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FISCAL POLICY STANCE, CENTRAL BANK DIGITAL CURRENCY, AND THE OPTIMAL MONETARY-MACROPRUDENTIAL POLICY MIX

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ABSTRACT

This paper seeks to answer the following policy-relevant questions: (i) does the complementarity between monetary and macroprudential policies depend on the monetary and fiscal policy stances, and (ii) what is the likely aggregate effect of a central bank digital currency (CBDC) issuance on the existing central bank policy mix (CBPM) framework. We analyze these questions within a medium-scale Dynamic Stochastic General Equilibrium (DSGE) model for Indonesia with a non-trivial fiscal policy and a parsimonious CBDC effect. On the first question, we find that monetary-fiscal policy stances do matter for whether a macroprudential policy rule stabilizes business cycle fluctuations and is welfare-improving. It is still the case, however, a passive monetary, active fiscal regime (PMAF) is sub-optimal compared to the active monetary, passive fiscal (AMPF) regime counterpart. On the second question, we find that a CBDC issuance lowers the transaction costs and its effects on aggregate economic variables are similar to the effects of a permanent technological progress.

Keywords: integrated policy framework; central bank policy mix; DSGE model for Indonesia; monetary-fiscal policy coordination; macroprudential-fiscal policy coordination; central bank digital currency (CBDC).

JEL Classifications: E12; E32; E58; E61; E63; F41.

1 Introduction

As the nation central bank, Bank Indonesia (BI) has an important role in regulating the fluctuations in both the business cycle and financial cycle arising from domestic and external shocks. To this end, BI has adopted a so-called central bank policy mix (CBPM) framework (Agung et al. (2016), Warjiyo (2017), Warjiyo and Juhro (2019)), on top of the official inflation targeting policy. This CBPM framework, or an integrated policy framework (Adrian et al. (2020), Basu et al. (2020)), may involve a mix of monetary policy, macroprudential policy, and external-balance policy such as exchange rate and capital flow managements. In a recent research using an estimated DSGE model for Indonesia, Juhro et al. (2022a) show that a right mix of monetary and macroprudential policy rules can stabilize business cycle and financial cycle fluctuations, compared to the situation where monetary policy is used in isolation. They find that the complementarity between monetary policy and a given counter-cyclical macroprudential policy rule is shock-specific (state-dependent) and depends on whether the associated macroprudential instrument primarily affects the supply of credit (e.g. bank capital requirement ratio) or the demand for credit (e.g. loan-to-value ratio). For the estimated shock distributions, they find that supply-channel macroprudential policy instruments such as capital requirement ratio and macroprudential policy liquidity buffer (MPLB) are welfare-improving and reduce aggregate fluctuations.[1]

Recent events, however, call for a rethinking on whether the current CBPM framework is in need of further enhancements. During the height of the COVID-19 pandemic in 2020-2021, for example, many central banks are constrained in their efforts to mitigate the economic fallout by the zero lower bound (ZLB) on the nominal interest rate. Many such countries instead relied on fiscal policy measures to stabilize their economies. While the ZLB was never binding in Indonesia, both BI and the Indonesian government decided that a large fiscal stimulus was warranted in response to the pandemic.[2] This calls into question whether fiscal policy should belong to the CBPM framework, and particularly, what should be its interaction with monetary policy. Rapid technological innovations in the financial technology (FinTech) sector in the past decade have also prompted many central banks to contemplate the idea of issuing a central bank digital currency (CBDC) (Boar et al. (2021), Jahan et al. (2022)), Bank Indonesia included.[3] Furthermore, the current high-inflation environment globally creates a policy tradeoff for central banks with multiple objectives. Since the recent high inflation rates are primarily caused by the pandemic-related supply-side constraints and the increase in oil price, a central bank raising the policy interest rate to curb the rise in inflation would have to contend with lower real aggregate activities (output) in the short run. Multiple policy instruments are generally

[1] MPLB = *Penyangga Likuiditas Makroprudensial* (*PLM*)

[2] By July 2020, Bank Indonesia has indeed committed to purchase around 574 trillion rupiah of sovereign bonds directly from the Indonesian government to help finance its fiscal response to the pandemic.

[3] See a recently published white paper on digital rupiah (Bank Indonesia (2022)).

needed to mitigate a policy tradeoff of this kind.

In this paper we extend the DSGE model in Juhro et al. (2022a) to include a non-trivial fiscal policy and an aggregate effect of a possible CBDC issuance by the central bank. Using the model, we ask (and answer) two policy-relevant questions. First, does the complementarity between monetary and macroprudential policies depend on the monetary and fiscal policy stances. Specifically, does it really matter if the monetary or fiscal policy stance is *active* or *passive*, using the terms first coined by Leeper (1991) in the fiscal theory of price level (FTPL) literature.[4] Second, what would be the likely effect of a CBDC issuance on the fluctuations of aggregate variables in response to shocks, and hence, on the monetary-macroprudential policy complementarity across different monetary-fiscal policy regimes. The answer to the first question is important since it relates to the role of monetary and fiscal policy interaction in an environment where the central bank also conducts macroprudential policy, such as in Indonesia. It is unclear a priori to what extent does this interaction matter, especially in a medium-to-large scale DSGE model such as the model in Juhro, Lie, and Sasongko. The second question is highly relevant to BI's plan to issue a CBDC sometime in the next several years. Although we only parsimoniously model the effect of a CBDC issuance as a near-permanent technological innovation, the rich feature of our DSGE model allows us to offer some guidance on the likely aggregate effect.

Our findings are as follows. On the first question, we find that the complementarity of a given macroprudential policy rule does crucially depend on the monetary-fiscal regime. When the interest rate response to inflation is strong and the tax response to government debt is strong, i.e. an active monetary and a passive fiscal regime (**AMPF**), the conclusion in Juhro et al. (2022a) remains intact. This result is not surprising, given that in that paper, the regime is by default an AMPF regime. Under a passive monetary, active fiscal regime (**PMAF**), however, we find that supply-channel macroprudential policy rules may no longer be complementary to monetary policy. That is, the welfare gain and the stabilizing effect of a countercyclical capital requirement (CR) rule or MPLB rule is now smaller. We find that the additional *wealth effect* arising under the PMAF regime may cause higher inflation and output fluctuations, and hence, increase business cycle fluctuations, even though it remains the case that the macroprudential policy is able to stabilize the financial cycle (aggregate credit) more. A countercyclical loan-to-value ratio (LTV) rule, which primarily affects the demand for credit, may be welfare-improving, however. Despite this, the additional wealth effect overall causes higher variations in key economic and financial variables, rendering the PMAF regime sub-optimal compared to the AMPF regime. This finding accords well to that in Schmitt-Grohé and Uribe (2006a) and Schmitt-Grohé and Uribe (2007), who find that the optimal policy features an active monetary rule and a passive fiscal rule. We show that this result is unaffected by the inclusion of financial frictions and heterogenous agents such as in our model.

With regard to the second question, we find that the effect of a CBDC issuance

[4]See Canzoneri et al. (2010) for a comprehensive survey of the FTPL literature.

is akin to the effect of a permanent technological progress. A CBDC shock reduces the transaction costs in purchasing goods and services, permanently raising the levels of output, consumption, and investment, but lowering the inflation rate. The nominal policy interest rate also trends downward, which in turn lowers the loan rates and interest-rate spreads. Hence, as in the FinTech literature (see e.g. Rajan (2006), Stein (2013), and Hasan et al. (2020), the central bank's CBDC issuance may alleviate financial frictions and contribute to real stabilizations. The CBDC shock by itself, however, does not materially affect the complementarity between monetary and macroprudential policies. This is true both under the AMPF regime and PMAF regime.

1.1 Related literature and contribution

Our paper is related to four strands of literature. First, we contribute to the large literature on the role of macroprudential policy in supporting monetary policy to achieve macroeconomic stabilization. A selective list of studies includes Roger and Vlček (2011), Cecchetti and Kohler (2012), Angelini et al. (2014), Quint and Rabanal (2013), Unsal (2018), Rubio and Carrasco-Gallego (2014), Brzoza-Brzezina et al. (2015), Clancy and Merola (2017), Bekiros et al. (2018), and Basto et al. (2019). None of these studies, however, investigates the complementarity between monetary and macroprudential policies when the fiscal policy is assumed to be non-trivial and when a CBDC effect is present. To the best of our knowledge, there is only one other study, Boscá et al. (2020), that investigates the interaction between fiscal and macroprudential policies. Their study, however, is motivated by a different set of questions and focuses on whether a national discretionary macroprudential policy in a monetary union (the Euro area) modifies the effect of a higher tax rate to stabilize the national government debt level and influences the fiscal stance.

The second strand involves the literature on monetary-fiscal policy interaction, particularly in relation to the fiscal theory of the price level (Leeper (1991), Beetsma and Jensen (2005), Davig and Leeper (2006), Schmitt-Grohé and Uribe (2007), Davig and Leeper (2011), Bhattarai et al. (2016), Bianchi and Ilut (2017)). Two common findings from this literature are that the existence and uniqueness of the model equilibrium dynamics crucially depends on the monetary and fiscal policy stances, whether they are active or passive, and that the optimal monetary-fiscal policy mix usually involves an active monetary and a passive fiscal (AMPF) regime. We show that these findings also translate in a model environment with financial frictions, heterogenous agents, and a macroprudential policy authority conducting a countercyclical policy rule.

We also contribute to the literature on the modelling of CBDC within a macroeconomic model and its subsequent implications on aggregate fluctuations (Andolfatto (2021), Chiu and Davoodalhosseini (2021), Agur et al. (2022), Barrdear and Kumhof (2022), Davoodalhosseini (2022), Minesso et al. (2022), Williamson (2022)). Most of these studies, however, model the impact of a CBDC issuance within a simple macroeconomic model and frequently in a partial equilibrium setting. Out of the aforementioned studies, only Barrdear and Kumhof (2022) and Minesso et al. (2022) consider a rigorous modelling of CBDC within a quantitative, medium-scale DSGE model. Consistent with their finding, our parsimonious modelling of the CBDC effect lowers transaction costs and permanently raises output. Our paper further shows that a CBDC issuance is unlikely to affect the complementary between monetary and macroprudential policies and the implication from a given monetary-fiscal policy regime. We acknowledge, however, the value of a rigorous modelling of a CBDC issuance within a rich DSGE model such as ours — we leave this for future research.

Finally, our paper contributes to the growing literature on the effect of various types of central bank policy mix on aggregate fluctuations in Indonesia. This includes studies on monetary-macroprudential policy interaction (Harmanta et al. (2014), Chawwa (2021), Setiastuti et al. (2021)), monetary-fiscal policy interaction (Hermawan and Munro (2008), Rizvi et al. (2021), Juhro et al. (2022b)), and the effect of CBDC (Harahap et al. (2017), DKEM (2021), Syarifuddin and Bakhtiar (2021)). A differentiating factor of our paper is with regard to the joint modelling and analysis of monetary-macroprudential policy complementarity in an environment with a non-trivial fiscal policy and the effect of a CBDC issuance, within an estimated medium-scale DSGE model.[5] Our paper thus complements these aforementioned studies and contributes to a deeper understanding of what should be the ideal policy mix adopted by Bank Indonesia. For example, our finding regarding the sub-optimality of the PMAF regime is consistent with the finding in Juhro et al. (2022b) that monetary and fiscal policies should be synchronized to achieve maximum stability.

The rest of the paper proceeds as follows. Section 2 presents the DSGE model with a non-trivial fiscal policy and CBDC extensions. Section 3 characterizes different monetary-fiscal policy stances and their effect on the model equilibrium dynamics. Section 4 analyzes monetary-macroprudential policy complementarity under different monetary-fiscal regimes. In section 5, we investigate the likely aggregate of a CBDC issuance. Section 6 concludes.

2 The DSGE model with fiscal policy and CBDC extension

The core of the model is the open-economy DSGE model for Indonesia presented and estimated in Juhro et al. (2022a) (henceforth, JLS). We extend the model in two ways. First, we include the a fiscal authority that may conduct an *active* fiscal policy or a *passive* fiscal policy, in a sense of Leeper (1991) and Davig and Leeper (2007). In the original JLS model fiscal policy is assumed to be always passive and the fiscal authority always seeks to satisfy its budget constraint. Second, we include parsimonious effects of a central bank digital currency (CBDC) issuance by the central bank.

[5]The most recent Bank Indonesia's BIPOLMIX model (Juhro et al. (2022c)) also features a mix of monetary, macroprudential, payment system, and fiscal policies. Although useful for economic projections and policy simulations, the BIPOLMIX model, however, is not a full DSGE model. See appendix for a brief description of the BIPOLMIX model.

Since all other parts of the model are the same as in the JLS model, we only briefly mention these and focus here on how the two extensions fit into the model and affect the transmissions of monetary and macroprudential policies. We refer readers to Juhro et al. (2022a) for the complete description of the JLS model. The complete list of equilibrium equations in our extended model is contained in the appendix.

The model has six sets of domestic, private-sector agents: patient (type-P) households, impatient (type-I) households, wholesale goods-producing entrepreneurs, final goods retailers, importers, and financial intermediaries (banks). Fluctuations in the economy are driven by nineteen stochastic (exogenous) shocks: technology, preference, domestic and import cost-push, monetary policy, housing-demand, investment, government-spending, risk-premium, households' loan-to-value (LTV) ratio, firms' LTV, bank balance sheet, foreign output, foreign inflation, foreign interest-rate, fiscal policy, government transfer, government debt target shocks, and CBDC shocks. The last four shocks are new shocks which are not present in JLS. The economy is also subject to shocks originated in the foreign economy, which is summarized by a VAR(2) process in foreign output (real GDP), inflation, and interest rate. There are two policy authorities in the model: the central bank is in charge of both monetary and macroprudential policy formulations and implementations, while the government is in charge of fiscal policy.

2.1 Fiscal policy extension

We start by describing how we incorporate an active/passive fiscal policy (**AF/PF**) into the model.

2.1.1 The consolidated government budget constraint

The nominal government budget constraint is given by

$$B_t^g = R_{t-1}^g B_{t-1}^g + P_t g_t - P_t \left(\tau_t - \vartheta_t\right), \tag{1}$$

where B_t^g is the stock of (one-period) nominal government bonds, R_t^g is the (gross) nominal interest rate on the bonds, P_t is the aggregate CPI price level, g_t is the government spending (in real term), and $(\tau_t - \vartheta_t)$ is government taxes net of transfers. As in Schmitt-Grohé and Uribe (2006b), we assume that τ_t could be lump-sum or distortionary, although we focus here on lump-sum taxation. Dividing by P_t and defining gross inflation $\pi_t \equiv P_t/P_{t-1}$, we obtain the real government budget constraint

$$b_t^g = R_{t-1}^g b_{t-1}^g \frac{1}{\pi_t} + g_t - \tau_t + \vartheta_t. \tag{2}$$

We assume that the stock or domestic (real) government bonds is held by patient households in the amount of $B_t^{g,b}$ and by banks in the amount of $B_t^{g,P}$, so that

$$b_t^g = B_t^{g,b} + B_t^{g,P}.$$

Following Bhattarai et al. (2016), we separate government transfers from taxes. This allows us to analyze the impact of government subsidy, e.g. in response to the COVID-19 pandemic shocks, separately from the tax policy stance (active or passive). $\ell_{t-1} \equiv R^g_{t-1}B^g_{t-1}/P_{t-1}$ is the government's total real liabilities outstanding at the end of period *t-1*, in units of period *t-1* goods. We note that the budget constraint (1) is largely identical to that assumed in Bank Indonesia's *BIPOLMIX* model (Juhro et al. (2022c)).

2.1.2 The fiscal policy rule and government spending and transfers

We follow Bhattarai et al. (2016) and Davig and Leeper (2006) and assume that the government levies taxes according to the following rule:

$$\frac{\tau_t}{\bar{\tau}} = \left(\frac{\tau_{t-1}}{\bar{\tau}}\right)^{\rho_\tau} \left[\left(\frac{b^g_{t-1}}{b^{g*}_{t-1}}\right)^{\tilde{\psi}_b} \left(\frac{y_t}{y^*_t}\right)^{\tilde{\psi}_y}\right]^{1-\rho_\tau} \exp\left(\varepsilon_{\tau,t}\right). \tag{3}$$

y^*_t is the natural (potential) level of output, defined as the level of output under flexible-price, flexible-wage, flexible-rate environment with no cost-push shocks. b^{g*}_t is the government debt target, assumed to follow an AR(1) process,

$$b^{g*}_t = (1-\rho_b)\,\bar{b}^g + \rho_b b^{g*}_{t-1} + \varepsilon_{b,t}.$$

Both the unsystematic tax shock $\tilde{\varepsilon}_{\tau,t}$ and the debt target shock $\varepsilon_{b,t}$ are i.i.d. shocks with zero mean. A special case of the rule (3) is when $\rho_\tau = 0$ and $\tilde{\psi}_y = 0$ (no tax smoothing and no response to output gap fluctuations). Under this condition, we have the same tax rule as in the cashless model in Schmitt-Grohé and Uribe (2006b),

$$\frac{\tau_t}{\bar{\tau}} = \left(\frac{b^g_{t-1}}{b^{g*}_{t-1}}\right)^{\tilde{\psi}_b} \exp\left(\tilde{\varepsilon}_{\tau,t}\right). \tag{4}$$

A crucial parameter in the fiscal rule above is $\tilde{\psi}_b$, which determines whether the fiscal policy is active or passive, as discussed below.

On government spending, we assume

$$\frac{g_t}{\bar{g}} = \left(\frac{g_{t-1}}{\bar{g}}\right)^{\rho_g} \left(\frac{y_{t-1}}{y^*_{t-1}}\right)^{-\tilde{\chi}_y(1-\rho_g)} \exp\left(\varepsilon_{g,t}\right) \tag{5}$$

That is, we allow for the possibility that the government uses spending in order to smooth out output fluctuations (as a stabilizing tool), i.e. when $\tilde{\chi}_y > 0$. The government transfers simply follow an AR(1) process

$$\vartheta_t = (1-\rho_\vartheta)\bar{\vartheta} + \rho_\vartheta \vartheta_{t-1} + \varepsilon_{\vartheta,t}. \tag{6}$$

The government spending shock $\varepsilon_{g,t}$ and transfer shock $\varepsilon_{\vartheta,t}$ are i.i.d. shocks.

2.1.3 The distribution of taxes and transfers

For simplicity, we assume that lump-sum taxes are levied proportionally according to the measures of type-P households (γ^P), type-I households (γ^I), and entrepreneurs (γ^E) in the economy:

$$
\begin{aligned}
t_t^P &= \frac{\gamma^P}{\gamma^P+\gamma^I+\gamma^E}\tau_t^L, \\
t_t^I &= \frac{\gamma^I}{\gamma^P+\gamma^I+\gamma^E}\tau_t^L, \\
t_t^E &= \frac{\gamma^E}{\gamma^P+\gamma^I+\gamma^E}\tau_t^L.
\end{aligned}
$$

Here, t_t^P, t_t^I, and t_t^E are the taxes levied to type-P households, type-I households, and entrepreneurs, respectively. Since all taxes are lump sum, $\tau_t = \tau_t^L$ and $t_t^P + t_t^I + t_t^E = \tau_t^L$. We follow the same assumption regarding the corresponding lump-sum government transfers:

$$
\begin{aligned}
\vartheta_t^P &= \frac{\gamma^P}{\gamma^P+\gamma^I+\gamma^E}\vartheta_t, \\
\vartheta_t^I &= \frac{\gamma^I}{\gamma^P+\gamma^I+\gamma^E}\vartheta_t, \\
\vartheta_t^E &= \frac{\gamma^E}{\gamma^P+\gamma^I+\gamma^E}\vartheta_t.
\end{aligned}
$$

2.2 Households and entrepreneurs

Each patient (type-P) household $i \in [0,1]$ in each period choose the amount of consumption c_t^P, housing stock h_t^P,labor effort n_t^P, bank deposit d_t^P, foreign bond holding d_t^*, and domestic government bond holding $b_t^{g,P}$ to maximize

$$
E_0 \sum_{t=0}^{\infty} \beta_P^t \left[\begin{array}{c} (1-a^P)\frac{\varepsilon_{z,t}\left(c_t^P - a^P z_t^P\right)^{1-\sigma}}{1-\sigma} + \varepsilon_{h,t}\log h_t^P(i) - \frac{n_t^P(i)^{1+\phi}}{1+\phi} \\ +\chi_d \ln(\gamma + d_t^P) + \chi_g \ln(\gamma + b_t^{g,P}) \end{array} \right] \quad (7)
$$

subject to the budget constraint

$$
\begin{aligned}
c_t^P + q_t^h\left(h_t^P - h_{t-1}^P\right) + d_t^P + e_t d_t^* + b_t^{g,P} &= w_t^P n_t^P + (1+r_{t-1}^d)\frac{d_{t-1}^P}{\pi_t} + e_t \frac{d_{t-1}^*}{\pi_t}(1+r_{t-1}^*)\zeta_t \\
&\quad + (1+r_{t-1}^g)\frac{b_{t-1}^{g,P}}{\pi_t} + \Gamma_t + \vartheta_t^P - t_t^P. \quad (8)
\end{aligned}
$$

We remove the index i in (7) and (8) for clarity and easy of exposition. Here, $z_t^P \equiv a^P c_{t-1}^P$ is external habit, q_t^h is the real house price, e_t is the nominal exchange rate, w_t^P is the real wage (for type-P labor), π_t is gross inflation, ϑ_t^P is the government transfer to type P HHs, t_t^P is the lump-sum tax levied to type-P HHs, and Γ_t denotes profit and dividend transfers from domestic retailers, importers, and banks, all owned by type-P households. r_t^d, r_t^*, and r_t^g are the nominal interest rates on bank deposit, foreign bonds, and domestic government bonds directly. We note that compared to the JLS model, we additionally assume that households may hold government bonds in their portfolio. The additional two terms in the second line of (7), i.e. that type-P HHs' utility depends on bank deposit amount and government bond holding, are non-conventional. We add these to allow for the possibility that $r_t^g \neq r_t^d$, following the approach in Boscá et al. (2020). The parameters $\{\chi_g, \chi_d\} \geq 0$ govern households' relative preference between bank deposit and government bond: If $\chi_g > \chi_d$ ($\chi_g < \chi_d$), households prefer government bond (bank deposit) over bank deposit (government bond), all else equal. They are indifferent which asset to hold when $\chi_g = \chi_d$, necessitating $r_t^g = r_t^d$ and $d_t^P = b_t^{g,P}$. The parameter $\gamma \geq 0$ affects the curvature of the marginal utility.[6]

Solving the maximization problem, we obtain the following efficiency conditions:

$$0 = \varepsilon_t^z (1 - a^P) \left(c_t^P - a^P c_{t-1}^P \right)^{-\sigma} - \lambda_t^P \tag{9}$$

$$0 = \varepsilon_t^h \left(h_t^P \right)^{-1} - \lambda_t^P q_t^h + \beta_P E_t \lambda_{t+1}^P q_{t+1}^h \tag{10}$$

$$0 = - \left(n_t^P \right)^{\phi} + \lambda_t^P w_t^P \tag{11}$$

$$0 = \beta_P E_t \lambda_{t+1}^P \left(1 + r_t^d \right) \pi_{t+1}^{-1} - \lambda_t^P + \chi_d \frac{1}{(\gamma + d_t^P)} \tag{12}$$

$$0 = \beta_P E_t \lambda_{t+1}^P e_{t+1} (1 + r_t^*) \pi_{t+1}^{-1} \zeta_{t+1} - \lambda_t^P e_t \tag{13}$$

$$0 = \beta_P E_t \lambda_{t+1}^P \left(1 + r_t^g \right) \pi_{t+1}^{-1} - \lambda_t^P + \chi_g \frac{1}{(\gamma + b_t^{g,P})} \tag{14}$$

For impatient (type-I) households, the utility function and the budget constraint, and hence, the efficiency conditions, are identical to those in Juhro et al. (2022a). These households do not hold government bonds, consistent with their characterization as an impatient agent (borrowers instead of savers). We mention here that type-I households' borrowings are subject a collateral constraint

$$(1 + r_t^{bH}) b_t^I \leq m_t^I E_t \left[q_{t+1}^h h_t^I \pi_{t+1} \right]. \tag{15}$$

à la Kiyotaki and Moore (1997) and Iacoviello and Neri (2010). r_t^{bH}, b_t^I, m_t^I, and h_t^I denote the type-I household loan rate, loan amount, loan-to-value (LTV) ratio, and housing stock. The housing stock therefore acts as the collateral for the loan. The LTV ratio m_t^I is subject to a macroprudential regulation.

The setup of entrepreneurs $\in [0, 1]$ are also virtually identical to that in Juhro, Lie, and Sasongko, except that we assume the production function is now given by

$$y_t^E = Z_t \left(k_{t-1}^E u_t \right)^{\alpha} \left(n_t^E \right)^{1-\alpha} \tag{16}$$

where

$$Z_t \equiv \left(\varepsilon_t^a \right)^{1-\Gamma_z} \left(X_t \right)^{\Gamma_z}. \tag{17}$$

[6] The definitions of other parameters are contained in Table 1.

ε_t^a is the standard persistent, but temporary AR(1) technology shock, while X_t is the near-permanent, technology shock (technological progress) that could arise, for example, due to CBDC issuance by the central bank. $\Gamma_z \in [0, 1)$ is the relative weight on the technological progress. The functional form for X_t is discussed in Section 3. Similarly to type-I households', entrerpreneurs' loans b_t^E are subject to a collateral constraint

$$\left(1 + r_t^{bE}\right) b_t^E \leq m_t^E E_t \left[q_{t+1}^k \pi_{t+1}(1 - \delta) k_t^E\right]. \tag{18}$$

Here, the expected repayment of the loans cannot exceed the expected value of entrepreneurs' capital ($q_{t+1}^k \pi_{t+1}(1 - \delta) k_t^E$), adjusted by the loan-to-value ratio m_t^E mandated by the macroprudential authority.[7]

2.3 Capital goods producers, domestic goods retailers, and importers

We assume identical setups as in the JLS model with regard to the capital goods producers, domestic goods retailers, and importers. Perfectly-competitive capital goods producers produce physical capital goods k_t, sell them to entrepreneurs (to be used for wholesale goods production) at market price q_t^k, and then buy back the capital back from entrepreneurs at end of each time period. Capital goods depreciate at rate δ and their production is subject to a quadratic adjustment (or installment) cost. Hence, capital accumulates according to

$$k_t = (1 - \delta) k_{t-1} + \left[1 - \frac{\kappa_i}{2} \left(\frac{i_t \varepsilon_t^{qk}}{i_{t-1}} - 1\right)^2\right] i_t, \tag{19}$$

i_t is the physical capital investment and $\frac{\kappa_i}{2}\left(\frac{i_t \varepsilon_t^{qk}}{i_{t-1}} - 1\right)^2$ represents the adjustment cost.

A continuum of domestic goods retailers $j \in [0, 1]$ buy wholesale goods from entrepreneurs and differentiate them at no cost. They then sell the differentiated retail goods to patient and impatient households, entrepreneurs, and government to be used for consumption purpose. These retailers operate in a monopolisticaly-competitive setting and can adjust their prices in a Calvo (1983) manner, with probability of optimal price adjustment $1 - \theta_H$. Each importer $j \in [0, 1]$ is assumed to buy a differentiated foreign variety j and sells it to domestic households and entrepreneurs. We assume that the low of one price for each foreign variety holds at the dock — however, it does not hold at the retail level and these importers are monopolistically competitive and can charge a markup over the import price. Similar to domestic retailers, importers can adjust their prices in a Calvo manner (with probability of optimal price adjustment $1 - \theta_F$). These setups mean we can obtain the following (log-linearized) domestic-price Phillips curve,

$$[\hat{\pi}_{H,t} - \delta_H \hat{\pi}_{H,t-1}] = \beta_P E_t [\hat{\pi}_{H,t+1} - \delta_H \hat{\pi}_{H,t}] + \frac{(1 - \theta_H)(1 - \theta_H \beta_P)}{\theta_H} \hat{\kappa}_t + \hat{\varepsilon}_t^H \tag{20}$$

[7]Both the collateral constraints (15) and (18) are satisfied with equality.

and the import-price Phillips curve,

$$[\hat{\pi}_{F,t} - \delta_F \hat{\pi}_{F,t-1}] = \beta_P E_t [\hat{\pi}_{F,t+1} - \delta_F \hat{\pi}_{F,t}] + \frac{(1-\theta_F)(1-\theta_F \beta_P)}{\theta_F} \widehat{\Psi}_{F,t} + \hat{\varepsilon}_t^F. \tag{21}$$

$\hat{\pi}_{H,t}$, $\hat{\pi}_{F,t}$, $\hat{\kappa}_t$, and $\widehat{\Psi}_{F,t}$ denote the domestic-price inflation, import-price inflation, domestic marginal cost, and import price, respectively, in terms of their deviation from the steady-state value. $\hat{\varepsilon}_t^H$ and $\hat{\varepsilon}_t^F$ are (reduced-form) cost-push shocks. $\widehat{\Psi}_{F,t}$ is the relevant driving process for import-price inflation as it represents the deviation from the law of one price, or the law-of-one-price (LoP) gap (see Gali and Monacelli (2005) and Monacelli (2005)). We assume that when domestic retailers and importers are not able to adjust prices optimally, they index their prices to past inflation — $\{\delta_H, \delta_F\} \in [0, 1]$ are the respective indexation parameters.

2.4 Banks

The banking sector and frictions follow closely the setup in Juhro, Lie, and Sasongko, which is based on the setup in Gerali et al. (2010). There is a continuum of banks in the economy with unit measure. Each bank's operation comprises of a wholesale unit and retail unit. The wholesale unit is responsible for managing the bank's balance-sheet position and ensure compliance with central bank regulations, e.g. the capital or liquidity requirement. The monopolisticaly-competitive retail unit is responsible for collecting deposits from type-P households and disbursing loans to type-I households and entrepreneurs. The unit's maximization problem implies a markup (markdown) of the loan (deposit) rate with respect to the central bank's policy rate. When adjusting the loan and deposit rates, however, banks are subject to a quadratic adjustment cost. This "sticky-rate" environment means that the adjustments of the rates, which affect the transmission of monetary policy, is gradual.

Differently than the benchmark model in JLS, we assume that banks are also holders of government bonds. They do so for the purpose of satisfying the macroprudential policy liquidity buffer (MPLB) requirement. Their holding of the bond is

$$B_t^{g,b} = \xi_t B_t \tag{22}$$

where ξ_t is the MPLB requirement and B_t is bank's total assets

$$B_t = B_t^{g,b} + B_t^b. \tag{23}$$

$B_t^b = (1 - \xi_t) B_t$ is the amount of outstanding loans to the private sector (loans to type-I households and entrepreneurs). Each bank's balance sheet follows

$$B_t = (1 - \theta_t) D_t + K_t^b, \tag{24}$$

which must be satisfied in each period. K_t^b is bank capital, which is accumulated out of retained earning j_{t-1}^b and is subject to a constant depreciation rate δ_b. θ_t is the reserve requirement ratio.

In addition to the MPLB requirement, banks are subject to capital requirement ν_t imposed by the macroprudential policy authority. Whenever the actual capital-to-assets ratio K_t^b/B_t deviates from the target value ν_t, each bank is required to pay a quadratic adjustment cost (à la Rotemberg (1982)) that is proportional to the level of bank capital:

$$\frac{\kappa_{Kb}}{2}\left(\frac{K_t^b}{B_t}-\nu_t\right)^2 K_t^b, \tag{25}$$

with κ_{Kb} is the cost scale parameter. The presence of this quadratic cost means that changes in capital requirement ν_t would affect banks' interest and profit margins. This is the channel in which macroprudential policy, in the form of capital regulation, may affect the real economy. It also affects the transmission of monetary policy, creating a role for monetary-macroprudential policy coordination.

2.5 Monetary and macroprudential policy

The central bank conducts monetary policy through its management of the policy interest rate r_t, in accordance to the Taylor-type rule,

$$(1+r_t)=(1+\bar{r})^{1-\phi_R}(1+r_{t-1})^{\phi_R}\left(\left(\frac{\pi_t}{\bar{\pi}}\right)^{\phi_\pi}\left(\frac{y_t}{y_{t-1}}\right)^{\phi_{\Delta y}}\left(\frac{\tilde{e}_t}{\tilde{e}_{t-1}}\right)^{\phi_e}\right)^{1-\phi_R}\varepsilon_t^r. \tag{26}$$

Here, ϕ_R is the interest-rate smoothing parameter, and ϕ_π, $\phi_{\Delta y}$, and ϕ_e denote the feedback coefficients on the deviation of inflation from the target $\bar{\pi}$, output growth y_t/y_{t-1}, and exchange-rate depreciation $\tilde{e}_t/\tilde{e}_{t-1}$, respectively. ε_t^r is the i.i.d. unsystematic monetary-policy shock.

Macroprudential policy is conducted using three instruments: the capital requirement (CR) ν_t, the MPLB requirement ξ_t, and the LTV-ratio pair $\{m_t^I, m_t^E\}$. As in Juhro, Lie, and Sasongko, we assume the following countercyclical rules for these instruments:

$$\nu_t=\bar{\nu}^{(1-\rho_\nu)}\nu_{t-1}^{\rho_\nu}\left(\frac{B_t}{B_{t-1}}\right)^{\psi_\nu(1-\rho_\nu)}, \tag{27}$$

$$\xi_t=\bar{\xi}^{(1-\rho_\xi)}\xi_{t-1}^{\rho_\xi}\left(\frac{B_t}{B_{t-1}}\right)^{\psi_\xi(1-\rho_\xi)}, \tag{28}$$

and

$$\begin{aligned} m_t^I &= \left(\bar{m}^I\right)^{(1-\rho_m)}\left(m_{t-1}^I\right)^{\rho_m}\left(\frac{B_t}{B_{t-1}}\right)^{\psi_m(1-\rho_m)}, \\ m_t^E &= \left(\bar{m}^E\right)^{(1-\rho_m)}\left(m_{t-1}^E\right)^{\rho_m}\left(\frac{B_t}{B_{t-1}}\right)^{\psi_m(1-\rho_m)}. \end{aligned} \tag{29}$$

Counteryclical macroprudential policy rules such as (27), (28), and (29) have been shown in the literature to be able to mitigate the fluctuations in both the financial and business cycles and improve welfare. See, for example, Cecchetti and Kohler (2012)Angelini et al. (2014), Clancy and Merola (2017), and Bekiros et al. (2018) for CR rules, Quint and Rabanal (2013), Rubio and Carrasco-Gallego (2014), and Brzoza-Brzezina et al. (2015) for LTV rules, and Roger and Vlček (2011), Barroso et al. (2020), and Martínez et al. (2020) for liquidity or MPLB rules.

3 Monetary-fiscal policy stance and the central-bank digital currency

It is well known since Leeper (1991), Sims (1994), and Woodford (1995) that the monetary-fiscal policy stance affects the equilibrium model dynamics — in particular, a non-uniqueness (equilibrium indeterminacy) or multiple equilibria can exist. In this section we characterize the conditions in which monetary and fiscal policy can be considered as *active* (AM for monetary policy, AF for fiscal policy) or *passive* (PM, PF), following the term coined by Leeper (1991). We also elaborate on our parsimonious approach in treating the CBDC issuance as a form of technological progress.

3.1 Active/passive monetary and fiscal stance

We characterize the AF/PF and AM/PM conditions based on the linearized versions of the fiscal (tax) rule (3) and the monetary policy rule (26), following the standard approach in the literature (see e.g. Davig and Leeper (2006), Davig and Leeper (2011), and Bhattarai et al. (2016)).[8] This approach is consistent with our use of linearized (first-order) approximate solution in characterizing the equilibrium of the model.

Fiscal policy The linearized version of the government budget constraint (2) is

$$\hat{b}_t^g = \left[\frac{\bar{R}^g}{\bar{\pi}}\right]\hat{b}_{t-1}^g + \left[\frac{\bar{R}^g\bar{b}^g}{\bar{\pi}}\right]\left(\hat{R}_{t-1}^g - \hat{\pi}_t\right) + \hat{g}_t - \hat{\tau}_t + \hat{\vartheta}_t, \tag{30}$$

where $\bar{b}^g$ and $\bar{R}^g$ denote the steady-state level of government bond and the associated interest rate, respectively, and the hatted variables are in terms of the variables' deviations from their steady-state values.[9] Consider the linearized version of the tax rule (3) with no smoothing ($\rho_\tau = 0$) and no output gap response ($\tilde{\psi}_y = 0$):

$$\hat{\tau}_t = \psi_b\left(b_{t-1t}^g - b_{t-1}^{g*}\right) \tag{31}$$

In the steady state, $\frac{R^g}{\pi} = \Omega_\beta \equiv \frac{1}{\beta_P} - \frac{1}{\varepsilon^d}\left(\frac{1}{\beta_P} - \frac{1}{\pi}\right)$. By combining the simple rule (31) and the linearized budget constraint (30) one can obtain the following AF/PF condition:

$$\text{if} \quad \begin{array}{ll} \psi_b \in (\Omega_\beta - 1, \Omega_\beta) & : \textit{PF (passive)} \\ \psi_b < \Omega_\beta - 1 \text{ or } \psi_b > \Omega_\beta & : \textit{AF (active)} \end{array} \tag{32}$$

[8]The alternative is to characterize the active-passive behaviour using the non-linear rules directly as in Schmitt-Grohé and Uribe (2006b).

[9]Specifically, $\hat{b}_t^g \equiv db_t^g = b_t^g - \bar{b}^g$, $\hat{R}_t^g \equiv dR_t^g/\bar{R}_g$, $\hat{\pi}_t \equiv d\pi_t/\bar{\pi}$, $\hat{g}_t \equiv dg_t$, $\hat{\tau}_t \equiv d\tau_t$, $\hat{\vartheta}_t \equiv d\vartheta_t$.

If we allow non-zero ρ_τ and $\tilde{\psi}_y$, it is generally not feasible to obtain an analytical characterization of the AF/PF condition such as (32). But it still the case that the condition would depend on the steady state values of government bond return and inflation, in a manner similar to the above. We can confirm numerically, however, that the general condition (with possibly non-zero ρ_τ and $\tilde{\psi}_y$) is virtually identical to that in (32).

We note that the AF/PF condition in (32) is slightly different to the standard condition (see e.g. Bhattarai et al. (2016)). This is because our model has a banking friction, which creates a wedge between the policy interest rate and the government bond rate. When there is no banking friction and there is no wedge between the two interest rates in the steady state ($\bar{R}^g = \bar{R} = \bar{\pi}/\beta_P$, (32) becomes

$$\text{if} \quad \begin{array}{ll} \psi_b \in \left(\frac{1}{\beta_P} - 1, \frac{1}{\beta_P}\right) & : \textit{PF (passive)} \\ \psi_b < \frac{1}{\beta_P} - 1 \text{ or } \psi_b > \frac{1}{\beta_P} & : \textit{AF (active)} \end{array} \tag{33}$$

which is the same general condition as in Davig and Leeper (2006) and Bhattarai et al. (2016).[10] Intuitively, the condition (32) or (33) says that a passive fiscal policy is one where the fiscal authority responds to an increase in government debt sufficiently, so that the debt would return to the target and the government budget constraint is satisfied. In other words, a *passive fiscal* (PF) policy authority would ensure that the government debt would eventually stabilized around the target level. An *active fiscal* (AF) policy, however, does not stabilize the debt level, presumably to pursue other objectives, as the tax response to debt is weak. Under this scenario, the task of ensuring that the government budget constraint is satisfied falls on the monetary policy authority and fiscal dominance—Sargent et al. (1981)' unpleasant monetarist arithmetic— occurs.

Monetary policy As is familiar since Leeper (1991), the active-passive monetary policy stance (AM/PM) based on the Taylor-type rule (26) is given by

$$\text{if} \quad \begin{array}{ll} \phi_\pi \leq 1 & : \textit{PM (passive)} \\ \phi_\pi > 1 & : \textit{AM (active)} \end{array} \tag{34}$$

The condition holds exactly when there is no interest rate smoothing and when the rule only responds to inflation deviation. As we show numerically below, the AM/PM condition (34) is a good approximation to the more general condition. Here, if the so-called *Taylor principle* holds ($\phi_\pi > 1$), the monetary policy stance is *active* and the monetary policy stabilizes inflation. Under a *passive* stance ($\phi_\pi \leq 1$), the response of the interest rate to inflation movements is too weak and inflation would deviate further from the target.

[10]We, however, include upper limit of $\psi_b$to rule out oscillatory behaviour in government debt. If oscillations occur, we consider the debt as never reaches the steady state, and hence, an active fiscal policy.

3.1.1 The existence and uniqueness of equilibrium

It is well known since the seminal paper of Davig and Leeper (2007) that when fiscal policy is present, the standard Taylor principle is not a sufficient condition of the existence and uniqueness of the model's equilibrium. That is, the existence and uniqueness of the equilibrium our model depends on both the monetary and fiscal stance. Indeterminacy (non-uniqueness) of equilibrium arises under a passive monetary and passive fiscal policy regime (**PMPF**). On the contrary, when both regimes are active (**AMAF**), the equilibrium does not exist. Our model's equilibrium is determinate, i.e. it exists and is unique, under two cases: under an active monetary and a passive fiscal regime (**AMPF**) and a passive monetary and an active fiscal regime (**PMAF**).[11]

These four possible regions are presented in Figure 1 for feasible range of ϕ_π and ψ_b. Following Schmitt-Grohé and Uribe (2006b), we call the two determinate regions—AMPF and PMAF—as the implementability region, i.e. these are the regions of $\{\phi_\pi, \psi_b\}$ in which the equilibrium is determinate and the monetary and fiscal policy rules (26) and (3) are implementability. Our analysis below would focus on these two implementable regions.

3.2 CBDC as technological progress (supply-side effect) and transaction technology (demand-side effect)

For analyzing the effect of a CBDC issuance as part of the central bank policy mix, we parsimoniously model CBDC as having a supply-side effect and demand-side effect.

Supply-side effect The idea is to include the effect of CBDC as part of the total factor productivity (TFP) growth. At the moment, we assume that the TFP growth is exogenous — but in the future, we can assume it to depend on the nominal interest rate and other digital and financial market indicators. The modification to the model is as follows. We assume that the entrepreneurs' production function is now given by:

$$y_t^E = Z_t \left(k_{t-1}^E u_t\right)^\alpha \left(n_t^E\right)^{1-\alpha},$$

where

$$Z_t \equiv (\varepsilon_t^a)^{1-\Gamma_z} (X_t)^{\Gamma_z}$$

is the composite technology, which is a function of temporary technology shock ε_t^a and the new, near-permanent TFP shock X_t due to a CBDC issuance. The parameter $\Gamma_z \in [0, 1)$ controls the degree to which CBDC affects the productivity of entrepreneurs — when $\Gamma_z = 0$, we obtain the original JLS model without CBDC effect. Specifically, X_t evolves as

$$\log\left(\frac{X_t}{\bar{X}}\right) = \rho_z \log\left(\frac{X_{t-1}}{\bar{X}}\right) + \varepsilon_{x,t} \tag{35}$$

[11] A more general condition is obtained when we consider the possibility of regime switching — see Davig and Leeper (2006).

where $\bar{X} = 1$. Here, we assume $\rho_z = 0.995$ so that we can treat a CBDC issuance as a (near) permanent technology shock, following the literature on trend inflation (see e.g. Cogley and Sargent (2005) and Justiniano and Primiceri (2008)). Note on the identification process: ε_t^a and X_t are differentiated by their persistence. Here, ε_t^a is less persistent than X_t, which is a near-permanent disturbance.

Demand-side effect We also assume that CBDC affects the demand side of the economy by assuming that it lowers the transaction cost of purchasing goods and services, following the transaction cost literature (see e.g. Baumol (1952), Tobin (1956), Prescott (1987), and Dotsey and Ireland (1996)). Under this scenario, CBDC affects the shadow cost of consumption for all agents in the economy (type-P HHs, type-I HHs, and entrepreneurs). For now, we use a parsimonious modeling and assume the CBDC effect is exogenous.[12] As in the supply-side effect, we can later assume that it is endogenous (e.g. depends on the policy rate as in the transaction cost or cash-in-advance approach).

The modification to the model is as follows. The three first-order conditions of agents maximization problem w.r.t to consumption are now:

$$0 = \varepsilon_t^z (1 - a^P) \left(c_t^P - a^P c_{t-1}^P\right)^{-\sigma} - \boxed{\lambda_t^{X,P}} \tag{36}$$

$$0 = \varepsilon_t^z (1 - a^I) \left(c_t^I - a^I c_{t-1}^I\right)^{-\sigma} - \boxed{\lambda_t^{X,I}} \tag{37}$$

$$0 = (1 - a^E) \left(c_t^E - a^E c_{t-1}^E\right)^{-\sigma} - \boxed{\lambda_t^{X,E}} \tag{38}$$

where

$$\begin{aligned} \lambda_t^{X,P} &\equiv \lambda_t^P (X_t)^{-\Gamma_x} \\ \lambda_t^{X,I} &\equiv \lambda_t^I (X_t)^{-\Gamma_x} \\ \lambda_t^{X,E} &\equiv \lambda_t^E (X_t)^{-\Gamma_x} \end{aligned}$$

Here λ_t^P, λ_t^I, and λ_t^E are the shadow costs in the original JLS model without CBDC and X_t follows (35). The parameter $\Gamma_x \geq 0$ is a scale parameter that controls the degree of CBDC affects on the shadow cost of consumption (i.e. the CBDC role in reducing the aggregate transaction cost). For now, we treat the scale Γ_x as identical across the three types of agents, but can later assume this to be different, mimicking the possibility of different degrees of CBDC adoption across different agents.

4 Monetary-macroprudential policy complementarity under different monetary-fiscal regimes

In this section, we use the model to investigate to what extent does the monetary-fiscal policy regime affect the complementarity between monetary and macropruden-

[12] As in the supply-side effect, we can later assume that it is endogenous, e.g. the effect depends on the policy rate as in the transaction cost or cash-in-advance approach.

tial policy. In particular, we investigate the implication for the standard deviations of several key variables—namely output growth, inflation, nominal (policy) interest rate, and credit growth—and the associated welfare implication. As in Juhro et al. (2021), we assume that the social welfare function is well approximated by the following loss function:

$$Loss = \sigma(\hat{\pi}_t)^2 + \lambda_y \sigma(\hat{y}_t - \hat{y}_{t-1})^2 + \lambda_r \sigma(\hat{r}_t)^2 + \lambda_{cr} \sigma(\hat{B}_t - \hat{B}_{t-1})^2. \quad (39)$$

As shown in Woodford (2002) and Benigno and Woodford (2005), such a loss function could be derived from a second-order approximation to the utility function, and hence, is an appropriate proxy for welfare and the central bank's objective function.[13]

Calibration Table 1 shows the calibration of various parameters and steady-state variables of the model. This calibration is based on the posterior mean estimates of the DSGE model in Juhro et al. (2022a). In their model, however, there is no CBDC effect and fiscal policy is always active and the government seeks to balance their primary budget balance. The additional parameters are calibrated as follows.

We calibrate the government bond preference parameters in type-P households' utility (7) to $\chi_d = \chi_g = 0$, which implies equality between the bank deposit rate and the government bond rate. For the tax rule and government spending rule, we set $\rho_\tau = 0$, $\tilde{\psi}_y = 0$ and $\tilde{\chi}_y = 0$ in the benchmark calibration. The government debt target $\bar{b}^g$ and lump-sum tax $\bar{\tau}$ are calibrated so that the steady-state debt-to-GDP ratio is 30% and government spending-to-GDP ratio is 8.5%, consistent with the average spending-to-GDP ratio in Indonesia over the 2005.Q3-2021.Q2 period. We assume zero transfer in the steady state, $\bar{\vartheta} = 0$. These calibrated values imply that the government runs a steady-state 0.18% budget surplus.

For the analysis conducted below, we calibrate the macroprudential policy parameters as follows: $\psi_\nu = 0.9$, $\psi_\xi = 0.5$, $\psi_m = -2$, and ρ_ν=ρ_ξ=ρ_m=0.75. These values are ad-hoc — but they imply that each macroprudential policy rule is countercyclical and seeks to stabilize the credit growth, following the Basel III committee's recommendation. We consider two possible monetary-fiscal regimes: (i) an **AMPF** (active monetary, passive fiscal) regime with $\phi_\pi = 1.33$ and $\psi_b = 0.096$, and (ii) a **PMAF** (passive monetary, active fiscal) regime with $\phi_\pi = 0.9$ and $\psi_b = 0.0015$.[14] The rest of the monetary-policy rule parameters are as Table 1.

[13] Debortoli et al. (2019) show that a loss function such as (39), but with a dual mandate (equal weights on output and inflation stabilization), is a good approximation to the social welfare function in the Smets and Wouters (2007) calibrated to the US economy. The Smets and Wouters' model shares many similar features to our model, although it abstracts from financial frictions and macroprudential and fiscal policy consideration.

[14] $\phi_\pi = 1.33$ is the posterior mean estimate for the Indonesian economy, as estimated in Juhro et al. (2022a) based on data from 2005.Q3-2021.Q2. We do not have reliable information on the fiscal rule parameters in Indonesia — $\psi_b = 0.096$ in the passive fiscal case, however, is consistent with the estimated value for the U.S. economy in Bhattarai et al. (2016).

4.1 Implication on standard deviations and welfare

Table 2 reports the (model-implied) standard deviations of output growth, inflation, nominal (policy) rate, and credit growth for various monetary-macroprudential policy mix under the AMPF region (top panel) and the PMAF regime (bottom panel). The associated implication on the welfare loss is shown in Table 3, where we report the welfare loss *relative* to the benchmark MP case (no macroprudential policy). In all cases, we fix the relative weight on interest-rate variation to $\lambda_r = 0.05$, while varying the weights on output variation (λ_y) and credit variation (λ_{cr}).

AMPF regime Under the AMPF regime, we obtain the same conclusion as in Juhro et al. (2021) with regard to the complementary between monetary and macroprudential policy. Under the estimated parameter values and shock characteristics, we find that the CR rule (27) and the MPLB rule (28) is welfare-comparing compared to the benchmark MP case where the central bank conducts no macroprudential policy. Here, across different values of λ_y and λ_{cr}, the relative welfare losses are smaller than unity. As shown in Table 2, the higher welfare levels under the MP+CR and MP+MPLB policy mix are due to lower standard deviations in all four welfare-relevant variables. The welfare gain from the MP+CR mix, however, is noticeable larger than that from the MP+MPLB mix — for example, under $\lambda_{cr} = \lambda_y = 0.5$, the welfare gain of MP+CR mix relative to the benchmark MP case is 6.3%, compared to only 0.4% in the MP+MPLB mix.[15]

On the contrary, the MP+LTV policy mix produces a lower welfare level across the board, i.e. a relative welfare loss higher than unity. While the LTV rule (29) implies a lower standard deviation of the credit growth, it implies higher variations in output growth, inflation, and the policy interest rate. The LTV rule therefore is *not* complementary to the monetary policy in stabilizing the business-cycle (inflation and output) fluctuations. We note, however, as shown in Juhro et al. (2021), the complementarity between monetary and macroprudential policy is shock-specific.[16] For the main shocks responsible for business-cycle fluctuations in Indonesia during the inflation-targeting framework (ITF) period (2005.Q3 onward), however, a countercyclical CR rule or MPLB rule better complements monetary policy, compared to a countercyclical LTV rule.

PMAF vs. AMPF regime The bottom panels of Tables 2-3 show the PMAF region implies much higher standard deviations for all four variables across all policy combinations. The difference is striking. In the benchmark MP case, for example, output growth is almost ten times more variable in the PMAF regime than that in the AMPF regime. The standard deviation of inflation is three times larger in the PMAF regime. The PMAF regime therefore implies a lower welfare level than the standard AMPF

[15]This pattern of negligible welfare gains underthe MP+MPLB policy mix appears to be consistent for various values of MPLB policy response coefficient ψ_ξ.

[16]For other studies on the shock-specificness property of a given macroprudential policy rule or regulation, see Quint and Rabanal (2013), Unsal (2018), and Angelini et al. (2014).

regime. This finding is consistent with similar results in the fiscal theory of price level (FTPL) literature (see e.g. Canzoneri et al. (2010) and Davig and Leeper (2011)). Here, the additional wealth effect arising from the variation in the value of public debt (government bond) when fiscal policy is passive is responsible for the greater inflation and output fluctuations. We elaborate on this explanation in the impulse response function in the next section. Our finding that the AMPF regime is more stabilizing than the PMAF regime is consistent with the recommendation made in Juhro et al. (2022b) of the need for the monetary and fiscal policy actions to be synchronized.

In terms of the implication for the monetary-macroprudential policy complementarity, we find, somewhat surprisingly, that the welfare improvement seen in the AMPF regime from adopting either a countercyclical CR or MPLB rule becomes smaller. In fact, as shown in the bottom panel of Table 3, both the MP+CR and MP+MPLB policy mixes now have relative welfare losses above unity, i.e. a smaller welfare level compared to the benchmark MP case, for all considered stabilization weights. This result does not appear to be shock-specific, as shown in Table 4. The reverse occurs in the MP+LTV policy mix: while the relative welfare losses are still above unity, they are now closer to 1, relative to the corresponding cases in the AMPF regime. This suggests that the PMAF regime is conducive to a countercyclical LTV rule such as (29).

The results from Tables 2-4 therefore show that the complementarity between monetary policy and macroprudential policy depends crucially on the monetary and fiscal stances, and hence, on the interaction between monetary and fiscal policy.

4.2 Impulse responses

We focus here on the impulse responses to a preference shock when the macroprudential policy rule is the CR rule (27) or the LTV rule (29), varying the monetary-fiscal regime. The responses under the MPLB rule (28) are qualitatively similar to those under the CR rule.

MP vs. MP+CAR In Figure 2 we plot the impulse responses to a positive preference shock under the **AMPF** regime and compare the responses between the MP case and the MP+CR policy mix. The size of the shock is scaled so that the capital requirement ratio decreases by 0.25% on impact, given the rule (27). This positive demand shock increases both output (output growth) and inflation on impact in both the MP and the MP+CR cases. In response to the shock, the central bank increases the nominal (policy) interest rate to bring inflation back to the target and stabilize output. Given that banks set the loan rates as markups over the policy (and deposit) rates, higher policy rates imply higher households' and firms' loan rates. The higher rates also contribute to higher interest rate spreads on these loans as is standard in models with a monopolistically-competitive banking sector, although there is a slight decrease in the spread on households' loans on impact.[17] The higher loan rates and decrease in the availability of deposit to lend as type-P households spend more (not shown) lead to a lower overall credit level and growth in the economy, which prompts the macroprudential policymaker to lower the CR ratio for a number of periods. On the fiscal variables, a higher inflation rate means a lower real debt burden for the government, which reduces the amount of (real) government bond on impact. This drop in the amount of government debt prompts the fiscal authority to collect lower taxes, relative to the steady-state tax level, in the first several periods. There is, however, a number of periods in which the level of government debt and amount of taxes are above the steady-state level, as the effect of the shock dissipates.

On the complementarity between the MP rule and the CR rule, we note that consistent with the finding in Juhro et al. (2021), the implementation of the countercyclical CR rule (27) causes lower increase in the interest rate spreads and the loan rates. A lower bank capital requirement means that there is an increase in the availability of bank credit, i.e. the supply of credit. This would in turn stabilize the credit level (and growth) more, thus stabilizing the credit (financial) cycle. While the impulse responses of output and inflation in Figure 2 do not show a noticeable quantitative difference between the MP case and the MP+CR case, the variations in both variables are still smaller in the latter case.[18] This means that the CR rule complements the monetary policy rule in stabilizing the business cycle and is welfare-improving.

Figure 3 now replicates the shock scenario in Figure 2, but under the **PMAF** regime. Overall, the responses of the non-fiscal variables are qualitatively similar to those in the previous AMPF regime. However, it is apparent that quantitatively, the responses under the PMAF regime are of larger magnitude, consistent with the standard deviations reported in Table 2. As mentioned previously, the additional wealth effect arising from the active fiscal stance is responsible for these higher responses (variations). The higher policy interest rate (in response to the positive preference shock) raises the value of the government bond (public debt) as interest payments increase. For type-P households, who are holders of government bond, this increase in the value of public debt is akin to increasing their wealth. Lower taxes collected by the government creates a further positive wealth effect. The positive wealth effect in turn causes them to increase their spending further, eventually leading to a higher output level and inflation. While the size of the wealth effect depends on the model parameters, our calibration implies a quite sizeable wealth effect: output now increases by more than 2% on impact and inflation is more than 4% higher on impact, relative to the steady state (versus to only 1.5% higher in the PMAF case). Higher increases in output and inflation cause the central bank to increase the nominal policy rate by a higher amount than in the PMAF case, despite the passive monetary pol-

[17]On the relationship between interest rate movements and the spread between the loan rate and the policy or deposit rate in similar models with a monopolistically-competitive banking sector, see Quint and Rabanal (2013) and Unsal (2018).

[18]A common finding in the literature on macroprudential policy is that the mitigation effect of such policy on business cycle (real) fluctuations is small, particularly in comparison to the effect on financial cycle fluctuations — see e.g. Quint and Rabanal (2013) and Chawwa (2021).

icy ($\phi_\pi \leq 1$). This in turn contributes to a higher and more persistent decline in the aggregate credit (loans).

Comparing the impulse responses between the MP case vs. the MP+CR case, it is interesting that despite that the lower welfare level in the latter (see Table 4), we still find that a lower increase in both the loan rates and spreads. Recall that in the AMPF regime, this would improve the aggregate welfare. How can we reconcile this observation with the finding that the CR rule is now welfare-reducing in the PMAF regime? We conjecture that in the PMAF regime, the CR rule actually *amplifies* the positive wealth effect experienced by type-P households, who are holders of bank deposits.[19] This is due to a higher increase in the deposit rate in the PMAF regime, consistent with the higher policy interest rate. This additional wealth effect further increases both output and inflation and hence, causing a lower welfare gain from the adopting the macroprudential CR rule. In our calibration, this additional wealth effect more than offsets the welfare gain observed in the standard AMPF regime, resulting in a welfare loss from adopting the CR rule. To the best of our knowledge, this finding regarding the additional wealth effect from adopting a given macroprudential policy rule arising under the PMAF regime is new in the literature.

MP vs. MP+LTV Figures 4 and 5 plot the responses in the MP case vs. the MP+LTV policy mix under the AMPF regime and the PMAF regime, respectively. Overall, we observe similar responses in the MP+LTV compared to those in the MP+LTV mix, for virtually all variables. One difference is of course with regard to the movement of the respective macroprudential policy instrument. In the MP+LTV mix, based on the LTV rule (29), the policy authority would increase the loan-to-value ratio in response to a lower credit level and growth. Another difference, as first pointed out by Juhro et al. (2021), is on the complementarity of the LTV rule. Here, the LTV rule leads to higher variations in the loan rates and the interest-rate spreads. As this instrument primarily affects the credit demand, a higher LTV ratio leads to a higher demand for household and firm loans, which increases the loan rates and loan spreads, all else equal. This, in turn, leads to a higher inflation and output variations, contributing to a lower welfare level from adopting the LTV rule (see Table 4).

As shown in the table, however, the welfare loss from adopting the LTV rule is smaller under the PMAF regime. Unlike the CR rule, it thus appears that adopting the LTV rule *weakens* the positive wealth effect. Intuitively, since type-P households are lenders instead of borrowers, variations in the LTV ratio do not directly affect the wealth of these households. A lower LTV ratio in response to the positive preference shock thus causes a distributional shift of the wealth effect to type-I households and firms. Overall, this may lead to a lower positive wealth effect experienced by type-P households, which limits the increase in output and inflation variations.

[19] Further investigation is needed on this front.

5 Impact of CBDC issuance

This section investigates how the CBDC issuance, as modeled in Section 3, affects the transmission of monetary policy across the two different monetary-fiscal regime. We focus below on investigating the demand-side effect, i.e. the role of CBDC in reducing the transaction costs in purchasing goods and services. The implication of the supply-side effect turns out to be largely similar to the demand-side effect. The impact parameter Γ_x is calibrated to 0.1. A larger Γ_x would increase the size of the CBDC effect, without altering the transmission patterns.

Figure 6 plots the impulse responses of selective variables to a CBDC issuance, i.e. a 1% increase in the level of technology X_t, in the benchmark MP case (no macroprudential policy). The responses are reminiscent of the impact of a permanent technological progress. After the first period, there is a persistent increase in the output growth, consumption, and investment, with inflation is persistently (near-permanently) lower. The finding that a CBDC issuance leads to a permanent increase in output and decrease in the interest rate is consistent with that in Barrdear and Kumhof (2022) in a more rigorous modelling of CBDC transmission. Persistent lower inflation rates mean that the nominal policy rates are also trending lower. Hence, even though the CBDC issuance is assumed to only have a demand-side effect, the responses in Figure 6 support our modeling approach in treating CBDC as a (near-permanent) technological innovation, eventually leading to positive aggregate real effects. Further to this, the innovation causes an expansion in the aggregate credit, as both the loan rates and the interest-rate spreads are permanently lower. Hence, we find that a CBDC issuance alleviates financial frictions, similar to the effect of digital payment technologies or FinTech (Rajan (2006), Stein (2013)).

In Figure 7 we plot together the responses to a positive preference shock in the benchmark MP case and the MP+CR and MP+LTV policy mixes, under the AMPF region. The difference compared to Figures 2 and 4 is that in the current figure, we include an additional CBDC effect in the form of a 10% increase in the near-permanent technology shock X_t. Overall, our previous conclusion regarding the complementarity between monetary policy and each respective macroprudential role is intact. The CBDC shock, however, acts as a moderating effect on inflation and output variations, i.e. the increases in output and inflation (and the decrease in the credit level) are lower, compared to the previous case of no CBDC.

We find a similar finding under the PMAF regime, depicted in Figure 8. We still find that the PMAF regime implies (i) higher fluctuations in all key variables, including output, inflation, interest rate, and aggregate credit, and (ii) all else equal, a welfare loss (gain) from adopting the CR (LTV) macroprudential policy rule, vis-à-vis the AMPF regime. As in the AMPF regime in Figure 7, a CBDC shock acts as a moderating influence on aggregate fluctuations.

6 Conclusion and policy implications

This paper seeks to answer the following policy-relevant questions: (i) does the complementarity between monetary and macroprudential policies depend on the monetary and fiscal policy stances, and (ii) what is the likely aggregate effect of a central bank digital currency (CBDC) issuance on the existing central bank policy mix (CBPM) framework. We analyze these questions within a medium-scale Dynamic Stochastic General Equilibrium (DSGE) model for Indonesia with a non-trivial fiscal policy and a parsimonious CBDC effect. On the first question, we find that monetary-fiscal policy stances do matter for whether a macroprudential policy rule stabilizes business cycle fluctuations and is welfare-improving. It is still the case, however, a passive monetary, active fiscal regime (PMAF) is sub-optimal compared to the active monetary, passive fiscal (AMPF) regime counterpart. On the second question, we find that a CBDC issuance lowers the transaction costs and its effects on aggregate economic variables are similar to the effects of a permanent technological progress.

Our finding that an active monetary, passive fiscal regime is more stabilizing means that fiscal dominance should not be part of Bank Indonesia's central bank policy mix. Monetary policy should feature a strong interest rate response to inflation fluctuations and fiscal policy should feature a strong tax response to government debt fluctuations. This holds true irrespective of Bank Indonesia's macroprudential policy formulation. Despite our parsimonious modelling of the CBDC effect, we shed light on the likely aggregate effect of a CBDC issuance by Bank Indonesia. Such an issuance does not materially affect the complementarity between monetary and macroprudential policies, irrespective of the monetary-fiscal policy regime. We recommend further future research on the effect of a CBDC issuance, particularly using a more rigorous CBDC transmission model.

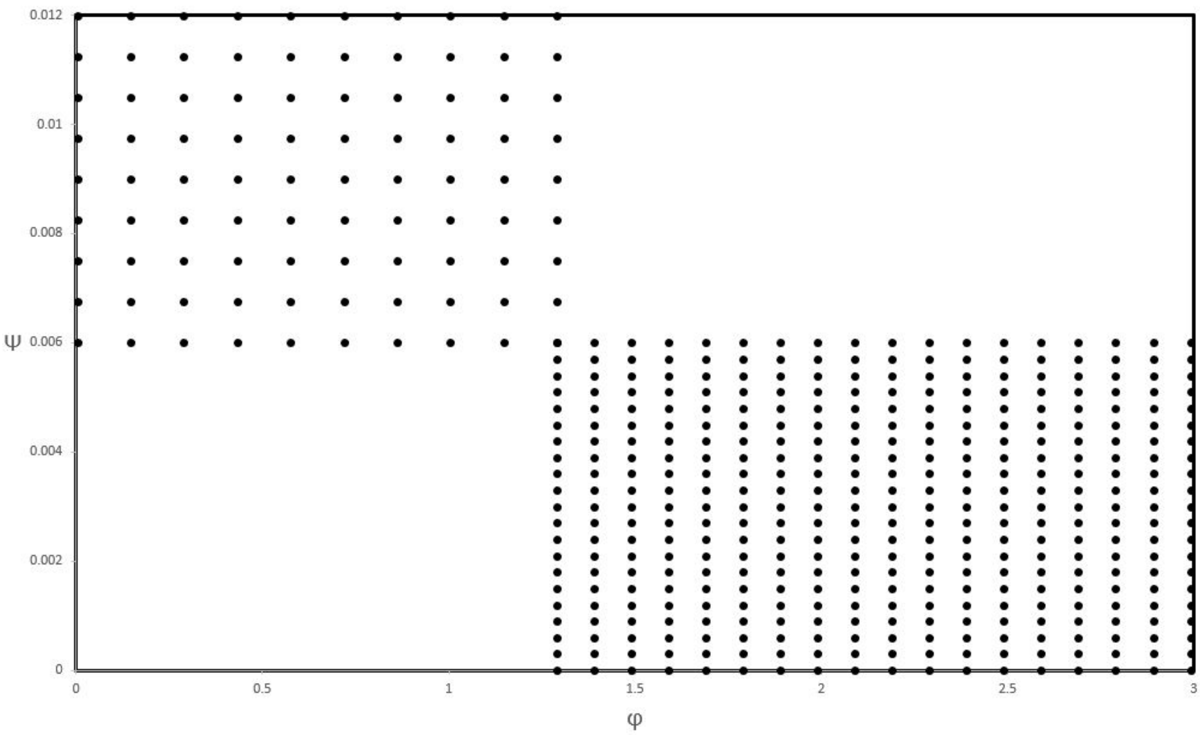

Figure 1: Implementability of Monetary-Fiscal Regions (AM-PF and PM-AF)

Appendix: Bank Indonesia's BIPOLMIX model

Bank Indonesia developed a new core model, Bank Indonesia Policy Mix (BIPOLMIX), which includes a more integrated policy interaction, to support the formulation of an optimal policy mix. BIPOLMIX was built in several phases of development based on the existing core model, ARIMBI[20]. BIPOLMIX modeling approach is based on enhanced Taylor Rule and three main agenda of Bank Indonesia's policy transformation which includes: (i) deeper comprehension of business and financial cycle; (ii) deeper understanding of macro-financial-external linkages; and (iii) extensive knowledge on real sector and structural reform. BIPOLMIX consists of five modeling blocks, including: (i) aggregate supply and demand; (ii) real sector; (iii) financial sector; (iv) external sector; and (v) central bank's policy response.

In BIPOLMIX modeling specification, the instrument of monetary policy, macroprudential policy, and exchange rate policy are complementary (mutually supportive) to achieve the Bank Indonesia's mandate in safeguarding the Rupiah and financial system stability while supporting economic growth. In the early phase of its development, BIPOLMIX incorporated four instruments for policy simulation: policy rate, macroprudential intermediation ratio, exchange rate stabilization (FXP), and liquidity instrument (Reserve Requirement/RR). The policy rate is implemented to achieve the inflation target and support economic growth. The intermediation ratio is formulated to maintain balanced bank intermediation, while the objective of FXP and RR is to maintain the stability of exchange rates and liquidity (Wijoseno et al. (2021)).

BIPOLMIX incorporates several frictions or imperfections in the economy to increase its forecast accuracy and policy simulation. On the financial side, there are three frictions incorporated into the model. First is financial risk friction. It is based on the pro-cyclicality of the financial system (banking), referring to the financial accelerator approach (Bernanke et al. (1999)). Using this approach, external financing premium or financial risk partly determines loan price, thus affecting banking credit dynamic. As described in equation 40, financial risk is negatively correlated with the macroeconomic condition.

$$\widehat{finrisk}_t = \alpha_{f1}\widehat{finrisk}_{t-1} - \alpha_{f2}\hat{y}_t + \alpha_{f3}\widehat{npl}_t + \alpha_{f4}\hat{z}_t + \alpha_{f5}\widehat{risk}_t + e_t^{finrisk} \tag{40}$$

Second, loan capacity friction. It is incorporated into the model as the bank needs to maintain reserve or liquid asset holding in a certain amount to mitigate liquidity risk and to satisfy authorities' requirements. Reserve held by banks affects the available funding or loan capacity for credit extension (equation 41).

$$\widehat{loancap}_t = \alpha_{l1}\widehat{dpk}_t + \alpha_{l2}oth\widehat{loanfund}_t - \alpha_{l3}\widehat{resrv}_t + e_t^{loancap} \tag{41}$$

[20]ARIMBI is a semi-structural New Keynesian model adopted from the IMF's Quarterly Projection Model (QPM), calibrated and estimated using Bayesian to represent the Indonesian economy. The model is characterized by nominal rigidities, short-term non-neutrality of money and monopolistic competition and captures the interactions between the financial sector and the real sector as well as the dynamics of the external sector (Waluyo et al. (2019)).

Third, capital flow friction. It incorporates the dynamic of domestic funding, which is also affected by the amount of capital inflow to the economy and the banking system (equation 42).

$$\widehat{dpk_t} = \alpha_{d1}\widehat{dpk_{t-1}} + \alpha_{d2}\hat{y}_t + \alpha_{d3}\hat{r}_t + \alpha_{d4}\widehat{fa_t} + e_t^{dpk} \tag{42}$$

In the external sector, BIPOLMIX incorporates several frictions, including risk premium, private borrowing spread, exchange rate, and capital flow risk premium. The risk premium is modeled using Country Default Swap (CDS) as an observable variable and is affected by several factors such as economic growth, inflation, and capital account dynamics (equation 43).

$$\widehat{risk_t} = \alpha_{r1}\widehat{risk_{t-1}} - \alpha_{r2}\hat{y}_t + \alpha_{r3}\hat{\pi}_t^{CPI} + \alpha_{r4}\widehat{ca}_t + e_t^{risk} \tag{43}$$

The private borrowing spread represents the premium incurred when a corporate issue a private bond. The premium increases due to exchange rate depreciation. Thus private borrowing spread widens, and borrowing constraint is binding which further may lower economic growth.

Given the increased uncertainty and complexity of economic and financial condition due to structural changes, technological developments, the pandemic, and other strategic issues, the central bank faces big challenges in formulating sound policy responses. The central bank's policy need to aim at maintaining macroeconomic and financial system stability while responding to various challenges in the new era with technological developments and increasingly accelerated and hyperconnected problems. The central bank needs to strengthen collaboration with the government and relevant policy authorities to seek a competitive economic structure and achieve macroeconomic policy objectives, namely social welfare. In this regard, the emphasis of the policy mix strategy in a broader interest is integrating central bank policies, particularly monetary, macroprudential, and payment system policies, with macroeconomic and financial policies of the government and relevant authorities to address economic problems as a whole on the demand and supply side. In addition to policy coordination with the government, in line with the growing trend of digital technology, the central bank needs to study the potential benefits and risks of each technology, and the innovation options that can be used. The benefits of digital technology must be optimally pursued in the development of inclusiveness, efficiency, and innovation in the economy. In order to incorporate the need for policy coordination with the government and answering to the acceleration of digital economic and finance, the framework of BIPOLMIX modeling is broaden to include (i) the role of payment system policy instruments in boosting productivity, particularly in relation to the developing ecosystems for digital economy and finance and (ii) the role of fiscal policy.

In Indonesia, the development of digital economy and finance has accelerated over the past several years. The rapid adoption of digital technology, supported by Bank Indonesia's payment system policy and the development of the payment system's instrument and infrastructure, has improved the efficiency of the Indonesian economy through lower operational costs, higher efficiency along the value chain, and new product innovation. Given the broad and significant impact of digital economy and finance on the Indonesian economy, the development of BI's economic model should properly consider its role. In the current model, we select two indicators to represent the development of digital economy and finance and to incorporate its impact on the economy: (i) e-commerce and (ii) digital banking. The growth of e-commerce and digital banking, as a proxy for digital economy and finance development in Indonesia, will affect the total factor productivity growth and further increase domestic demand and trigger a disinflationary effect due to higher efficiency.

In the model simulation, a more efficient and higher availability of digital payment instruments, as reflected by a 1% increase in the growth of e-money, leads to higher e-commerce transactions, productivity, and economic growth. In this case, a positive shock in the supply side leads to higher economic growth that is not accompanied by inflationary pressure, as the positive digital economy and finance shock results in economic efficiency and higher productivity growth.

The second issue is taking into account the role of fiscal policy in the model. Bank Indonesia maintains strong coordination and synergy with the government so that Bank Indonesia policy mix formulation aligns with the fiscal condition. The integrated policy approach in the modeling is reflected by incorporating fiscal policy instruments into the Bank Indonesia core model. Fiscal policy is a countercyclical instrument to achieve output stabilization while maintaining deficit targets and government borrowing constraints (debt level). This policy objective is accomplished by implementing government spending instruments and setting taxes. Government spending is negatively affected by the output gap, thus serving as a stabilization instrument and also constrained by the deficit target. Tax is positively correlated with the output gap and deficit target. Fiscal constraint derived from government budget constraint which limit government spending depend on tax collection, debt level, and target of budget deficit.

In the model simulation, in a case of weakening domestic GDP growth, the fiscal policy may serve as an automatic stabilizer by increasing government spending. In the monetary policy side, given lower inflation rate, the central bank has the policy space thus lowering the policy rate to help prop up the economic growth. In addition to accommodative monetary policy, the central bank also loosens the macroprudential policy to alleviate financing constraint and boost credit growth.

Bank Indonesia continuously develops its core model to reflect its policy transformation in coping with challenges in a rapidly changing environment and to strengthen its policy mix strategy to achieve macroeconomic and financial system stability.

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Table 1: Calibration of parameters and steady state variables

Description	Param.	Value	Description	Param.	Value
Patient HHs' subjective discount factor	β^P	0.9942	*Exog. shock process*		
Impatient HHs' subjective discount factor	β^I	0.975	*Autoregr. coefficients*		
Entrepreneurs' subjective discount factor	β^E	0.975	technology	ρ_a	0.98
Labor income share of patient HHs	μ	0.80	preference	ρ_z	0.61
Housing weight in HHs' utility	ε_h	0.20	domestic cost-push	ρ_H	0.12
Patient HHs' habit parameter	a^P	0.24	import cost-push	ρ_F	0.47
Impatient HHs' habit parameter	a^I	0.24	risk premium	ρ_ζ	0.31
Inv. elas. of intertemporal substitution	σ	1	investment adj.	ρ_{qk}	0.56
Inverse Frisch elas. of labor supply	ϕ	1	housing demand	ρ_h	0.97
Share of imports in consumption basket	ω	0.22	firms' LTV	ρ_{m^E}	0.88
Elas. of subs. domestic and imported goods	η	1.40	HHs' LTV	ρ_{m^I}	0.91
Risk-premium scale parameter	χ	0.01	banks' capital	ρ_{Kb}	0.27
Capital share in goods production	α	0.30	govt. spending	ρ_g	0.65
Physical capital depreciation rate	δ	0.05	*Standard deviations*		
Goods market elasticity (markup)	ε	6	technology	σ_a	0.43
Deposit rate elasticity (markdown)	ε^d	-6.54	preference	σ_z	6.11
Loan rate to HHs elasticity	ε^{bH}	1.80	domestic cost-push	σ_H	3.64
Loan rate to entrepreneurs elasticity (markup)	ε^{bE}	2.08	import cost-push	σ_F	7.36
Bank's capital depreciation rate	δ^b	0.24	risk premium	σ_ζ	5.75
Bank's retained earnings ratio	ϱ_b	1	investment adj.	σ_{qk}	3.68
Required reserve ratio	$\bar{\theta}$	0.065	housing demand	σ_h	8.61
Index. to past inflation, domestic firms	δ_H	0.19	firms' LTV	σ_{m^E}	4.45
Index. to past inflation, importers	δ_F	0.04	HHs' LTV	σ_{m^I}	1.33
Calvo price stickiness, domestic firms	θ_H	0.65	banks' capital	σ_{Kb}	10.06
Calvo price stickiness, importers	θ_F	0.59	govt. spending	σ_g	4.22
Taylor rule coefficients			mon. policy	σ_r	0.55
int. rate. smoothing	ϕ_R	0.75	foreign output	σ_{y^*}	1.61
inflation	ϕ_π	1.33	foreign inflation	σ_{π^*}	0.30
output	ϕ_y	0.18	foreign interest rate	σ_{r^*}	0.11
output growth	ϕ_{Δ_y}	0.25			
exchange rate	ϕ_e	0.20			
Adjustment costs					
investment	κ_i	8.76			
deposit rate	κ_d	6.64			
firms loan rate	κ_{bE}	1.81			
households loan rate	κ_{bH}	7.59			
banks leverage	κ_{Kb}	7.59			
Steady-state variables					
quarterly net inflation rate	$\bar{\pi}$	1%			
govt. spending-to-output ratio	$\bar{g}/\bar{y}$	0.085			
Impatient HHs' LTV ratio	m^I	0.70			
Entrepreneurs' LTV ratio	m^E	0.45			
target capital-to-assets ratio	$\bar{\nu}$	0.086			

Notes: *(1)* The calibration above is based on the calibration and posterior mean estimates reported in Juhro, Lie, and Sasongko (2022); *(2)* the three foreign variables (US output, inflation, and nominal interest rate) are assumed to follow VAR(2).

Table 2: Standard deviations of select variables for various policy mix and monetary-fiscal regime

AMPF

Policy mix	$\sigma(\hat{y}_t - \hat{y}_{t-1})$	$\sigma(\hat{\pi}_t)$	$\sigma(\hat{r}_t)$	$\sigma(\hat{B}_t - \hat{B}_{t-1})$
Monetary policy (MP)	0.0400	0.2284	0.2607	0.0541
MP+CR	0.0399	0.2210	0.2522	0.0517
MP+MPLB	0.0400	0.2279	0.2602	0.0539
MP	0.0396	0.2268	0.2589	0.0520
MP+LTV	0.0409	0.2436	0.2782	0.0437

PMAF

Policy mix	$\sigma(\hat{y}_t - \hat{y}_{t-1})$	$\sigma(\hat{\pi}_t)$	$\sigma(\hat{r}_t)$	$\sigma(\hat{B}_t - \hat{B}_{t-1})$
Monetary policy (MP)	0.3831	0.7156	0.6497	0.4317
MP+CR	0.3857	0.7198	0.6553	0.4296
MP+MPLB	0.3832	0.7158	0.6500	0.4317
MP	0.3831	0.7156	0.6497	0.4314
MP+LTV	0.4060	0.7195	0.6483	0.3710

Notes: *(1)* all entries are in %; *(2)* CR, MPLB, and LTV refer to capital requirement (bank capital-to-assets ratio), liquidity buffer, and loan-to-value ratio, respectively; *(3)*) entries for the last policy mix (MP+LTV) are generated under zero LTV exogenous shocks; *(4)* AMPF refers to the active monetary, passive fiscal regime, while PMAF refers to passive monetary, active fiscal regime.

Table 3: Relative welfare losses for various policy mixes and monetary-fscal regime

AMPF

	MP	MP+CR	MP+MPLB	MP+LTV
$\lambda_{cr} = 0$				
$\lambda_y = 0.05$	1	0.9366	0.9961	1.1536
$\lambda_y = 0.5$	1	0.9366	0.9961	1.1535
$\lambda_y = 1$	1	0.9367	0.9961	1.1535
$\lambda_{cr} = 0.5$				
$\lambda_y = 0.05$	1	0.9366	0.9961	1.1529
$\lambda_y = 0.5$	1	0.9366	0.9961	1.1528
$\lambda_y = 1$	1	0.9367	0.9961	1.1527
$\lambda_{cr} = 1$				
$\lambda_y = 0.05$	1	0.9365	0.9961	1.1522
$\lambda_y = 0.5$	1	0.9366	0.9961	1.1521
$\lambda_y = 1$	1	0.9366	0.9961	1.1520

PMAF

	MP	MP+CR	MP+MPLB	MP+LTV
$\lambda_{cr} = 0$				
$\lambda_y = 0.05$	1	1.0117	1.0007	1.0110
$\lambda_y = 0.5$	1	1.0118	1.0007	1.0119
$\lambda_y = 1$	1	1.0118	1.0007	1.0129
$\lambda_{cr} = 0.5$				
$\lambda_y = 0.05$	1	1.0115	1.0006	1.0080
$\lambda_y = 0.5$	1	1.0115	1.0006	1.0089
$\lambda_y = 1$	1	1.0115	1.0006	1.0099
$\lambda_{cr} = 1$				
$\lambda_y = 0.05$	1	1.0113	1.0006	1.0050
$\lambda_y = 0.5$	1	1.0113	1.0006	1.0059
$\lambda_y = 1$	1	1.0113	1.0006	1.0069

Notes: *(1)* CR, MPLB, and LTV refer to capital requirement (bank capital-to-assets ratio), liquidity buffer, and loan-to-value ratio, respectively; *(2)* entries above are welfare losses *relative* to the case where the central bank only conducts monetary policy (no macroprudential policy); *(3)* the welfare loss function has a general form of $L = \sigma(\hat{\pi}_t) + \lambda_y \sigma(\hat{y}_t - \hat{y}_{t-1}) + \lambda_r \sigma(\hat{r}_t) + \lambda_{cr} \sigma(\hat{B}_t - \hat{B}_{t-1})$; *(4)* $\lambda_r = 0.05$ in all cases; *(5)* AMPF refers to the active monetary, passive fiscal regime, while PMAF refers to passive monetary, active fiscal regime.

Table 4: Relative welfare losses for various policy mixes and monetary-fscal regime— selective shocks

AMPF

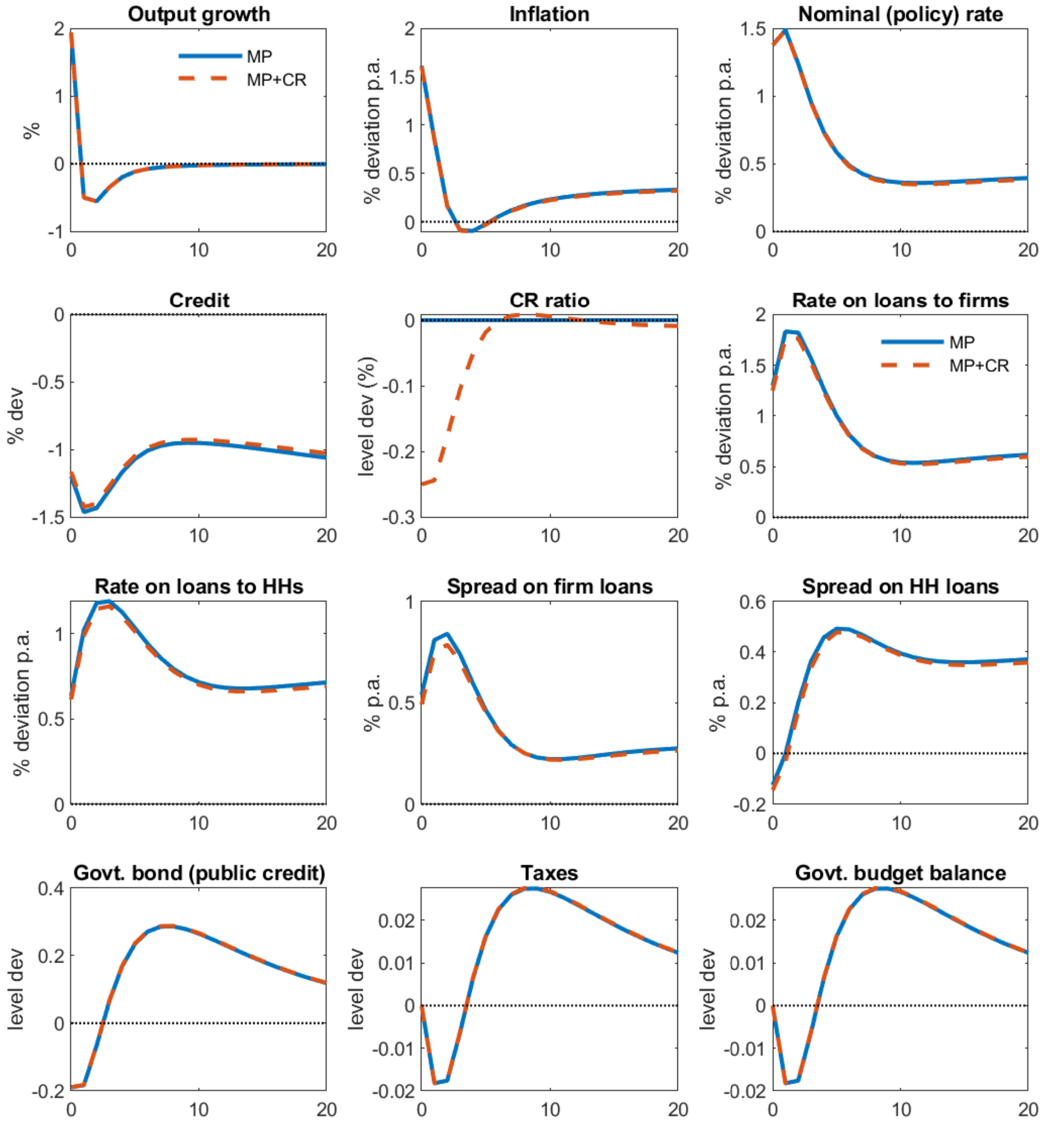
	MP	MP+CR	MP+MPLB	MP+LTV
Technology shocks	1	0.9355	0.9960	1.1520
Preference shocks	1	0.9909	0.9995	1.1883
Domestic cost-push shocks	1	1.0044	1.0002	0.9912

PMAF

	MP	MP+CR	MP+MPLB	MP+LTV
Technology shocks	1	1.0140	1.0009	0.9715
Preference shocks	1	1.0103	1.0006	1.0107
Domestic cost-push shocks	1	1.0094	1.0006	0.9737

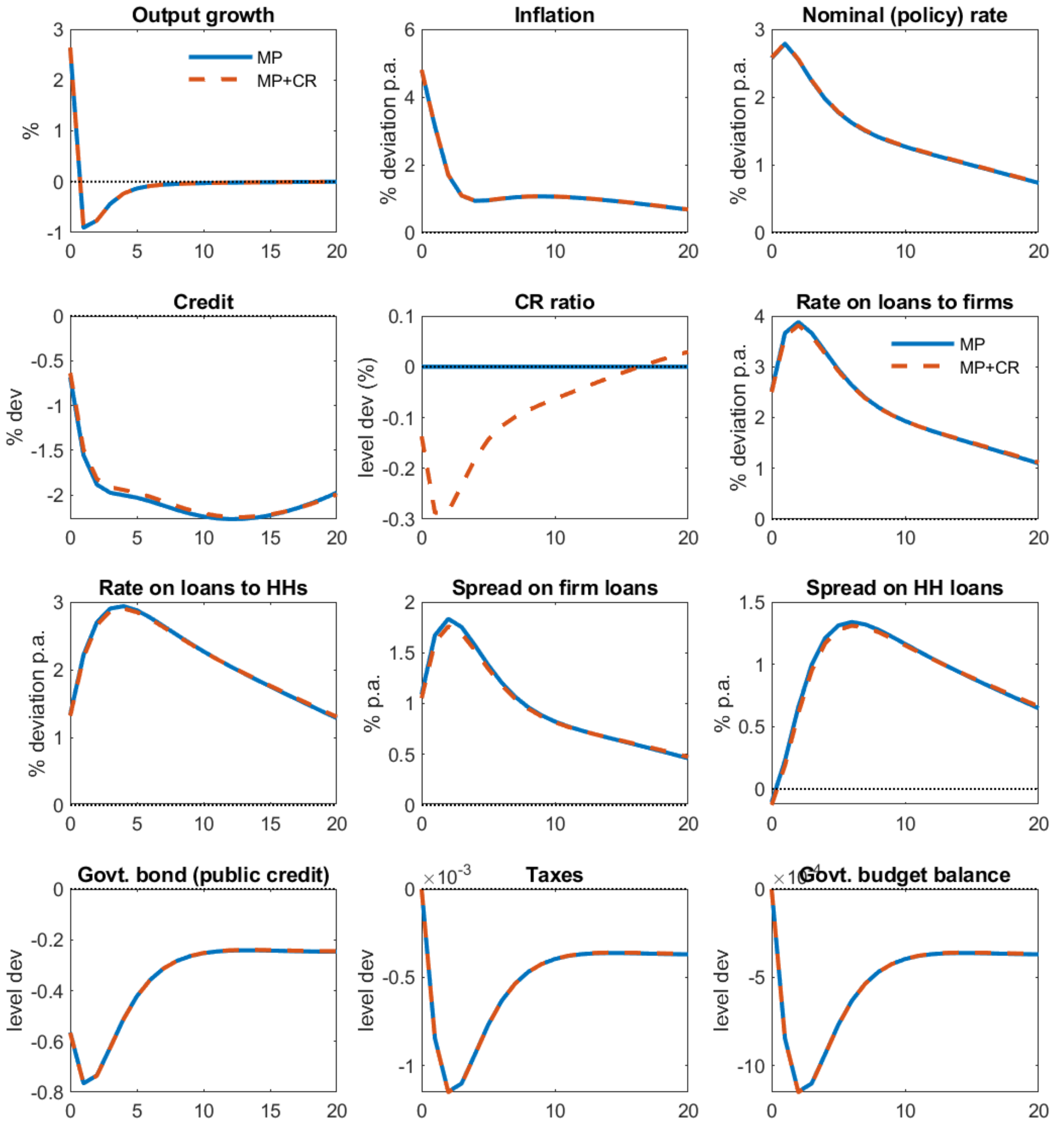
Notes: *(1)* The above table redo Table 3 under selective shocks based on the estimated posterior mean standard deviation(s) — all the other shocks are assumed to have zero variances; *(2)* the welfare loss function has a general form of $L = \sigma(\hat{\pi}_t) + \lambda_y \sigma(\hat{y}_t - \hat{y}_{t-1}) + \lambda_r \sigma(\hat{r}_t) + \lambda_{cr} \sigma(\hat{B}_t - \hat{B}_{t-1})$; *(3)* $\lambda_r = 0.05$, $\lambda_y = 0.5$, and $\lambda_{cr} = 0.5$ in all cases; *(4)* AMPF refers to the active monetary, passive fiscal regime, while PMAF refers to passive monetary, active fiscal regime.

Figure 2: Impulse responses to preference shock — MP vs. MP+CR under **AMPF** regime



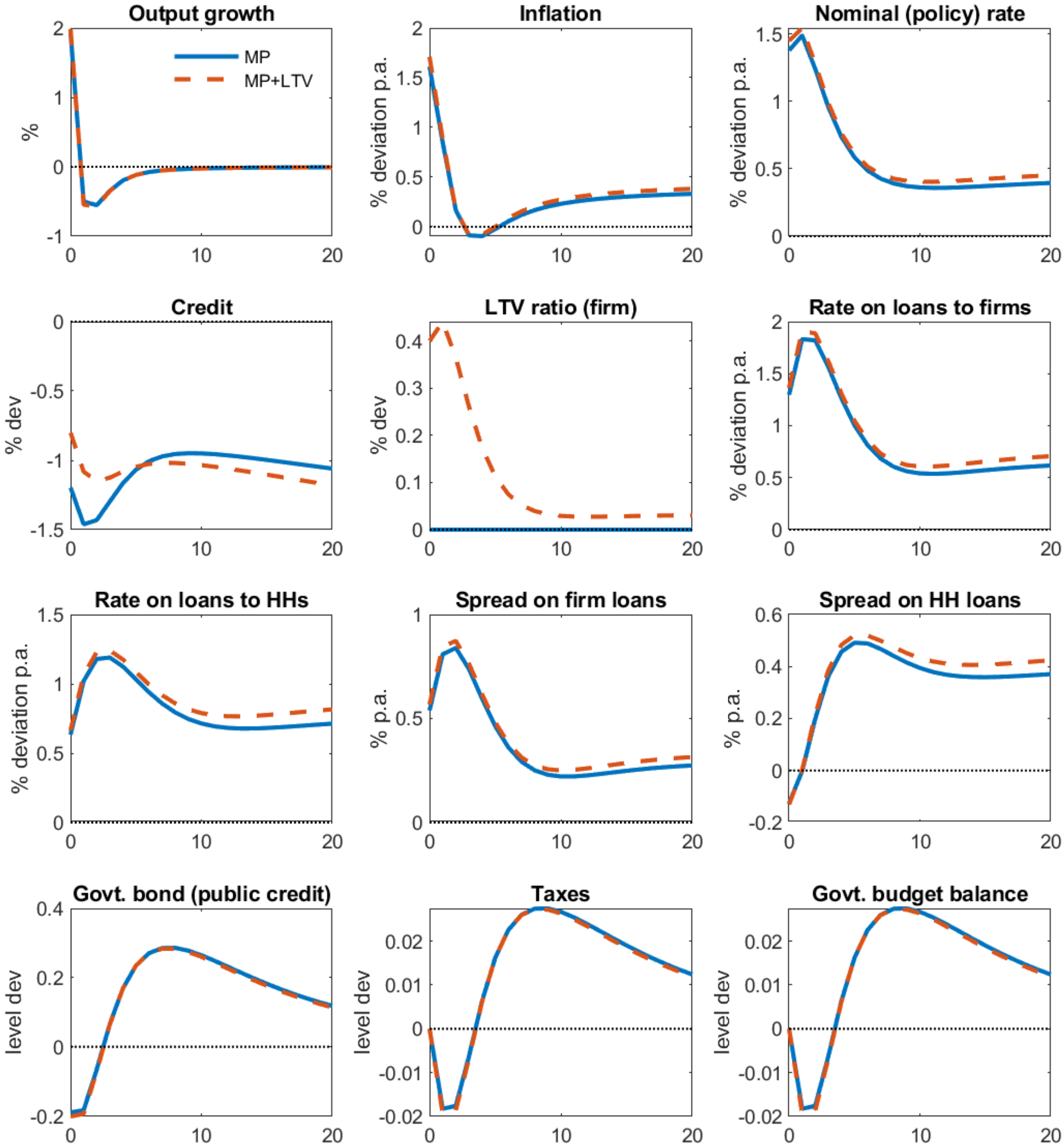
Notes: *(1)* MP and CR refer to monetary policy and capital requirement (bank capital-to-assets) ratio, respectively; *(2)* AMPF refers to active monetary, passive fiscal regime.

Figure 3: Impulse responses to preference shock — MP vs. MP+CR under PMAFregime



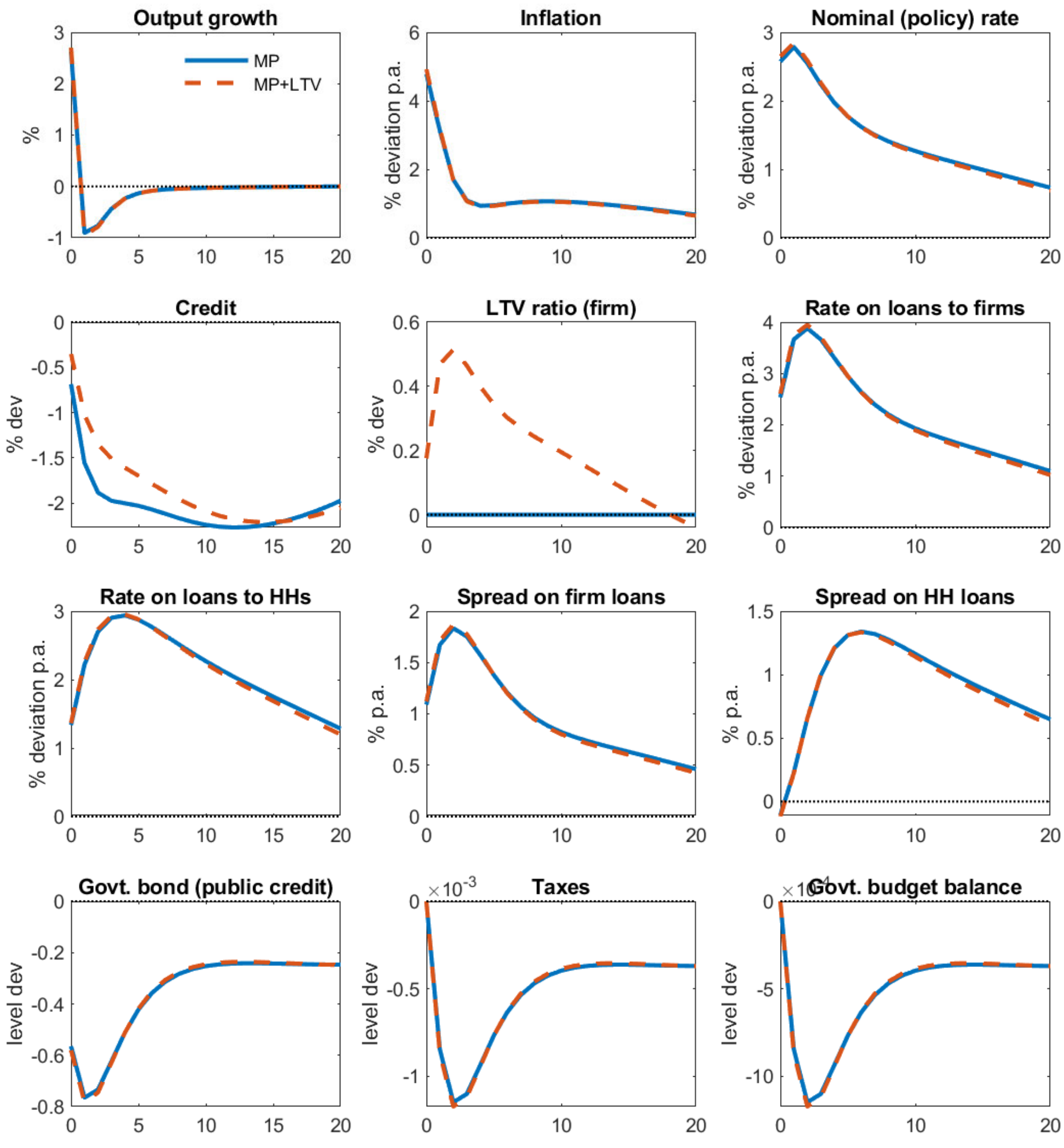
Notes: *(1)* MP and CR refer to monetary policy and capital requirement (bank capital-to-assets) ratio, respectively; *(2)* PMAF refers to passive monetary, active fiscal regime.

Figure 4: Impulse responses to preference shock — MP vs. MP+LTV under AMPF regime



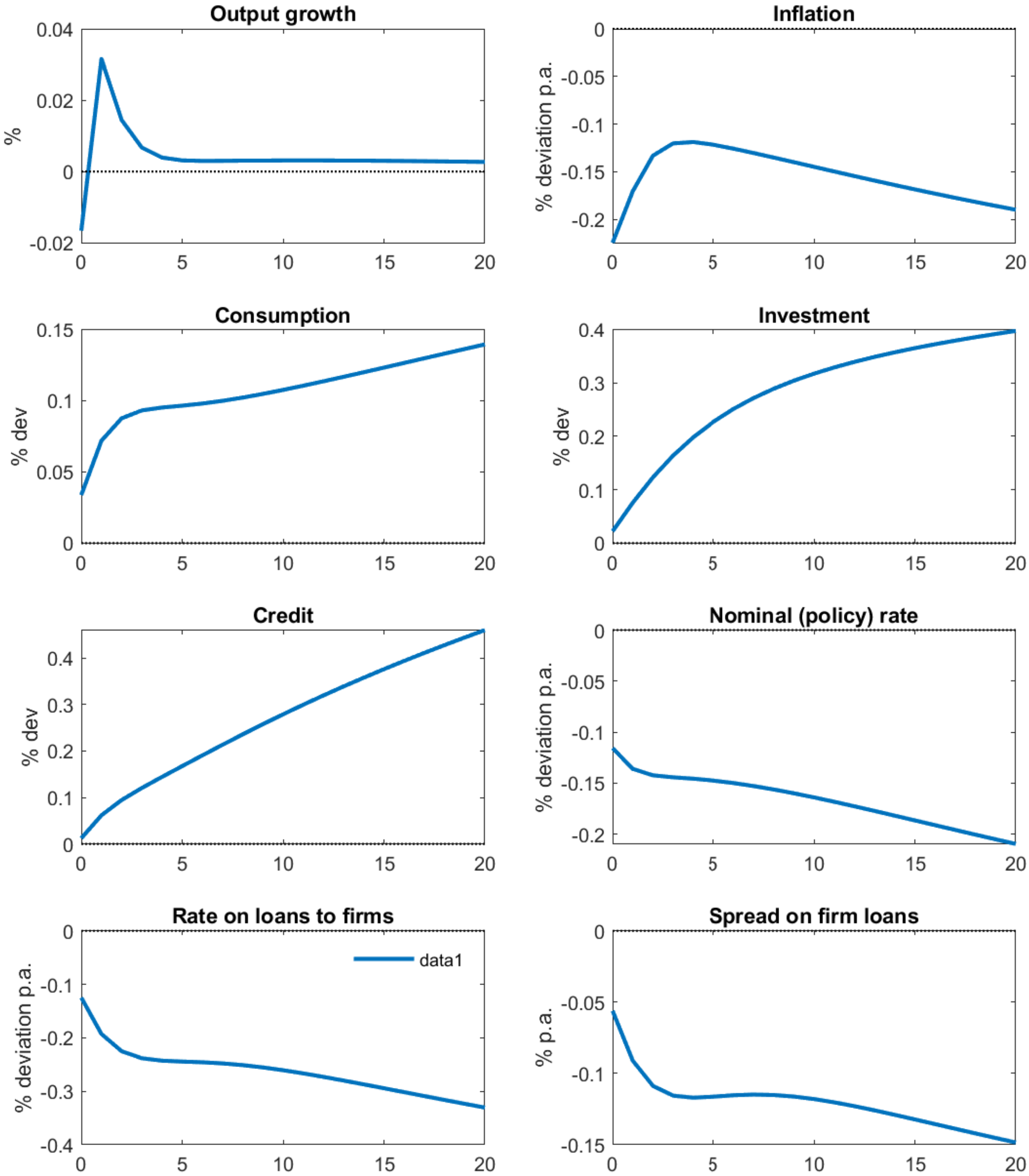
Notes: *(1)* MP and LTV refer to monetary policy and loan-to-value ratio, respectively; *(2)* AMPF refers to active monetary, passive fiscal regime.

Figure 5: Impulse responses to preference shock — MP vs. MP+LTV under PMAFregime



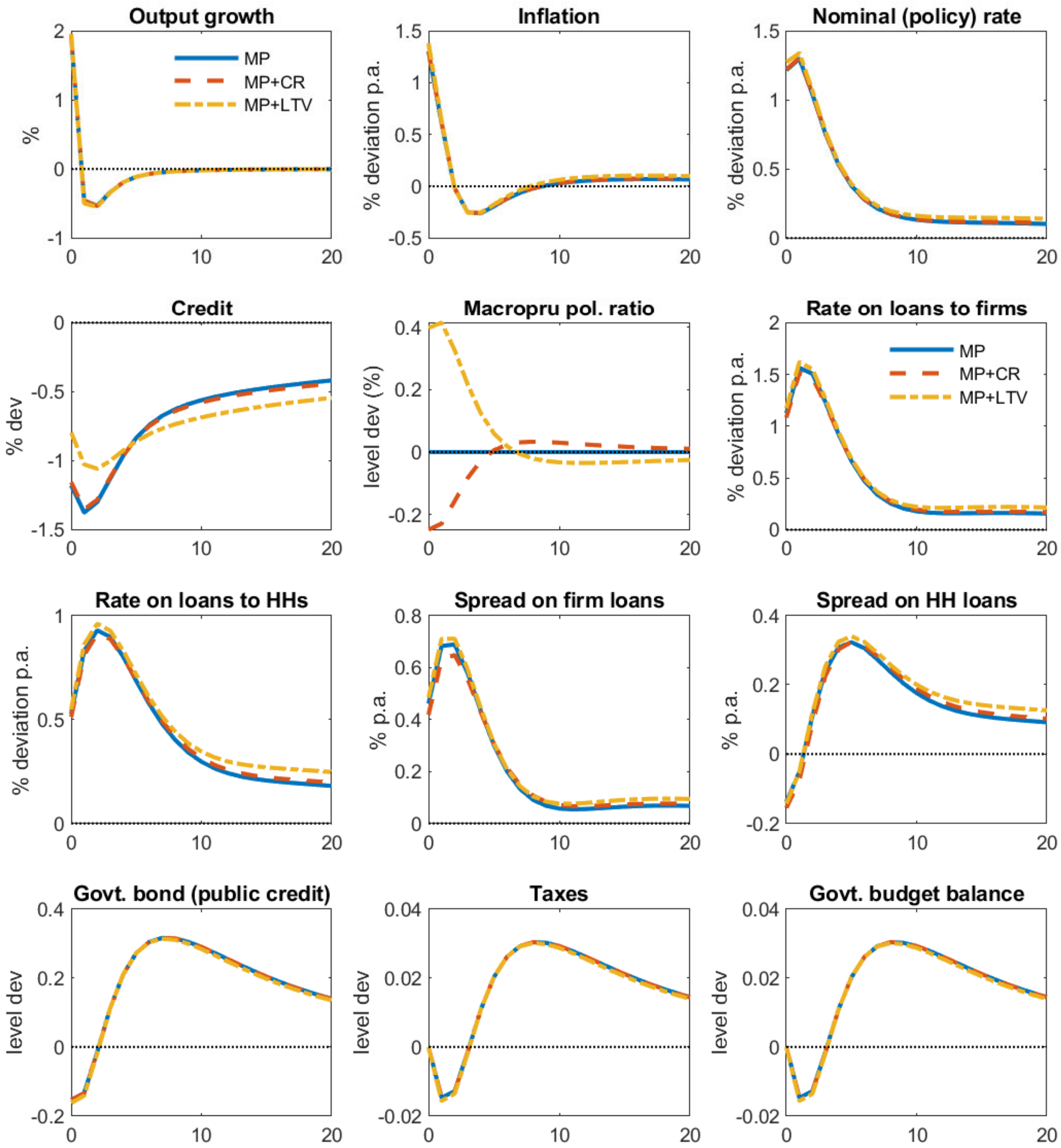
Notes: *(1)* MP and LTV refer to monetary policy and loan-to-value ratio, respectively; *(2)* PMAF refers to passive monetary, active fiscal regime.

Figure 6: Impulse responses to CBDC shock — MP under **AMPF** regime



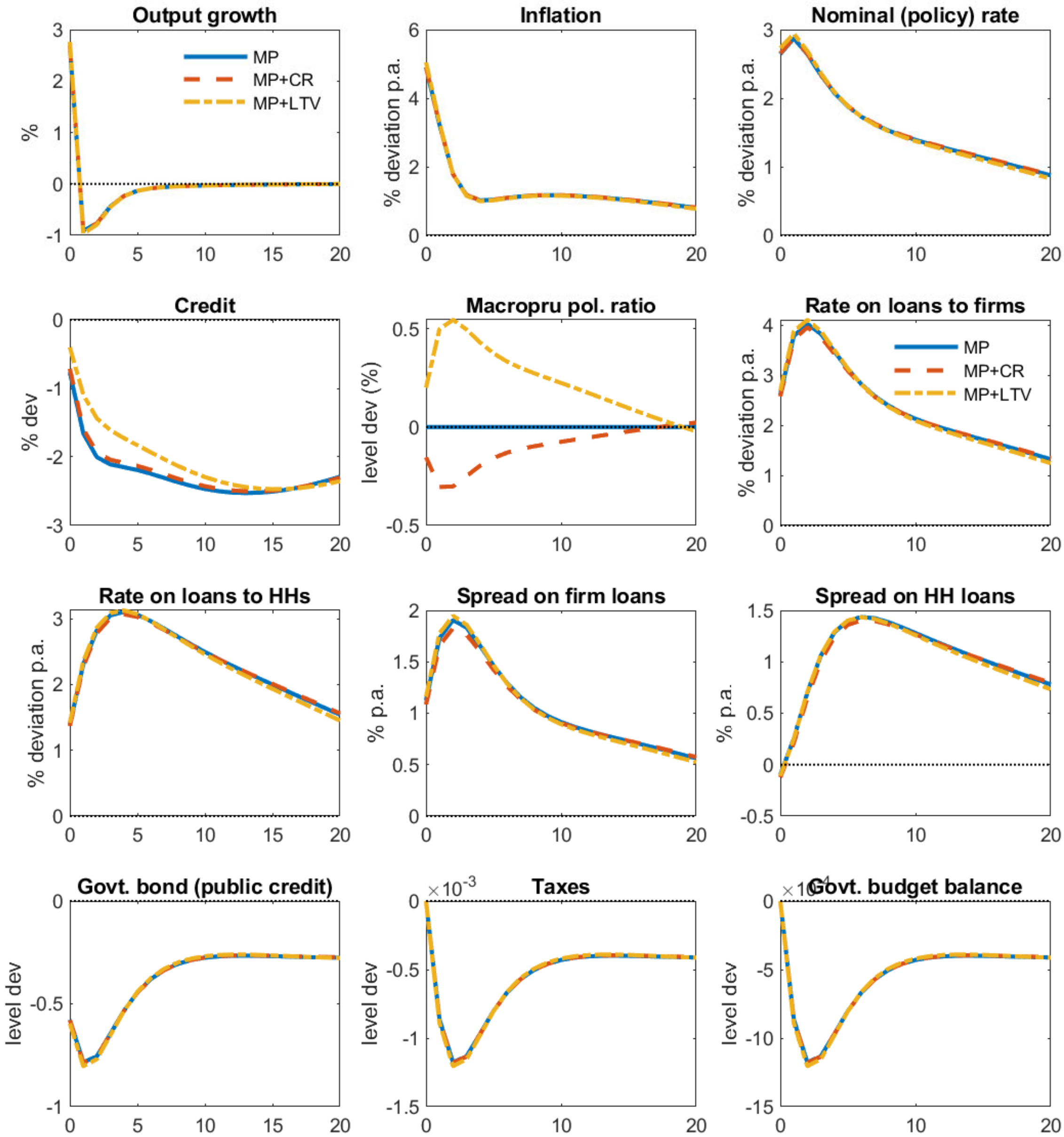
Notes: *(1)* The figure plots the impulse response to a 1% CBDC (TFP) shock with only demand-side effect, under the MP case (no macroprudential policy); *(2)* AMPF refers to active monetary, passive fiscal regime.

Figure 7: Impulse responses to preference shock with CBDC effect under **AMPF** regime



Notes: *(1)* The figure plots the impulse response to a positive preference shock (as in Figure (2)), with an additional 10% CBDC (TFP) shock (with only demand-side effect); *(2)* M, CR, and LTV refer to monetary policy, capital requirement ratio, and loan-to-value ratio, respectively; *(3)* AMPF refers to active monetary, passive fiscal regime.

Figure 8: Impulse responses to preference shock with CBDC effect under **PMAF** regime



Notes: *(1)* The figure plots the impulse response to a positive preference shock (as in Figure (2)), with an additional 10% CBDC (TFP) shock (with only demand-side effect); *(2)* M, CR, and LTV refer to monetary policy, capital requirement ratio, and loan-to-value ratio, respectively; *(3)* PMAF refers to passive monetary, active fiscal regime.