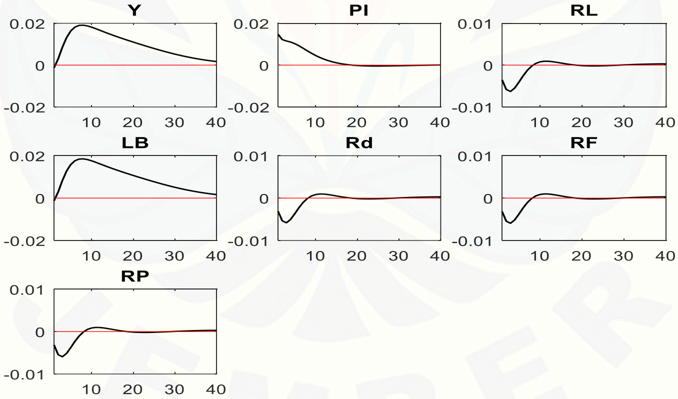

Figure 1. *Impulse Response from Monetary Policy Shock to the Plain Vanilla Taylor Rule Model*

4. Meanwhile, the response of deposit rates, lending rates and foreign interest rates showed the same pattern in the range of negative deviations and became positive and headed for equilibrium after the 10th period, which means that the spread between interest rates is relatively small to both domestic interest rates and foreign interest rates.

b. Lean Against the Wind Taylor Rule

The lean against the wind taylor rule model is the adoption of a model in response to the 2008 global financial crisis, whereby the stabilization of the financial system was responded to through a policy of controlling credit. This model is different from the plain vanilla taylor rule, namely by adding credit indicators as the main indicators of stabilization. This is because the financial crisis has vital implications for the existence of frictions in credit that affect economic stability.

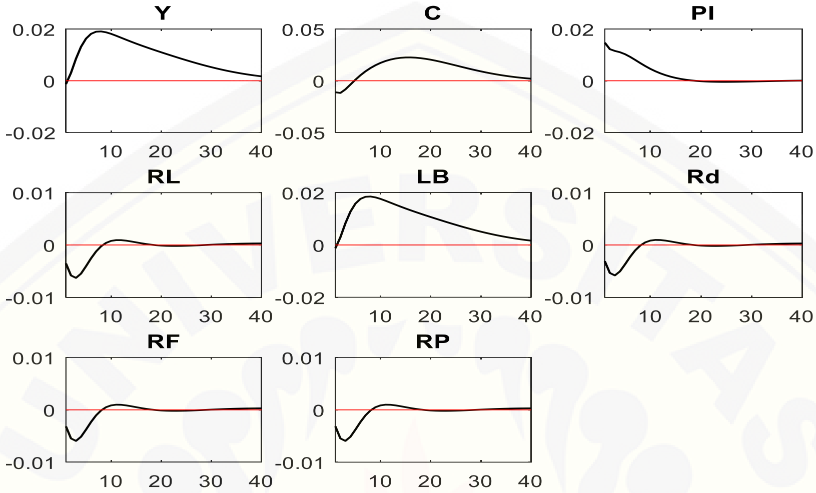

Figure 2. *Impulse Response from Monetary Policy Shock to the Lean against the Wind Model*

The results of the impulse response analysis showed that the shock of monetary policy influenced several macroeconomic indicators namely the response pattern and the same amount of deviation on output, inflation, credit and interest rates in the plain vanilla taylor rule model. The use of policy rates gives an impact of an increase in output at the beginning of the period and decreases although it is still positive until it reaches a state of equilibrium. Likewise, inflation also shows the same response pattern as the plain vanilla taylor rule model. Inflation (PI) positively responds to an increase in interest rates with deviations that are still lower than output and declines towards equilibrium (Figure 2).

c. Lean Against the Wind with Macroprudential Policy Rule

The lean against the wind taylor rule model with the macroprudential policy rule is the development of the previous lean against the wind taylor rule model only by adding macroprudential policy instruments in the modelling. This model of the policy reaction function emphasizes the importance of separate macroprudential policy instruments and interest rate instruments in achieving the ultimate goal of monetary policy. This third model simulation aims to see whether the addition of macroprudential instruments gives the minimum loss.

This study also indicated that the shock of monetary policy had the same relative impact as the previous model (Figure 3). The same pattern of response and the amount of deviation in output, inflation, credit and interest rates in the plain vanilla taylor rule model. The use of policy rates gives an impact of an increase in output at the beginning of the period and decreases although it is still positive until it reaches a state of equilibrium. Likewise, inflation also shows the same response pattern as the plain vanilla taylor rule model. Inflation (PI) positively responds to an increase in interest rates with deviations that are still lower than output and declines towards equilibrium.

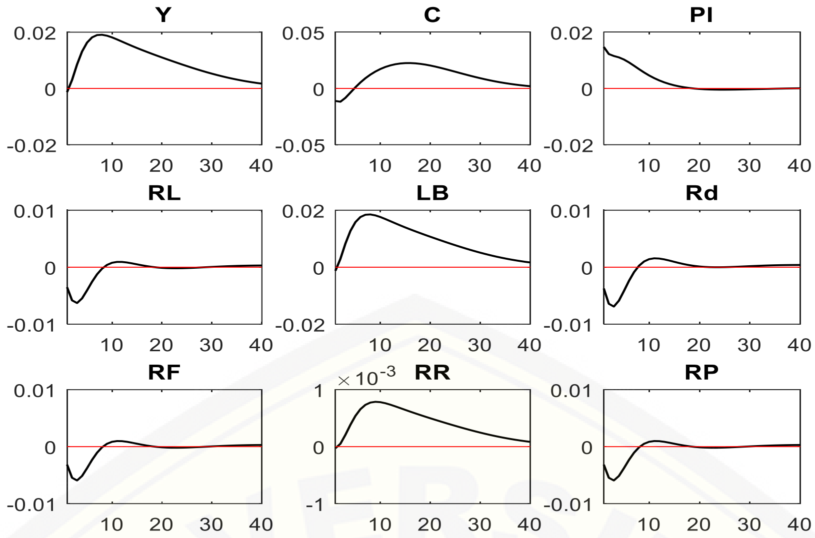

Figure 3. *Impulse Response from Monetary Policy Shock to the Lean against the Wind Model with Macroprudential Policy*

d. Independent Macroprudential Policy Rule

This model of the policy reaction function emphasizes the importance of separate macroprudential policy instruments and interest rate instruments in achieving the ultimate goal of monetary policy. This third model simulation aims to see whether the addition of macroprudential instruments gives the minimum loss (Figure 4).

This study demonstrated that the monetary policy shock has the same effect as the other policy reaction models on output, inflation, credit and interest rates. This shows that the interrelation patterns between variables in various policy reaction models have the same impact. Thus, it can be concluded that there are interactions of business cycle patterns and financial cycles in responding to existing policies. Likewise, with the technology diffusion, as a whole has not had a significant impact on the pattern of business cycles or financial cycles, but it still puts pressure on prices.

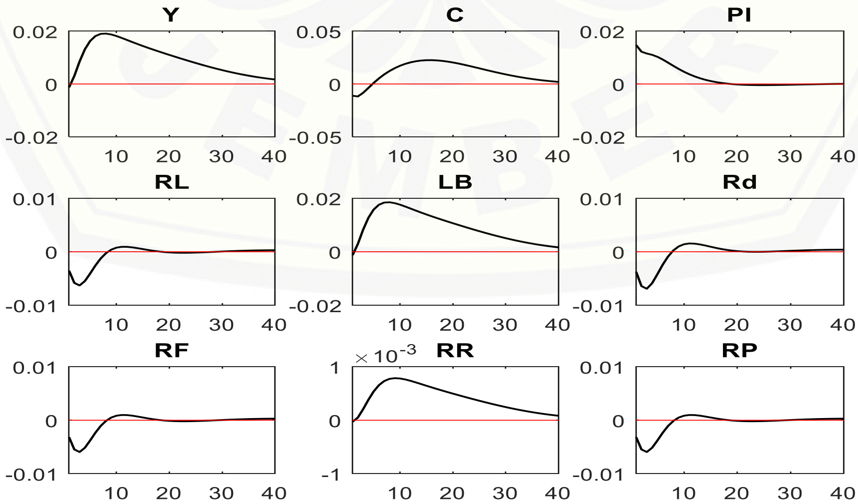

Figure 4. *Impulse Response from Monetary Policy Shock to the Independent Macroprudential Policy*

3.2 Welfare Loss Function

In achieving the ultimate monetary policy goal, the central bank has a policy framework through the policy reaction function to identify how effective the policy instruments being able to signal the achievement of the final policy objectives. The central bank has an objective function in the form of a loss function to be minimized, thus can provide maximum benefit for the economy (social welfare). The amount of weight given to variance is one with the inflation variance being given the greatest weight based on consideration, the sole objective of monetary policy is price stability.

Table 1. Loss Value 0f Optimal Simple Rule

Policy Rule Scenario	γ_R	γ_Y	γ_π	γ_S	γ_{LB}	**Loss**
Plain Vanilla Taylor Rule	-0.706	0.587	1.992	0.071	-	9.74206e-05
Lean Against the Wind Taylor Rule	-0.542	0.576	1.976	0.071	0.5661	0.00011764
Lean Against the Wind Taylor Rule with Macroprudential	-0.542	0.576	1.976	0.071	0.5661	0.00011764
Independent Macroprudential	-0.706	0.587	1.992	0.071	-	9.74206e-05

Source: Data Processed in 2019

Table 1 shows that all models show a policy response to greater variance in inflation compared to output and credit and an exchange rate that shows the smallest variance. This shows that price stability is still the main focus in overall macroeconomic stabilization. While the interest smoothing response is also relatively small, which indicates a slower adjustment process compared to the actual target value.

The scenario of the plain vanilla taylor rule gave the same loss value as the independent macroprudential policy. It has the smallest loss function value than the lean against the wind taylor rule and lean against the wind taylor rule with macroprudential. This shows that the modification of the taylor rule model with the macroprudential policy rule is quite effective in reducing the central bank's loss function. The use of macroprudential policy instruments provides greater benefits in achieving optimal monetary policy. This shows that monetary policy as a complement or buffer to monetary policy is quite effective in achieving macroeconomic stability.

The smallest loss function value was acquired when the central bank runs monetary policy and macroprudential policy comprehensively, where the two policy instruments are used for achieving two different purposes. In this case, the interest rate policy is aimed at achieving inflation and output stability, while macroprudential policy is used to achieve stabilization of credit growth.

Therefore, there is a substantial advantage from the cooperative actions of monetary and macroprudential policies. Financial shock is a major driver of macroeconomic fluctuations. Now, the additional macroeconomic stability by macroprudential policy over monetary policy itself was found to be significant. This advantage is "paid" by greater volatility in the policy rate and in the inflation rate. This result is most likely due to the central bank cooperation case "lending a hand" to macroprudential policy, partly deviating from its own target, while in the non-cooperative scenario focusing exclusively on price stability and ignoring the instability caused by financial shocks (Angelini et al., 2011).

A study Angelini et al. (2011) by follows the DGSE concept described in Junior (2017) and uses the DSGE model developed by Gerali et al. (2010) for the imperfectly competitive banking sector, and estimates the benefits of macroprudential policies, wherein all cases, the coordination between the central bank and macroprudential authorities resulted in superior outcomes. The results of the study show that macroprudential policy can improve macroeconomic stability. In normal conditions where the economic cycle is caused by supply-side shock, the macroprudential policy will provide stability benefits when compared to just carrying out monetary policy. Therefore, both the policy and the two authorities can interact through coordination in influencing the interest rate policy instruments for the central bank and the capital requirements for macroprudential authority. This is due to macroprudential and monetary policies having a relationship in variables (eg. interest rates, credit supply, etc.), but has different objective functions. The effectiveness of macroprudential policy depends on the shock and the degree of coordination with monetary policy.

A valuable lesson experienced by Indonesia from the 1998 financial crisis and the 2008 global crisis was that the costs of handling the crisis were very significant. The cost of crisis recovery is getting heavier because it takes a long time to revive public confidence in the financial system. The crisis proves that an unstable financial system can have a wide impact on the real sector and the task of maintaining price stability is increasingly difficult. Therefore, it is deemed necessary for policy makers to monitor financial system stability including prudent supervision and regulation, liquidity management, monetary policy, and crisis management.

The emergence of the credibility paradox of economic agent contributed to the procyclicality of the financial sector. The importance of maintaining price stability is expected to provide momentum for sustainable economic growth, which also needs to be supported by maintaining financial system stability. Thus, these objectives may simultaneously provide macroeconomic stability, as stated the principle of Tinbergen (i.e. at least one independent policy instrument for each policy objective). Therefore, in addition to achieving monetary stability, Bank Indonesia's objective, namely achieving and maintaining price stability, also needs to be added to maintaining financial system stability. This price stability includes the price stability of domestic goods and services and the stability of the Indonesian rupiah (IDR) exchange rate. One indicator of financial system stability is the price of assets, both physical assets (i.e. property) and financial assets (i.e. stocks, bonds, and other securities).

IV. Conclusion

The policy scenario using a combination of plain vanilla taylor rule and macroprudential rule shows the smallest loss function. While the policy rule that includes credit growth directly with the policy interest rate produces the largest or less effective loss function. This shows that macroprudential instruments, as a monetary policy buffer, were successfully reduce the loss function of the central bank. The central bank carried out a holistic monetary policy and macroprudential policy to achieve for two purposes as stated in the Tinbergen Principle. The interest rate policy was aimed for reaching inflation and output stability, whilst the macroprudential policy for credit growth. Macroeconomic stability with the addition of macroprudential policy is significant. Greater volatility in the policy rate and in the inflation rate was expected to be obtained.

References

Angelini, P., Neri, S., & Panetta, F. (2011). Monetary and Macroprudential Policies. Banca d'Italia Working Paper, 801.

Asyraini, Siti, Fristy, Poppy, Octiva, Cut Susan, Nasution, M. Hafiz Akbar, & Nursidin, M. (2022). Peningkatan Kesadaran Protokol Kesehatan di Masa Pandemi Bagi Warga di Desa Selamat Kecamatan Biru-biru. Jurnal Pengabdian Kontribusi (Japsi), 2(1), 33-36.

Beau, D., Chan, C., Clerc, L., & Mojon, B. (2012). Macro-Prudential Policy and the Conduct of Monetary Policy. Bauducco S, Christiano L, Raddatz C (Eds.) in Macroeconomic and Financial Stability: Challenges for Monetary Policy, 19(9), 273-314.

Bernanke, B. S. (2010). Monetary Policy and the Housing Bubble. Speech Given at The Annual Meeting of The American Economic Association on 11 April 2014, Atlanta, Georgia. Retrieved from http://www.federalreserve.gov/newsevents/speech/bernanke20100103a.htm.

Blanchard, O. (2013). Bubbles, Liquidity Traps, and Monetary Policy. Comments on Jinushi et al and on Bernanke; 2000. Retrieved from http://economics.mit.edu/files/718. on 12 June 2013.

Chakraborty, S., & Banerjee, S. (2009). Krisis Keuangan di Dunia Berkembang – Pasca "Bencana Penggelembungan Harga Aset" AS-Jalan Baru ke Depan. Buletin Ekonomi, Moneter dan Perbankan, 12(1), 5-32.

Gerali, A., Neri, S., Sessa, L., & Signoretti, F. (2010). Credit and Banking in a DSGE Model of the EURO Area. J. Money, Credit Bank. Suppl. 42, 107–141.

Harmanta, M., Bathaluddin, B., & Waluyo, J. (2011). Inflation Targeting Under Imperfect Credibility: Lessons from Indonesian Experience. Bul. Monetary Econ. Bank, 271-305.

Junior, C, J, C. (2017). Understanding DSGE Models: Theory and Applications. USA: Vernon Press.

Kent, C., & Lowe, P. (1997). Asset Price Bubbles and Monetary Policy, Reserve Bank of Australia. Research Discussion Paper, 9709.

Kusumadewi, R. (2019). The Role of Marketing and Individual Environment Association in Elevating the Customer Value. Budapest International Research and Critics Institute-Journal (BIRCI-Journal) Vol 2 (4): 451-460.Management, A., & Management, A. (2006). www.econstor.eu.

Octiva, Cut Susan. (2018). Pengaruh Pengadukan pada Campuran Limbah Cair Pabrik Kelapa Sawit dan Tandan Kosong Kelapa Sawit terhadap Produksi Biogas. Tesis. Medan: Fakultas Teknik, Program Studi Teknik Kimia, Universitas Sumatera Utara. https://repositori.usu.ac.id/bitstream/handle/123456789/12180/157022002.pdf?sequence=1&isAllowed=y.

Octiva, C. S., Irvan, Sarah, M., Trisakti, B., & Daimon, H. (2018). Production of Biogas from Co-digestion of Empty Fruit Bunches (EFB) with Palm Oil Mill Effluent (POME): Effect of Mixing Ratio. Rasayan J. Chem., 11(2), 791-797.

Octiva, Cut Susan, Indriyani, & Santoso, Ari Beni. (2021). Effect of Stirring Co-digestion of Palm Oil and Fruith for Biogas Production to Increase Economy Benefit. Budapest International Research and Critics Institute-Journal, 4(4), 14152-14160. DOI: https://doi.org/10.33258/birci.v4i4.3521.

Pandia, S., Tanata, S., Rachel, M., Octiva, C., & Sialagan, N. (2018). Effect of Fermentation Time of Mixture of Solid and Liquid Wastes from Tapioca Industry to Percentage Reduction of TSS (Total Suspended Solids). IOP Conference Series: Materials Science and Engineering, 309, 012086. DOI: 10.1088/1757-899X/309/1/012086.

Pandiangan, Saut Maruli Tua. (2015). Analisis Lama Mencari Kerja Bagi Tenaga Kerja Terdidik di Kota Medan. Skripsi. Medan: Fakultas Ekonomi dan Bisnis, Program Studi Ekonomi Pembangunan, Universitas Sumatera Utara. https://www.academia.edu/52494724/Analisis_Lama_Mencari_Kerja_Bagi_Tenaga_Kerja_Terdidik_di_Kota_Medan.

Pandiangan, Saut Maruli Tua. (2018). Analisis Faktor-faktor yang Mempengaruhi Penawaran Tenaga Kerja Lanjut Usia di Kota Medan. Tesis. Medan: Fakultas Ekonomi dan Bisnis, Program Studi Ilmu Ekonomi, Universitas Sumatera Utara. http://repositori.usu.ac.id/bitstream/handle/123456789/10033/167018013.pdf?sequence=1&isAllowed=y.

Pandiangan, Saut Maruli Tua, Rujiman, Rahmanta, Tanjung, Indra I., Darus, Muhammad Dhio, & Ismawan, Agus. (2018). An Analysis on the Factors which Influence Offering the Elderly as Workers in Medan. IOSR Journal of Humanities and Social Science (IOSR-JHSS), 23(10), 76-79. DOI: 10.9790/0837-2310087679. http://www.iosrjournals.org/iosr-jhss/papers/Vol.%2023%20Issue10/Version-8/K2310087679.pdf.

Pandiangan, Saut Maruli Tua, Resmawa, Ira Ningrum, Simanjuntak, Owen De Pinto, Sitompul, Pretty Naomi, & Jefri, Riny. (2021). Effect of E-Satisfaction on Repurchase Intention in Shopee User Students. Budapest International Research and Critics Institute-Journal, 4(4), 7785-7791. DOI: https://doi.org/10.33258/birci.v4i4.2697.

Pandiangan, Saut Maruli Tua, Oktafiani, Fida, Panjaitan, Santi Rohdearni, Shifa, Mutiara, & Jefri, Riny. (2022). Analysis of Public Ownership and Management Ownership on the Implementation of the Triple Bottom Line in the Plantation Sector Listed on the Indonesia Stock Exchange. Budapest International Research and Critics Institute-Journal, 5(1), 3489-3497. DOI: https://doi.org/10.33258/birci.v5i1.4016.

Pandiangan, Saut Maruli Tua. (2022). Effect of Packaging Design on Repurchase Intention to the Politeknik IT&B Medan Using E-Commerce Applications. Journal of Production, Operations Management and Economics (JPOME), 2(1), 15–21. http://journal.hmjournals.com/index.php/JPOME/article/view/442.

Romdonny, J., and Rosmadi, M.L.N. (2019). Factors Affecting Customer Loyalty in Products. Budapest International Research and Critics Institute-Journal (BIRCI-Journal Vol 2 (1): 337-343.

Taylor, J. B. (2009). The Financial Crisis and the Policy Responses: an Empirical Analysis of What Went Wrong. NBER Working Paper, 14631.

Tobing, Murniati, Afifuddin, Sya'ad, Rahmanta, Huber, Sandra Rouli, Pandiangan, Saut Maruli Tua, & Muda, Iskandar. (2018). An Analysis on the Factors Which Influence the Earnings of Micro and Small Business: Case at Blacksmith Metal Industry. Academic Journal of Economic Studies, 5(1), 17-23. https://www.ceeol.com/search/article-detail?id=754945.

Turner, P. (2013). Central Banks and the Financial Crisis; 2010. Retrieved from http://www.bis.org/publ/bppdf/bispap51e.pdf. on 17 September 2013.