Central Bank Policy Mix: Policy Perspectives and Modeling Issues

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Central Bank Policy Mix: Policy Perspectives and Modeling Issues[‡]

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Abstract

This paper discusses the core model of Bank Indonesia policy mix (BIPOLMIX), a macroeconomic modeling breakthrough designed for economic and financial projections and policy simulations. The BIPOLMIX model captures the integrated central bank policy responses, e.g. monetary, macroprudential, and payment system policies, and considers the role of fiscal policy. The strategy of developing the model is flexible, dynamic, and forward-looking to make the model relevant as the basis for Bank Indonesia policy transformation in coping with challenges in a rapidly changing environment. In this regard, the model takes into account various economic dynamics and policy instrument mix in optimizing the achievement of macroeconomic and financial system stability. Amid main issues related to the model parameter consistency, in line with theoretical and technical considerations, the modeling framework is believed to be useful as a pivotal reference by the central banks in EMEs in developing core models to support optimal policy responses.

Keywords: Central Bank Policy Mix, Policy Modeling, Projections and Simulations, Bank Indonesia.

JEL Classification: C51, E37, E58

[‡] The views expressed in this paper are those of the authors and do not necessarily reflect the views of Bank Indonesia.

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I. Introduction

The increasingly rapid changes in the global environment and the higher level of economic openness, accompanied by a broader and more contagious risk dimension, have prompted a more integrated policy transformation in several central banks. In this context, the expectation of the central bank's position to play a strategic role and be always relevant in a rapidly changing environment demands capabilities and perspectives beyond conventional wisdom. Against that background, the challenges faced by Bank Indonesia, as the central bank of Indonesia, in maintaining the stability of the rupiah and the financial system while always paying attention to economic growth have also become more complex amidst various emerging risks in recent years. The risks are mainly related to increased spillovers, dynamics of foreign capital flows, and the increasingly tight linkages between the macro-financial sector (macro-financial linkages) and the external sector (macro-financial-external linkages) (Warjiyo & Juhro, 2022; Juhro et al., 2021; Wijoseno et al., 2021; Warjiyo & Juhro, 2019; Agung et al., 2016; Juhro & Goeltom, 2015). Therefore, Bank Indonesia cannot rely only on implementing monetary policy but also needs to implement macroprudential policy and supervision to ensure financial intermediation runs smoothly and mitigate systemic risks to the financial system in order to maintain financial system stability.

External risks in the form of the high volatility of foreign capital flows due to loose monetary policy practices in developed countries and the recent increase in global uncertainty have also affected macroeconomic and financial system stability in various emerging market economies (EMEs), including Indonesia. In this case, the dynamics of foreign capital flows also affect the volatility and synchronization of the economic and financial cycles (Juhro et al., 2021). Thus, as has been the policy focus of central banks in EMEs, in addition to monetary and macroprudential policies, Bank Indonesia also needs to implement exchange rate policies and foreign capital flows management to mitigate the risk of instability that threatens the domestic economy. This condition makes Bank Indonesia faces new challenges in managing the policy trilemma (trilemma management) in an open economy, namely how to integrate monetary policy, macroprudential policy, and exchange rate stabilization and management of foreign capital flows into an optimal central bank policy mix. The formulation of the policy mix certainly requires an analytical framework and assessment of complex transmission mechanisms, as well as considering trade-offs and interactions between policies.

The purpose of this paper is to discuss the development of the policy mix core model in Bank Indonesia and its use in policy formulation. The model captures monetary, macroprudential, and payment system policy responses in an integrated way and takes into account fiscal policy. The development of the policy mix model is carried out in line with the developments and challenges the central bank faces in managing macroeconomic and financial system stability. In developing the model, simplicity and the ability to capture economic conditions are needed so that the model can be used for economic and financial projections and policy simulations. The most fundamental issue in developing the model is maintaining the consistency of model parameters within theoretical and technical considerations.

The remainder of the paper is organized as follows. Section 2 describes the development of the core model at Bank Indonesia, starting with the core model for monetary policy. Section 3 discusses the need for a more integrated model. Section 4 provides some conclusions.

II. Development of Bank Indonesia's Core Economic Modeling

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.[1] 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. 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.

BIPOLMIX, built based on the New Keynesian DSGE model, is extended to incorporate several frictions or imperfections in the economy to increase its forecast accuracy and policy

[1]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).

simulation. 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 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). Each policy instrument has its own objective. 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).

The modeling specification of BIPOLMIX incorporates three frictions: real sector, financial sector, and external sector friction. In the real sector friction, export and import variables are introduced into the model to accommodate the analysis of Local Currency Pricing (LCP) and Dominant Currency Paradigm (DCP) assumption in the external trade and their impacts on export and import dynamics and the economy, as described in equations (1) – (5).

$$\hat{y}_t = (1 - s_{\mathrm{nx}})\hat{y}_{d,t} + s_{\mathrm{nx}}(\hat{x}_t - \widehat{m}_t) \tag{1}$$

$$\hat{x}_t = y_t^* - \epsilon_x\left(p_{x,t} - p_t^*\right) + \varepsilon_t^x \tag{2}$$

$$\widehat{m}_t = (1 - s_x)\widehat{m}_{d,t} + s_x\widehat{m}_{x,t} \tag{3}$$

where

$$\widehat{m}_{d,t} = \hat{y}_{d,t} - (1 - s_x)\epsilon_m\left(p_{m,t} - p_{d,t}\right) + \varepsilon_t^{m^d} \tag{4}$$

$$\widehat{m}_{x,t} = y_t^* - (1 - s_x)\epsilon_x\left(p_{m,t} - p_{d,t}\right) - \epsilon_x\left(p_{x,t} - p_t^*\right) \tag{5}$$

Import ($\widehat{m}_t$) is affected by several factors, including domestic demand for imported consumer goods, intermediary goods to produce export products, and the relative price of imported goods to domestic goods. Meanwhile, export ($\hat{x}_t$) is influenced by global demand and the relative price of export goods to foreign goods. By introducing export and import and their relative prices into the model, BIPOLMIX accommodates another real sector friction, i.e., imperfect exchange rate pass-through, such that the exchange rate affects domestic prices through imported inflation (equation 6).

$$\hat{\pi}_t = \omega_1 \hat{\pi}_{dom,t} + (1-\omega_1)\hat{\pi}_{ext,t} + \varepsilon_t \tag{6}$$
$$\hat{\pi}_{dom,t} = \beta_1 \hat{\pi}_{dom,t-1} + (1-\beta_1) E_t\{\hat{\pi}_{dom,t+1}\} + \beta_2 \hat{y}_t$$
$$\hat{\pi}_{ext,t} = \gamma_1 \hat{\pi}_{ext,t-1} + (1-\gamma_1) E_t\{\hat{\pi}_{ext,t+1}\} + \gamma_2 \widehat{mcm}_t$$

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, Gertler, and Gilchrist, 1999). Using this approach, external financing premium or financial risk partly determines loan price, thus affecting banking credit dynamic. As described in equation 7, financial risk is negatively correlated with the macroeconomic condition.

$$\widehat{finrisk}_t = \partial_1 \widehat{finrisk}_{t-1} - \partial_2 \hat{y}_t + \partial_3 \widehat{npl}_t + \partial_4 \hat{z}_t + \partial_5 \widehat{risk}_t + e_t^{finrisk} \tag{7}$$

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 8).

$$\widehat{loancap}_t = x_1 \widehat{dpk}_t + x_2 \widehat{othloanfund}_t - x_3 \widehat{resrv}_t + e_t^{loancap} \tag{8}$$

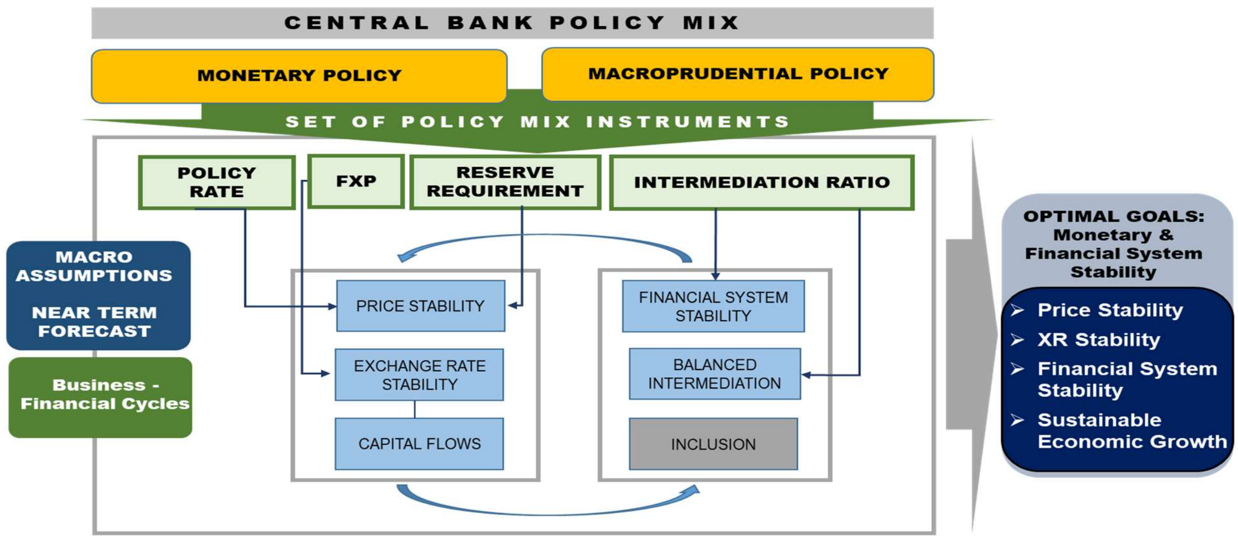
Third, capital flow friction. It incorporates the dynamic of domestic funding, which is also affected by the amount of capital inflow to the economy and the banking system (equation 9).

$$\widehat{dpk}_t = \sigma_1 \widehat{dpk}_{t-1} + \sigma_2 \hat{y}_t + \sigma_3 \hat{r}_t + \sigma_4 \widehat{fa}_t + e_t^{dpk} \tag{9}$$

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 10).

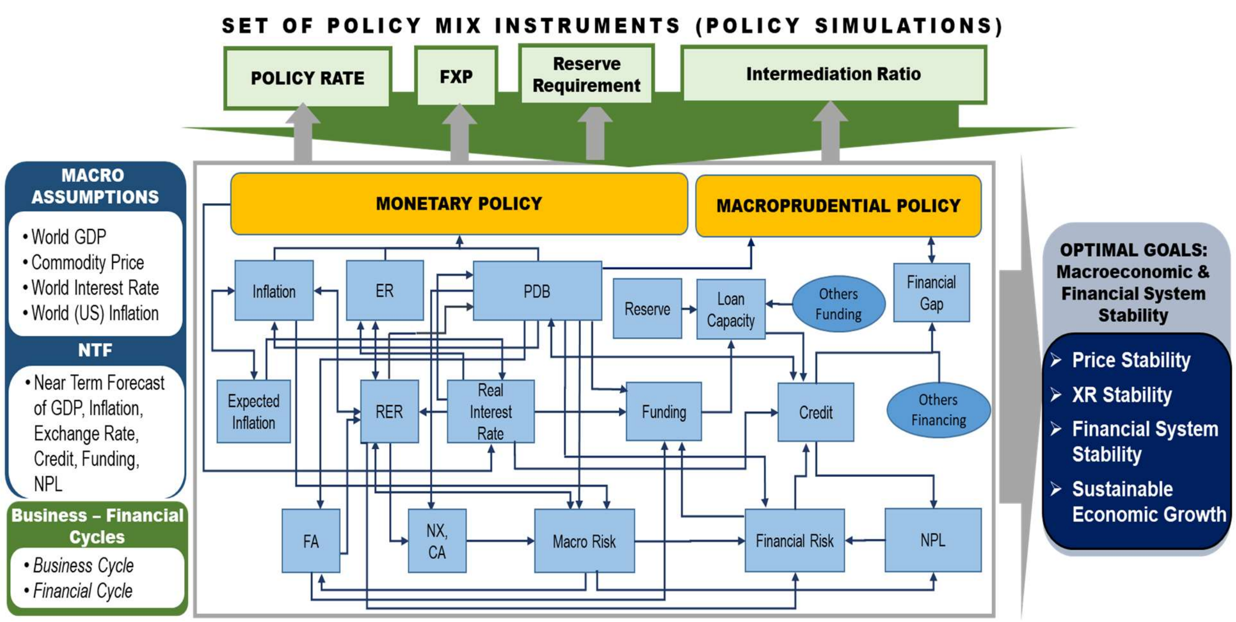
$$\widehat{risk}_t = \beta_1 \widehat{risk}_{t-1} - \beta_2 \hat{y}_t + \beta_3 \hat{\pi}_t^{CPI} - \beta_4 \widehat{ca}_t + e_t^{risk} \tag{10}$$

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. Pictures 1 and 2 describe the framework of the BIPOLMIX model, given the theoretical background, policy strategy, and several constraints and frictions.



Source: Wijoseno et al. (2021)

Graph 1. The Framework of BIPOLMIX 2021 (Policy Trilemma Perspective)



Source: Wijoseno et al. (2021)

Graph 2. The Framework of BIPOLMIX 2021 (Variables Perspective)

The evaluation of the BIPOLMIX model shows that it can be used in formulating Bank Indonesia's policy mix that integrates monetary policy instruments, macroprudential, and exchange rate stabilization to achieve the Rupiah stability and financial system stability while supporting economic growth. The development of the model can capture economic friction so that it can describe the economy more realistically. In addition, the model has also been able to estimate parameters quite well by producing an impulse response that is in line with economic theory and empirical evidence. This capability is obtained as the BIPOLMIX model has integrated related research into the model to make the estimation results more robust (Wijoseno et al., 2021).

In terms of accuracy, the results of the in-sample forecast of the BIPOLMIX model have a good accuracy compared to the in-sample forecast on the ARIMBI 2019 model (Waluyo et al., 2019). In addition, by comparing the root mean square error (RMSE) of ARIMBI 2019 and that of BIPOLMIX, the accuracy of the BIPOLMIX model for several variables such as inflation, credit, non-performing loans (NPL) and financial accounts, is better than the 2019 ARIMBI model (Table 1). Thus, the forecast results of the BIPOLMIX model tend to be better than the ARIMBI 2019 model, so the BIPOLMIX model can replace the role of the ARIMBI 2019 model in conducting projections and simulations.

Table 1. Comparison of the RMSE of the ARIMBI 2019 model with the BIPOLMIX model

Variable	**RMSE**	
	ARIMBI 2019	**BIPOLMIX**
Inflation	1.1041	0.8925
GDP	5.5591	6.6093
Exchange rate	1.9406	2.6736
Credit	7.0222	6.8461
NPL	0.4451	0.3400
Current Account	1.9022	2.6721
Financial Account	2.4191	2.2568

*shaded area shows smaller RMSE/better accuracy

Source: Wijoseno et al. (2021)

Notwithstanding the usefulness of the existing BIPOLMIX model, the room for further development of the BIPOLMIX model is still open, including complementing the model with fiscal policy. In addition, the resulting policy mix can be developed in line with the development of the central bank's policy instruments, especially in navigating the digital era.

III. Toward a More Integrated Central Bank Policy Mix

Based on historical experiences and the challenges of strategic environment changes, three trends (new realities) need to be observed in analyzing the central bank from time to time (Warjiyo & Juhro, 2022). First, the uncertainty and complexity of the problems will be higher, including structural changes, technological developments, the spread of the pandemic, and other strategic issues that affect the implementation of the central bank's mandates. The issue of monetary and financial stability is also increasingly widespread and interconnected. This will escalate due to trends in technology development and innovation in various lines of the economy. The formulation of policy response and timing will also become increasingly challenging, given the relatively short length of the technology cycle. This pushes the central bank to prepare for possible measurable changes in conditions, aligning with strategies for managing monetary and financial stability.

Second, the welfare and economic sustainability issues cannot be separated from the central bank's role in achieving and maintaining price stability, such as economic growth, full employment, income distribution and inclusiveness, and environmental issues/climate change. The pandemic amplifies shocks that are initially small to become very large in the entire system in a country or in the world, thus demanding a developmental role from the central bank.

Third, the central bank becomes a digital regulator that can strategically create a favorable environment for the economy and remain relevant in the digital era. The increasingly fast changes and interconnecion in the digital era raise another fact when technology has enabled market/public players to engage in economic transactions without the need for a central authority role so that a central bank is no longer needed.

Therefore, several principles that can be adhered to by the central bank in overcoming the complexity of the problem, as well as being the regulator/relevant policy authority, are as follows. The most important thing is to strengthen the strategy for implementing the central bank's policy mix. Substantively, the central bank's policy mix framework remains valid in maintaining macroeconomic and financial system stability. However, the strategy for implementing the central bank's policy mix needs to be strengthened to respond to various economic and financial challenges in the new era with technological developments and increasingly accelerated and hyperconnected problems. The central bank is not the only game in town, so catalytic collaboration needs to be built 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. The demand-side management strategy (short term) is integrated with supply-side management to address structural problems (medium-long term). In the perspective of central bank policy, the meaning of achieving stability is in the context of supporting sustainable growth (stability for sustainability). Therefore, the realization of sustainability needs support for strengthening the coordination of central bank policies and related authorities to manage related dimensions of sustainability, including economic and financial resilience, efficiency, and inclusiveness.

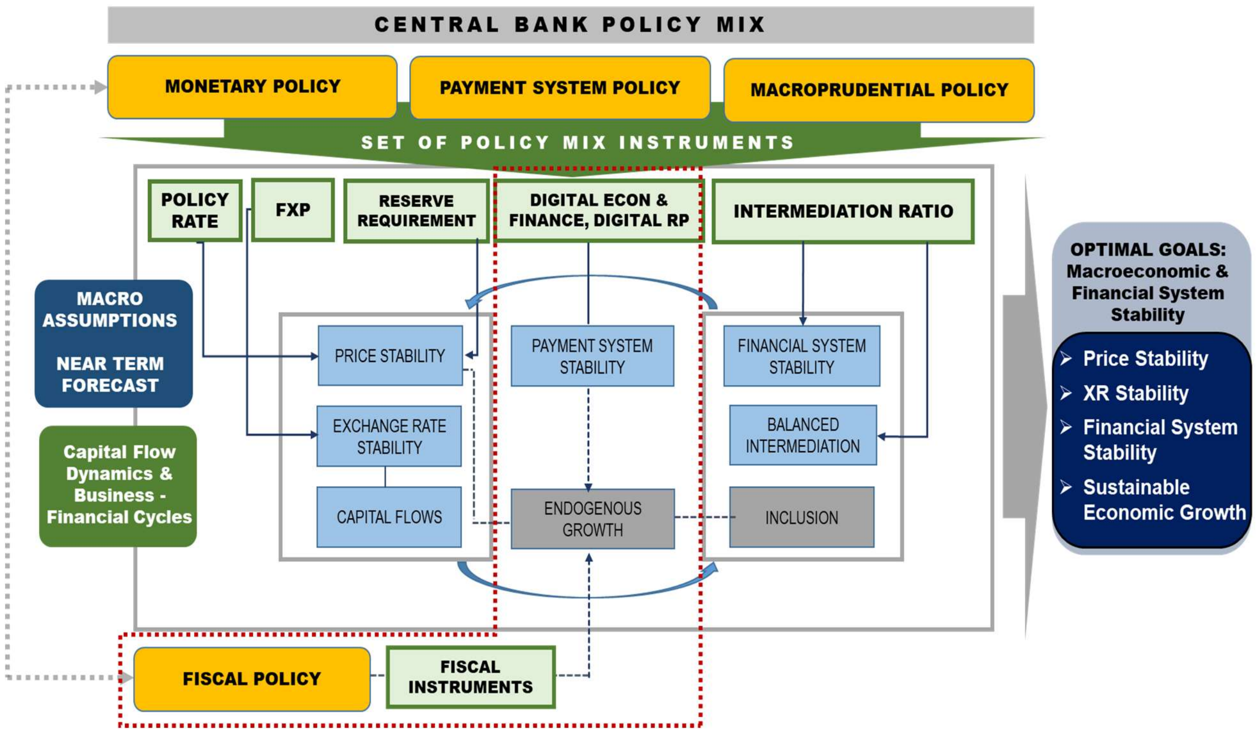
In addition, in line with the growing trend of digital technology, the central bank needs to study the potential benefits and risks of each technology, and the innovation options that can be used. The benefits of digital technology must be optimally pursued in the development of inclusiveness, efficiency, and innovation in the economy. Preparing for the future of money is part of guarding the existence of a central bank in the digital era. Central Bank Digital Currency (CBDC) issuance is an integral part of enriching and strengthening central bank policy instruments (policy mix) to maintain stability and support sustainability. The new realities and dynamics of thought above have fundamental implications for the development of a more integrated Bank Indonesia Policy Mix framework and related economic modeling. In this case, three aspects of further development are carried out to improve the BIPOLMIX Model framework in the complete version.

First, although still based on three main themes of Bank Indonesia's policy transformation—namely: (i) understanding the economic and financial cycle; (ii) understanding macro-financial-external linkages; (iii) understanding the real sector and structural reforms—, the strengthening policy process includes not only monetary-financial policy trilemma but also more broadly on the stability of the macroeconomic and financial system. In this respect, the indicators of economic growth are more clearly articulated, particularly in relation to the stability-growth nexus. This captures the central bank's role in the economic recovery process in which bolstering economic growth is inseparable from the central bank's responsibility to maintain stability.

Second, with increasing efforts to navigate in the digital era, the role of payment system policies to support economic productivity and efficiency as an endogenous component of economic growth is becoming increasingly relevant. The endogenous growth theory emphasizes that technological progress will increase economic productivity as a driver of economic growth. However, most research on technological advances' role in boosting productivity focuses mainly on variables related to R&D activities, education, and funding. As an enhancement, it is necessary to streamline with central bank policy mix paradigm, which takes into account the role of payment system instruments in boosting productivity, particularly in relation to the ecosystem development for digital economy and finance (EKD). Further development is to take into account the existence of CBDC as an important part of strengthening the central bank policy mix in the digital era.

Third, it is necessary to incorporate features on coordination between monetary policy and fiscal policy. Many crises in the past provide lessons on the increasing importance of institutional arrangement and policy coordination among policymakers. Sound and sustainable monetary and fiscal policy coordination would optimize demand-side management policy space. It means that two policies support each other—or their effects should not cancel each other out—to improve economic performance and maintain stability and economic growth. Juhro et al. (2022a) show that coordination of monetary and fiscal policies in recent years is in the right direction to obtain a balanced policy interaction in achieving more optimal growth.

Based on those perspectives, the framework of BIPOLMIX development will become more integrated, as presented Graph 3.



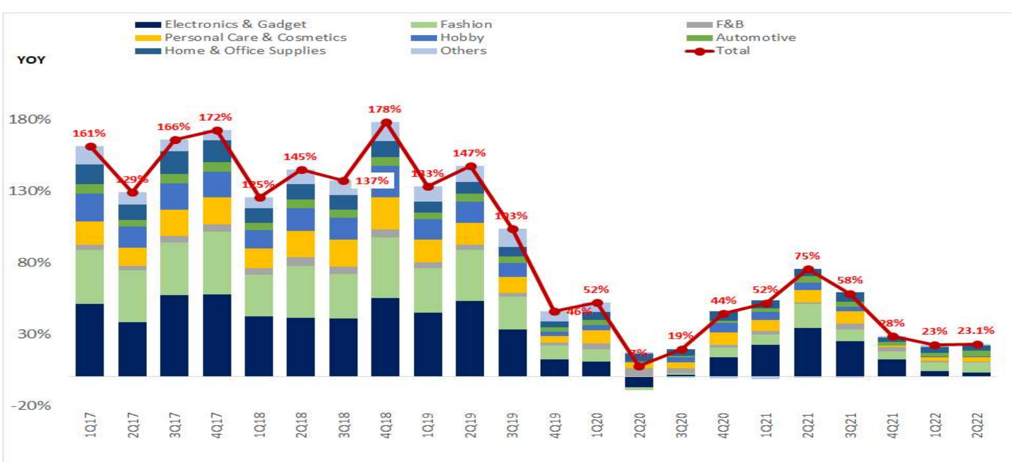
Graph 3. The Framework of BIPOLMIX 2022
(Managing Macroeconomic and Financial System Stability)

From the BIPOLMIX model integration framework, we can see that the central bank policy mix strategy needs to be integrated to optimize macroeconomic welfare with a broader dimension of stability, namely macroeconomic and financial system stability, as well as supports the achievement of sustainable economic growth. Furthermore, there are at least two issues.

The first issue is how to incorporate the role of payment system policy instruments in boosting productivity, particularly in relation to the developing ecosystems for EKD and optimizing the role of CBDC. The first challenge is related to the selection of representative variables and parameter calibration in the modeling. Although the payment system—including including in the form of money circulation—has been inherent in the function of the central bank since its establishment, payment system policy so far has been seen as a supporting policy for monetary and financial system policies. Moreover, payment system policy does not have yet a solid theoretical and empirical foundation like monetary and macroprudential policies. Meanwhile, the second challenge is related to the role of CBDC, which could be viewed as a form of technology advancement that could strengthen the role of money in the economy through increased economic productivity and the effectiveness of monetary policy transmission. However, adopting CBDC by central banks is not easy, and this aspect should be deployed gradually. These two challenges certainly need to be considered in the development of the economic model so that the policy mix formulation can adequately accommodate these policy instruments in the digital era.

In Indonesia, the development of EKD 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. Furthermore, greater efficiency in the economy leads to higher productivity growth. The increase in productivity through the adoption of digital technology in Indonesia may add approximately US$120 billion to the Indonesian economy in 2025 (McKinsey, 2016).

Given the broad and significant impact of EKD 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 EKD and to incorporate its impact on the economy: (i) e-commerce and (ii) digital banking. This is in line with the rapid growth of e-commerce transactions in Indonesia. Compared to the previous year, the total nominal transaction of e-commerce in 2022Q2 grew by 23.1%, which is mostly contributed by the sales of fashion and automotive goods (Graph 4).



Graph 4. The Growth of Nominal Transactions of E-Commerce in Indonesia

(source: Bank Indonesia, calculated based on 4 largest marketplaces in Indonesia)

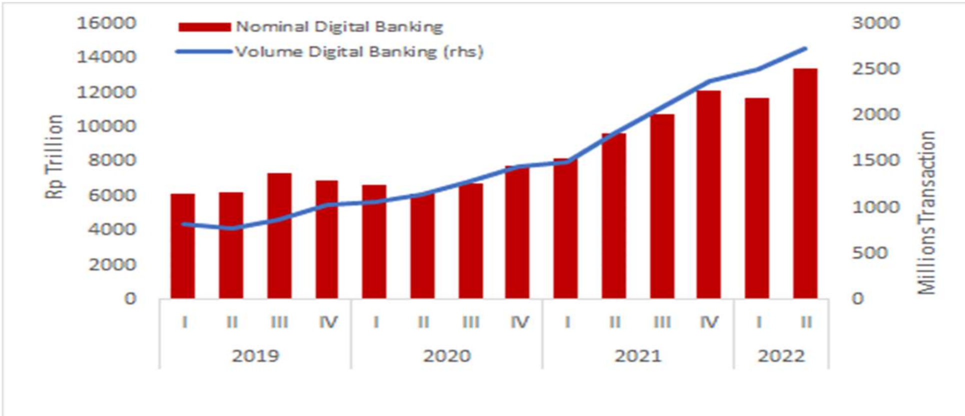
The significant growth of e-commerce in Indonesia is triggered by shifted consumer preferences to online shopping, particularly during and after the Covid-19 pandemic. The percentage of consumers who only shop online jumped from 11% before the pandemic to 25.5% at the beginning of 2022. The availability of multiple e-commerce channels contributed to the growth of e-commerce transactions. The majority of Indonesians who purchases goods online do it through online marketplace (69%), followed by home-based businesses (66%) and local businesses (63%). In addition, the trend of rapid e-commerce growth is also buoyed by significant improvement and the availability of digital payment instruments and infrastructure, including BI-FAST, electronic money (e-money), and QRIS.[2] The majority of e-commerce's payment methods are completed through bank transfers and e-money.

Equation (11) represents the growth of e-commerce ($\widehat{ecom}_t$) in Indonesia which is affected by the output gap ($\hat{y}_t$), as a proxy for economic activity, and e-money ($\widehat{emon}_t$) represents the availability of digital payment.

$$\widehat{ecom}_t = \beta_{ecom1}\widehat{ecom}_{t-1} + (1 - \beta_{ecom1})(\overline{ecom} + \beta_{ecom2}\hat{y}_t - \beta_{ecom3}\widehat{emon}_t) + e_t^{\widehat{ecom}} \qquad (11)$$

In addition to e-commerce, we include the growth of digital banking to represent the development of EKD in Indonesia. The growth of digital banking transactions, in terms of nominal and volume, increases along with a strong preference of Indonesian consumers to choose mobile and internet banking over traditional banking (Graph 5).

[2] BI-FAST is a payment system infrastructure provided by Bank Indonesia to facilitate retail payments. QRIS (Quick Response Code Indonesian Standard) is a digital payment using a standardized QR Code that can be used by the Payment System Service Provider so that the transaction process becomes easier, faster, and safe.



Graph 5. The growth of Digital Banking in Indonesia by Volume and Nominal
(source: Bank Indonesia)

Equation (12) represents the growth of digital banking ($\widehat{d\imath gbank_t}$) in Indonesia which is affected by the output gap ($\hat{y}_t$), as a proxy for economic activity.

$$\widehat{d\imath gbank}_t = \beta_{dig1}\widehat{d\imath gbank}_{t-1} + (1-\beta_{dig1})(\overline{d\imath gbank} + \beta_{dig2}\hat{y}_t) + e_t^{\widehat{d\imath gbank}} \tag{12}$$

The growth of e-commerce and digital banking, as a proxy for EKD development in Indonesia, will affect the total factor productivity ($\widehat{TFP}_t$) growth and further increase domestic demand ($\widehat{ydgap}_t$) and trigger a disinflationary effect ($\hat{\pi}_t$) due to higher efficiency, as formulated in equations (13) - (15). Thus, in addition to lag and expected domestic demand ($\widehat{ydgap}_{t-1}$, $\widehat{ydgap}_{t+1}$), real interest rate gap ($\widehat{rgap}_t$), private borrowing spread gap ($\widehat{pbsgap}_t$), and credit gap ($\widehat{crgap}_t$), the aggregate demand equation (14) is also affected by the productivity growth ($\widehat{tfpgap}_t$).

$$\widehat{TFP}_t = \beta_{tfp1}\widehat{TFP}_{t-1} + (1-\beta_{tfp1})(\overline{TFP} + \beta_{tfp2}\widehat{ecom}_t + \beta_{tfp3}\widehat{d\imath gbank}_t) + e_t^{\widehat{tfp}} \tag{13}$$

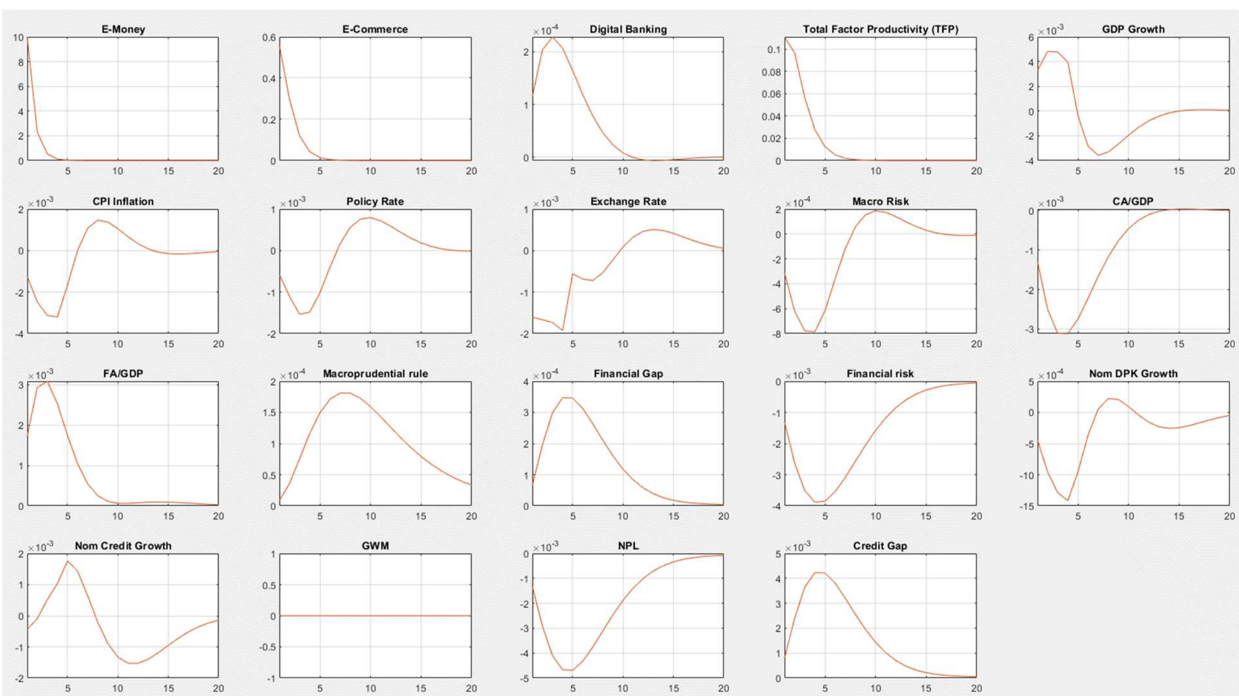
$$\widehat{ydgap}_t = \beta_{y1}\widehat{ydgap}_{t-1} + \beta_{y2}\widehat{ydgap}_{t+1} - \beta_{y3}(\widehat{rgap}_t + \widehat{pbsgap}_t) \tag{14}$$

$$+ \beta_{y4}\widehat{crgap}_t + \beta_{y5}\widehat{tfpgap}_t + e_t^{\widehat{ydgap}}$$

$$\hat{\pi}_t = \beta_{\pi1}\hat{\pi}_{t-1} + (1-\beta_{\pi1})\hat{\pi}_{t+1} + \beta_{\pi2}\hat{y}_t + \beta_{\pi3}\widehat{tgap}_t - \beta_{\pi4}\widehat{tfpgap}_t + e_t^{\widehat{tfp}} \tag{15}$$

Equation (15) shows the modified Philips Curve equation, in addition to lag and expected inflation ($\hat{\pi}_{t-1}, \hat{\pi}_{t+1}$) and output gap ($\hat{y}_t$), inflation is positively influenced by tax gap ($\widehat{tgap}_t$), while higher productivity growth ($\widehat{tfpgap}_t$) creates disinflationary effect.

Graph 6 shows the impulse responses of several key macroeconomic variables following a positive EKD shock. A more efficient and higher availability of digital payment instruments, as reflected by a 1% increase in the growth of e-money ($\widehat{emon}_t$), leads to higher e-commerce transactions, productivity ($\widehat{TFP}_t$), 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 EKD shock results in economic efficiency and higher productivity growth.



Graph 6. IRF – Macroeconomic Variable's Reponses to EKD Shock

The second issue is taking into account the role of fiscal policy in the model. Including fiscal policy 'endogenously', in addition to the central bank policies, in the model would make a more comprehensive and integrative analysis of the macroeconomic stability and the financial system. Hence, Bank Indonesia policy mix instruments are easier to manage and tend to generate welfare improving outcomes. The coordination of monetary and fiscal policies, which conventionally can be done actively and passively, needs to be arranged so that fiscal policy does not move to a fiscal dominance phenomenon in the economy which can lead to a welfare-reducing outcome.

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, as described in equations (16) - (19). Government spending ($\widehat{ggap}_t$) is negatively affected by the output gap ($\hat{y}_t$), thus serving as a stabilization instrument and also constrained by the deficit target ($\widehat{defygap}_t$). Tax ($\widehat{tgap}_t$) is positively correlated with the output gap and deficit target.

$$\widehat{ggap}_t = \beta_{ggap1}\widehat{ggap}_{t-1} + (1 - \beta_{ggap1})(-\beta_{ggap2}\hat{y}_t - \beta_{ggap3}\widehat{defygap}_t) + e_t^{\widehat{ggap}} \quad (16)$$

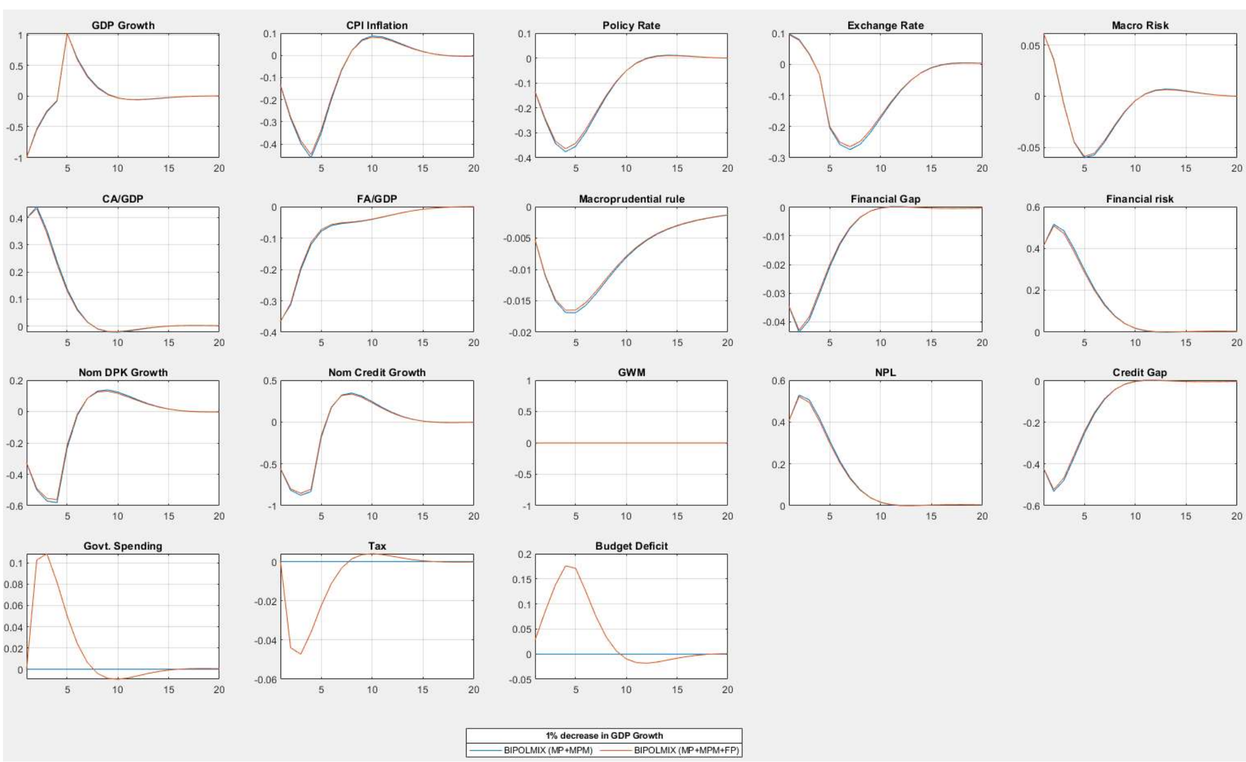
$$\widehat{tgap}_t = \beta_{tgap1}\widehat{tgap}_{t-1} + (1 - \beta_{tgap1})(\beta_{tgap2}\hat{y}_t + \beta_{tgap3}\widehat{defygap}_t) + e_t^{\widehat{tgap}} \quad (17)$$

Fiscal constraint derived from government budget constraint which limit government spending depend on tax collection, debt level ($\widehat{bgap}_t$), and target of budget deficit.

$$\widehat{bgap}_t = \beta_{bgap1}(\widehat{bgap}_{t-1} - \widehat{\pi gap}_t) + \beta_{bgap2}(\hat{y}_t + \widehat{defygap}_t) + e_t^{\widehat{bgap}} \quad (18)$$

$$\widehat{defygap}_t = \beta_{def1}\widehat{rgap}_{t-1} + \beta_{def2}(\widehat{bygap}_{t-1} + \hat{y}_{t-1}) - \beta_{def3}\widehat{\pi gap}_t - \beta_{def4}\hat{y}_t + \beta_{def5}\widehat{ggap}_t - \beta_{def6}\widehat{tgap}_t + e_t^{\widehat{defygap}} \quad (19)$$

Graph 7 shows the response of several key macroeconomic variables following a negative domestic demand shock. With a 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.



Graph 7. IRF – Macroeconomic variable's reponses to negative domestic demand shock

IV. Conclusions

As the ongoing policy transformation in Bank Indonesia, reflected in the strengthening of the Central Bank's Policy Mix strategy, the modeling framework being used is continuously transforming. As part of its policy transformation, Bank Indonesia is developing the BIPOLMIX model that captures the integrated central bank policy responses, e.g. monetary, macroprudential, and payment system policies, and considers the role of fiscal policy. In this context, starting from the core model framework of ARIMBI, the BIPOLMIX Model is developed in stages, considering various economic dynamics and Bank Indonesia's policy mix strategy in optimizing the achievement of macroeconomic and financial system stability.

The strategy of developing economic models in Bank Indonesia is flexible, dynamic, and always forward-looking. This strategy is taken so that the economic models can overcome the potential limitations and accommodate the dynamics of economic developments so that it remains relevant as the basis for Bank Indonesia policy transformation in coping with challenges in a rapidly changing environment. Although, in general, the Bank Indonesia model has attempted to become a reference model in policy making and is academically credible and realistic, there are still modeling challenges to improve the performance and credibility of the model in the future (Juhro et al., 2022b).

The most fundamental issue in developing economic models is maintaining consistency of model parameters within theoretical and technical considerations. Changes in the strategic environment, including shifts in economic structure and changes in the behavior of economic agents, encourage the development of more sophisticated models to accommodate the changes. Consequently, the economic model being built becomes more complex and larger, which becomes a challenge in maintaining the consistency of model parameters. In contrast, a simpler model (small-scale model) can better explain the occurring dynamics. In this regard, the development of satellite models also becomes increasingly important in supporting the performance of the core model.

Within the framework of the Forecasting and Policy Analysis System (FPAS), the development of satellite models in an integrated modeling system in Bank Indonesia can answer several issues that arise, such as forecasting dynamics in the short and long term, providing alternative scenarios, stochastic simulations, and stress test. Nonetheless, with the development of this modeling system, maintaining the consistency of parameter behavior and its economic impact is more challenging. Therefore, to minimize the dilemmas or paradoxes, the development of a modeling system needs to start from a framework or system that is as parsimonious as possible but remains to have a theoretical footing and the ability to explain empirical behavior well. The simplicity should also maintain the consistency of model parameters.

As a final note, the discussion of policy perspectives and modeling issues in this study has some fundamental policy implications for the formulation of central bank policy in many EMEs that have economic characteristics and complexity of challenges relatively similar to that of Indonesia. Amid the previously discussed issues related to the model parameter consistency, in line with theoretical and technical considerations, the BIPOLMIX modeling framework is believed to be useful as a pivotal reference by the central banks in EMEs in developing core models to support optimal policy responses.

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