Macroeconomic Effects of Macro-Prudential Regulation in Asian Economies

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Abstract

This paper examines the role of macro-prudential regulation (MPR) in enhancing financial stability and improving the effectiveness of monetary policy in Asian economies. We develop a New Keynesian DSGE model with an integrated banking sector featuring endogenous leverage, credit spreads, and capital quality shocks. Using Bayesian estimation and quarterly data for Thailand, China, Indonesia, and South Korea from 2001Q1 to 2019Q4, we estimate country-specific Taylor-type monetary rules and leverage-based MPR rules. Results indicate that MPR, designed to be countercyclical with output but procyclical with spreads, stabilizes credit during downturns and restrains leverage in booms. MPR produces very different policy stances across shocks. Model comparison shows that combining a Taylor rule with MPR provides a better fit than conventional monetary policy alone. Welfare analysis shows that optimal response of MPR is not symmetric to monetary policy. A strong MPR is optimal under monetary tightening whereas a moderate MPR is optimal under monetary loosening. Policy effectiveness, however, varies across countries: Thailand and South Korea display strong inflation targeting and balanced MPR; China emphasizes output stabilization with weaker MPR; Indonesia pursues aggressive monetary policy with slow leverage adjustment.

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1. Introduction

The global financial crisis underscored the limitations of relying on conventional monetary policy alone to safeguard macroeconomic stability. In emerging market economies, where banking sectors remain the dominant source of credit and financial frictions are amplified, the interplay between financial cycles and business cycles creates additional policy challenges. While the business cycle reflects fluctuations in output and employment, the financial cycle—typically associated with swings in credit and asset prices—often evolves over longer horizons and can diverge from real economic activity. When the two cycles are not synchronized, policymakers face the risk that stabilizing one dimension may exacerbate volatility in the other. This is particularly relevant in Asia, where credit booms and capital inflows have historically amplified macroeconomic fluctuations and raised concerns about systemic vulnerabilities. One key instrument in this matter has been the development of macro-prudential regulation (MPR), aimed at reducing systemic risks to financial stability. Macro-prudential policy has therefore become a dominant public policy in achieving financial stability across the world.

Prior to the financial crisis of 2007–2008, the literature on financial frictions in macroeconomics was relatively limited, and largely focused on asymmetric information problems and limited contract enforceability. For instance, Stiglitz and Weiss (1981) focus on financing inefficiencies, demonstrating how adverse selection in finance can lead to credit rationing. Diamond and Dybvig (1983) illustrate a case of coordination failure, highlighting how maturity mismatches in the presence of asymmetric information can trigger bank runs. The theoretical foundations linking financial frictions to macroeconomic dynamics stem from the financial accelerator framework of Bernanke and Gertler (1989) and Bernanke, Gertler, and Gilchrist (1999), showing how shocks to net worth and borrowing costs amplify macroeconomic fluctuations. Building on this framework, Kiyotaki and Moore (1997) emphasized the role of collateral constraints in driving credit cycles. More recent contributions by Gertler and Kiyotaki (2010), Gertler and Karadi (2011), and Gertler, Kiyotaki, and Queralto (2012) integrate banking into New Keynesian DSGE models, highlighting how balance sheet conditions, leverage, and spreads affect monetary transmission. This strand of work demonstrates that financial shocks, such as capital quality disturbances, can significantly amplify output volatility, while policy rules that respond to financial variables can improve welfare outcomes.

On the policy side, macro-prudential regulation (MPR) has gained prominence as a complementary tool to monetary policy. Adrian and Shin (2009) argue that leverage cycles and liquidity provision create procyclical dynamics that require regulatory counterweights. Faia and Monacelli (2007) and Gerali et al. (2010) show that incorporating capital requirements and credit constraints in DSGE models alters the transmission of shocks and improves stabilization. Cúrdia and Woodford (2010) further demonstrate that spreads contain valuable information about financial conditions that monetary policy alone may fail to capture. Empirically, studies such as Mohanty and Klau (2005) highlight that emerging market central banks often deviate from simple Taylor-type rules, assigning greater weight to output growth and financial stability considerations.

Research on Thailand emphasizes the role of capital inflows and banking sector vulnerabilities. Disyatat and Vongsinsirikul (2003) examined monetary policy rules in the presence of financial frictions, while Pongsaparn and Unteroberdoerster (2011, IMF) highlighted the importance of countercyclical capital measures to mitigate credit booms. More recent studies stress the Bank of Thailand's efforts to combine inflation targeting with MPR tools, including loan-to-value (LTV) restrictions and dynamic provisioning. For China, macro-prudential regulation has been linked to managing rapid credit growth and shadow banking. He and Wang (2012) discussed China's shift toward incorporating financial stability into monetary policy frameworks, while Zhang and Zoli (2016) documented the effectiveness of targeted MPR tools such as reserve requirements and housing-market measures. Chen and Qian (2019) showed that China's countercyclical use of MPR helps smooth credit cycles and complements monetary easing.

In Indonesia, research has highlighted the vulnerability of the banking sector to exchange-rate and capital-flow shocks. Warjiyo and Juhro (2019) discussed Bank Indonesia's policy mix combining interest-rate policy, exchange-rate stabilization, and macro-prudential instruments. Empirical work by Agung et al. (2018) found that loan-to-deposit ratios and LTV ratios serve as effective countercyclical buffers, supporting macroeconomic stability under volatile global conditions. For South Korea, the literature stresses the lessons from the Asian Financial Crisis and the importance of capital-flow management. Kim and Lee (2008) analyzed credit cycles and the use of macro-prudential instruments, while IMF (2013) studies noted the effectiveness of foreign-exchange-related prudential tools in reducing systemic vulnerabilities. More recently, Lim and Mohanty (2012) showed that Korea's macro-prudential stance—especially dynamic provisioning and leverage caps—helped dampen credit-driven volatility and complement inflation targeting.

Despite this growing literature, several key gaps remain. While there is extensive country-level research on macro-prudential regulation (MPR) in Asia, these strands remain largely country-specific and lack comparative synthesis across Asian economies. Prior studies typically evaluate MPR effectiveness in isolation. Very few analyze how MPR and monetary policy interact, particularly under different shocks. Much of the existing empirical work measures outcomes in terms of credit growth, house prices, or bank resilience. However, comparative welfare analysis—which policies deliver better stabilization outcomes for households and firms—remains underdeveloped in the Asian context. Although each country has tailored instruments, there is no systematic attempt to estimate and compare policy rules across Thailand, China, Indonesia, and South Korea using a unified framework. This leaves policymakers without clear evidence on relative aggressiveness, persistence, or optimality of MPR across economies.

This paper makes several contributions to addressing these gaps: (1) It develops a unified New Keynesian dynamic stochastic general equilibrium (DSGE) model with an integrated banking sector, endogenous leverage, and credit spreads. The results demonstrate that MPR designed to be countercyclical with respect to output and procyclical with respect to spreads smooths credit cycles by tightening leverage constraints during booms and relaxing them during downturns. This modeling approach thereby enhances financial stability across countries. (2) The paper employs Bayesian estimation using quarterly data from 2001–2019 to recover country-specific both conventional and macro-prudential policy rules, allowing systematic comparison of monetary policy behavior in Thailand, China, Indonesia, and South Korea. We recover that Thailand is balanced but inflation oriented. China has smoother monetary policy with higher growth sensitivity but less restrictive MPR. For Indonesia, monetary policy is aggressive and leverage adjustment is slow. South Korea is tight and proactive policy coordination. (3) We answer an important question whether it is sufficient for the central banks to pursue only conventional monetary policy. Using posterior model probabilities, the results highlight that it is inadequate to pursue only traditional mandates. The combination between conventional monetary policy and MPR is necessary for price and output stability as well as financial stability. (4) The analysis goes beyond instrument-level evaluations by examining the joint operation of MPR and monetary policy under alternative shocks, thus clarifying whether coordination enhances or undermines stability. The results demonstrate that MPR produces very different policy stances across shocks. (5) The study incorporates a welfare-based assessment of alternative regimes, identifying conditions under which moderate or strong MPR yields better outcomes. We discover that the optimal response of MPR is not symmetric. For all four countries, the results reveals that the strong MPR is optimally required in response to monetary tightening whereas the moderate MPR is optimal for monetary loosening. (6) By situating these results in a cross-country comparative perspective, the paper derives broader policy lessons for emerging Asia, showing how institutional differences in policy design—targeted borrower-based rules in Thailand, systemic supervisory frameworks in China, multi-instrument toolkits in Indonesia, and long-standing borrower constraints in South Korea—shape the effectiveness of MPR in complementing monetary policy.

By bridging theoretical modeling, empirical estimation, and welfare analysis, this study advances the understanding of how monetary and macro-prudential policies can jointly stabilize economies where financial and business cycles are imperfectly synchronized. The results hold relevance for Asian policymakers seeking to balance price stability, output stabilization, and financial stability in the presence of recurrent capital inflows, credit booms, and global shocks.

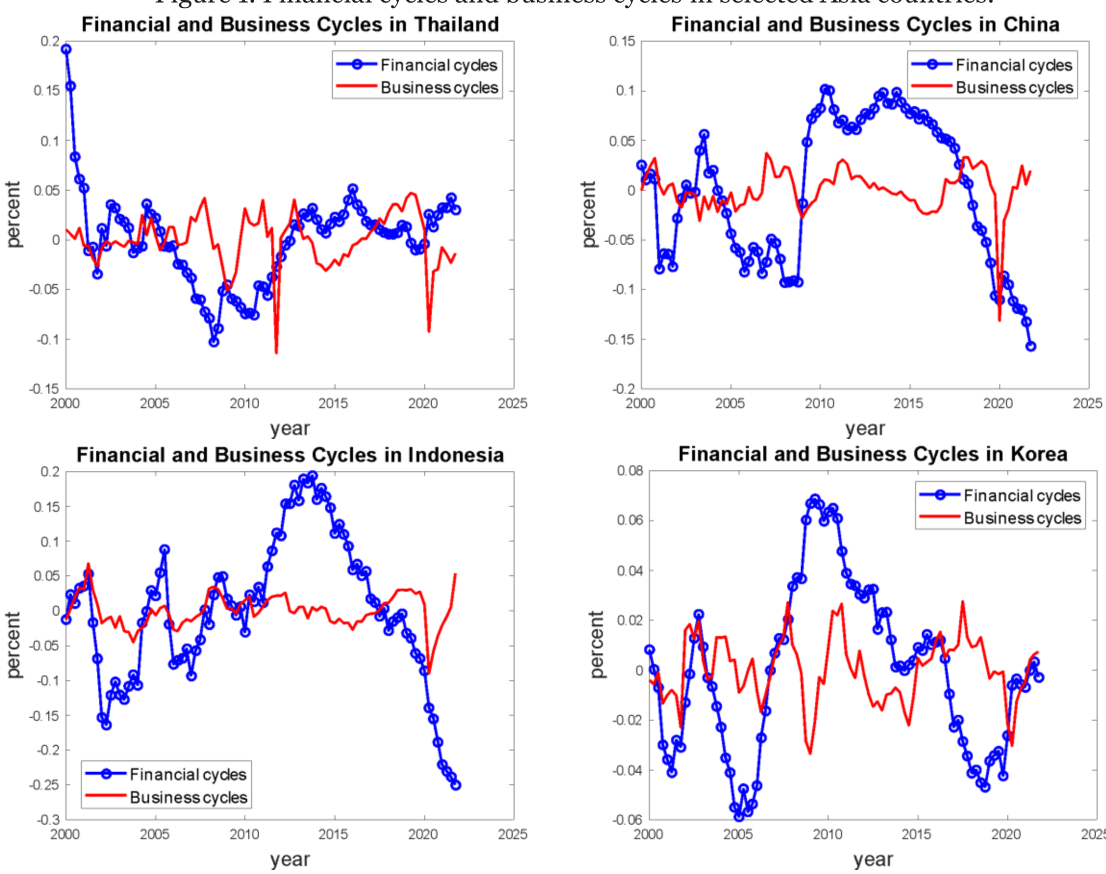
The remainder of the paper is organized as follows. Section 2 investigate financial and business cycles in Asian countries. Section 3 describes the macro-prudential policies in Asian countries. Section 4 presents the theoretical NK model. Section 5 introduces a banking section to the model. Section 6 describes capital quality shock. Section 7 discusses the dynamic effects of the NK model with banking sector. Section 8 introduces macro-prudential regulations. Section 9 presents Bayesian estimation and empirical implementation and identification of policy rules. Section 10 describes the dynamic effects of traditional monetary policy and macro-prudential regulation coordination. Section 11 compares two NK banking models with Taylor rule and another with the combination of Taylor and MPR rules. Section 12 explores the combination of conventional monetary policy and Macro prudential regulation including policy implication in Asian. Section 13 focuses on welfare analysis. Finally, Section 14 concludes.

2. Financial and business cycles in Asian countries

In this section, we investigate the relationship between financial cycles and business cycles. The financial cycle can be thought of as economic fluctuations that stem from or are amplified by the financial system, and it typically manifests itself as a co-movement between credit aggregates and property prices, whereas the business cycle is an interval of expansion followed by recession in real economic activity.

We use an HP filter to extract the cyclical component of each series, as we define financial and business cycles as transitory fluctuations from its long-run trend level. The sample periods are from the first quarter of 2000 to the fourth quarter of 2021. For financial cycles, we use a measure of total credit to the private non-financial sector in domestic currency, taken from the Bank for International Settlements. Then we measure credit indicator in real terms by deflating credit data by CPI. For business cycles, we construct a real GDP by dividing nominal GDP (in domestic currency) by CPI. The GDP and CPI are taken from International Financial Statistics database of IMF.

Figure 1. Financial cycles and business cycles in selected Asia countries.



In general, the financial cycle tends to be longer than the business cycle in duration as it normally takes time for a weakening of corporate fundamentals or property values to show up. Therefore, to extract the trend and the cyclical component, we set the smoothing parameter, lambda at 400,000 for financial cycle whereas the lambda is set at 1,600 as normally done when conducting the HP filter. The cyclical real credit and the cyclical real GDP components are shown in Figure 1.

It is known that the effectiveness of conducting monetary and macroprudential policies might depend upon the degree of synchronicity (or co-movement) between credit cycles and business cycles. In particular, when the two cycles co-move, either monetary policy or macroprudential policy could stabilize credit and economic activity. For example, during strong credit and economic expansion, policymaker could conduct monetary policy contraction or macroprudential policy tightening to slow down credit and economic activity.

However, as shown in Figure 1, financial and business cycles are not always synchronized. There have been some phases of strong credit expansion coinciding with weak economic activity. Examples include the mid-2010s in Indonesia, Thailand, and China. By contrast South Korea in the late-2010s experience a week credit position coinciding with above-trend economic activity. During such periods, potential policy conflicts could arise, i.e., using one type of policy could help to stabilize either the credit cycle or the business cycle, but it could have some negative side effects on the other cycle. For example, during strong economic activity but a weak credit position, contractionary monetary policy would stabilize business cycle but decrease credit even further.

This emphasizes the importance of our study which aims to examine how output, credit, and other key macro variables react to the macroprudential policy and monetary policy in both magnitude and direction. Understanding the different relative effects of output and credit on each type of policy would help policy makers to design an appropriate policy, especially during the phases of both cycles are poorly or not synchronized.

3. Macro-prudential policies in Asian countries

The macroprudential policy frameworks of Thailand, China, Indonesia, and South Korea exhibit important institutional and operational differences, reflecting their financial structures and policy priorities. In Thailand, the Bank of Thailand (BOT) has taken the lead in developing a macroprudential framework that complements its inflation-targeting monetary policy regime. BOT relies primarily on borrower- and lender-based instruments such as loan-to-value (LTV) ratios for housing loans, dynamic loan-loss provisioning, and credit limits on unsecured lending. These tools have been actively adjusted to address rapid household debt growth and to maintain stability in the banking system. The Thai approach highlights the integration of macroprudential regulation into a flexible inflation-targeting framework, where financial stability considerations are increasingly seen as part of the overall mandate.

In China, the People's Bank of China (PBOC) has formalized a unique system known as the Macro-Prudential Assessment (MPA), which functions as a second pillar alongside monetary policy. The MPA operates through a quarterly scorecard covering capital adequacy, credit growth, risk management, and cross-border activities, with outcomes tied to banks' access to liquidity facilities. This framework is reinforced by sector-specific instruments such as restrictions on property lending and prudential parameters on foreign exchange exposures. In recent years, the

PBOC has further institutionalized macroprudential oversight by establishing a financial stability committee, underscoring the central bank's dominant role in systemic risk management.

Indonesia's macroprudential framework, under the authority of Bank Indonesia (BI), is designed as part of a comprehensive policy mix strategy combining monetary, prudential, foreign exchange, and payment system policies. BI's toolkit includes both borrower-based measures such as LTV ratios for property and vehicle loans, as well as liquidity-oriented instruments including reserve requirements, the macroprudential intermediation ratio, and a countercyclical capital buffer. These tools are calibrated flexibly to manage credit cycles while supporting growth. Recent policy adjustments such as reducing reserve requirements to ease liquidity constraints illustrate how Indonesia uses macroprudential levers dynamically in response to macroeconomic conditions.

South Korea adopts a multi-agency model, where the Financial Services Commission (FSC) and the Financial Supervisory Service (FSS) work closely with the Bank of Korea (BOK) in maintaining systemic stability. Korea's framework is particularly well known for its borrower-based rules, including LTV and debt-to-income (DTI) ratios, and the more recently institutionalized debt-service-ratio (DSR) caps, which tightly constrain household leverage. The Korean method illustrates a comprehensive and coordinated approach, with credit regulation embedded in its macroprudential strategy.

4. The New Keynesian model

This paper extends the benchmark new Keynesian model by adding a financial friction between the household and the bank following Gertler and Kiyotaki (2010), Gertler and Karadi (2011) and Gertler et al. (2012). The model is composed of a single final good and a continuum of intermediate goods. The monopolictic competition firms produce differentiated goods and have some market power to set the price of the goods they produce.

4.1 Household cost minimization problem

Firstly, the household would like to consume a final consumption good C_t, at the lowest cost. Households choose an optimal combination of the intermediate goods that minimize the cost of achieving this level of the final good. Following Dixit and Stiglitz (1977), the consumption index is given by:

$$C_t = \left(\int_0^1 C_t(i)^{\frac{\zeta-1}{\zeta}} d(i) \right)^{\frac{\zeta}{\zeta-1}} \tag{1}$$

The monopolistically competitive firms produce intermediate goods for consumption. Assume the existence of a continuum of firms indexed by the subscript i, where i is distributed in the unit interval, $i \in [0,1]$. Therefore, a continuum of intermediate goods is produced. Firm i produces good $C_t(i)$ and its price is $P_t(i)$. ζ is the elasticity of substitution. The household seeks to minimize its expenditure $\int_0^1 P_t(i)C_t(i)di$ subject to a basket of goods given by (1).

4.2 Household utility maximization problem

Secondly, given the cost of achieving any given level of C_t from (1), households optimally choose consumption good C_t and labor N_t to maximize their expected utility with respect to their period budget constraint. The preferences follow a habit formation utility function as below:

$$U(C_t, L_t) = \frac{\left((C_t - \chi C_{t-1})^{(1-\varrho)}(1-N_t)^{\varrho}\right)^{1-\sigma} - 1}{1-\sigma} \tag{2}$$

χ is a coefficient of persistence in habits. $\varrho \in (0,1)$ is the consumption and labor share and σ stands for the risk aversion coefficient while its inverse is the intertemporal elasticity of substitution. The proportions of time for leisure and work are L_t and N_t respectively. Thus, $L_t + N_t = 1$. The budget constraint is given by:

$$B_t = R_{t-1}B_{t-1} + r_t^k K_{t-1} + W_t N_t - C_t - I_t - T_t \tag{3}$$

where B_t is the stock of financial assets at the end of period t, R_t is the gross real interest rate paid on assets held at the beginning of period t to pay out interest in period $t+1$, r_t^k is the rental rate, W_t is the real wage rate and, I_t is investment and T_t are lump-sum taxes. The law of motion of capital is governed over time by:

$$K_t = (1-\delta)K_{t-1} + (1 - S(X_t))I_t \tag{4}$$

Capital formation incorporates investment adjustment costs denoted by the function S where $X_t = \frac{I_t}{I_{t-1}}$. The parameter S refers to the existence of costs in terms of investment changes between periods as in Christiano, et al. (2005).

4.3 Production

The production is divided into three sectors, a final goods, retail and wholesale goods producers. A representative wholesale firm hires labor and capital from household and produces output selling it to a continuum of retail firm at P_t^W. The retail firms purchase wholesale output and repackage it, and sell it to a competitive final goods firm at $P_t(i)$ where retail firms are indexed by $i \in [0,1]$. The final goods firm combines retail output into a final output goods. Introducing a retail sector producing differentiated goods under monopolistic competition. The final goods is produced by a firm that aggregates retail goods into a single composite goods using the following Dixit and Stiglitz aggregator:

$$Y_t = \left(\int_0^1 Y_t(i)^{\frac{\zeta-1}{\zeta}} d(i)\right)^{\frac{\zeta}{\zeta-1}} \tag{5}$$

The final goods firm takes as given the price of intermediate good $P(i)$ and the price of the composite final goods P_t and then maximizes profits given a production function as in equation (5). Retailers purchase some wholesale output $Y_t^W(i)$ and repackage it into retail output $Y_t(i)$. Each firm acknowledges the downward-sloping demand curve it faces.

The model adds the feature of price stickiness by considering the case of a staggered price setting established by Calvo (1983). In any period, the probability that each retail firm will not adjust its price is ω and the probability that each retail firm will change its price is $1-\omega$. Let P_t^* be the optimal price chosen by all firms adjusting at time t. The aggregate of all prices in the economy will be:

$$P_t = (\omega P_{t-1}^{1-\zeta} + (1-\omega)(P_t^*)^{1-\zeta})^{\frac{1}{1-\zeta}} \tag{6}$$

Since all retail firms face the same marginal cost, the i index is dropped. The first order condition of profit maximization for optimal choice of P_t^* can be rearranged resulting in optimal pricing behavior of intermediate goods:

$$\frac{P_t^*}{P_t} = \frac{\zeta}{(\zeta-1)} \frac{E_t \sum_{k=0}^{\infty} \omega^k \Lambda_{t,t+k} Y_{t+k} \varphi_{t+k} \left(\frac{P_{t+k}}{P_t}\right)^{\zeta}}{E_t \sum_{k=0}^{\infty} \omega^k \Lambda_{t,t+k} Y_{t+k} \left(\frac{P_{t+k}}{P_t}\right)^{\zeta-1}} \tag{7}$$

where $\frac{\zeta}{(\zeta-1)}$ represents the mark up, describing the difference between the price and the marginal cost and φ_{t+k} represents the real marginal cost. Equation (7) indicates that in the case of the sticky price model, firm will mark up the price over the weighted average of flow of future marginal costs.

The wholesale firm produces output based on the following Cobb-Douglas production function:

$$Y_t^W = A_t N_t^{\alpha} K_{t-1}^{1-\alpha} \tag{8}$$

where A_t is the productivity process and K_t is end of period t capital stock. The price indexation is introduced to explain the inflation persistence as in Christiano, Eichenbaum and Evans (2005) and Smets and Wouters (2007). For a firm m that does not reoptimize with probability ω, their prices are partially indexed to last period's aggregate inflation:

$$P_t(m) = \pi_{t-1}^{\gamma_p} P_{t-1}(m) \tag{9}$$

where $\pi_{t-1} = \frac{P_{t-1}}{P_{t-2}}$ and $\gamma_p \in [0,1]$ is the magnitude of the indexation factor

The optimal price setting under the price indexation is that a firm chooses its price to maximize its discounted real profits using the firm's future demand and the price behavior with no reoptimization for the duration that it cannot reoptimize its price. The first order condition with MS_t as a markup yielding the optimal pricing behavior:

$$\frac{P_t^*}{P_t} = \frac{\zeta}{(\zeta-1)} \frac{E_t \sum_{k=0}^{\infty} \omega^k \Lambda_{t,t+k} Y_{t+k} \varphi_{t+k} MS_{t+k} \left(\frac{P_{t+k}}{P_t}\right)^{\zeta} \left(\frac{P_{t+k-1}}{P_{t-1}}\right)^{-\gamma_p \zeta}}{E_t \sum_{k=0}^{\infty} \omega^k \Lambda_{t,t+k} Y_{t+k} \left(\frac{P_{t+k}}{P_t}\right)^{\zeta-1} \left(\frac{P_{t+k-1}}{P_{t-1}}\right)^{-\gamma_p(\zeta-1)}} \tag{10}$$

4.4 Price dispersion and output equilibrium

The aggregate production function is not explicitly presented in the new Keynesian model. Distribution of inputs among the various differentiated good firms influences the aggregate output, Y_t. Christiano, Trabandt and Walentin (2010) assert that under the Calvo staggering price assumption, $P(i)$ differs across i resulting in unequally allocated resources across intermediate good producers. Therefore, price dispersion occurs in the Keynesian economy and generates an inefficient resource allocation. An unequal distribution of inputs causes the loss of aggregate output. Following Yun (1996), the price dispersion could be characterized by finding the relation between the aggregate output and aggregate factor inputs. Define Y_t^W as the integral of gross output across retail goods firms. Goods marketing clearing requires that:

$$Y_t^W = \int_0^1 Y_t(i)di = \int_0^1 \left(A_t N_t(i)\right)^{\alpha} K_{t-1}(i)^{1-\alpha} di = (A_t N_t)^{\alpha} K_{t-1}^{1-\alpha} \tag{11}$$

Using the demand of retail goods i from the firm's final goods optimization.

$$Y_t^W = \left(\frac{P_t^*}{P_t}\right)^{-\zeta} Y_t \tag{12}$$

where $P_t^* = \left[\int_0^1 P_t(i)^{-\zeta} di\right]^{\frac{-1}{\zeta}}$ and $\left(\frac{P_t^*}{P_t}\right)^{-\zeta} = \Delta_t$ which measures output loss due to price dispersion as in Yun (1996). Therefore, we obtain

$$Y_t = \frac{(A_t N_t)^{\alpha} K_{t-1}^{1-\alpha}}{\Delta_t} \tag{13}$$

where

$$\Delta_t = \zeta \pi_t^{\zeta} \Delta_{t-1} + (1-\zeta)\left(\frac{M_t}{MM_t}\right)^{-\zeta} \tag{14}$$

The model is completed with a balanced budget constraint with lump-sum taxes.

$$G_t = T_t \tag{15}$$

4.5 The effects of a conventional monetary policy

We use the generalized Taylor rule with interest rate smoothing and multiple output-related channels. Following the Taylor rule, a central bank should adjust its interest rate policy instrument for developments in inflation and output as:

$$log\left(\frac{R_{n,t}}{R_n}\right) = \rho_r log\left(\frac{R_{n,t-1}}{R_n}\right) + \\ (1-\rho_r)\left[\theta_\pi log\left(\frac{\pi_t}{\pi}\right) + \theta_y log\left(\frac{Y_t}{Y}\right) + \theta_{dy} log\left(\frac{Y_t}{Y_{t-1}}\right)\right] + \epsilon_{M,t} \quad (16)$$

where ρ_r is the interest-rate smoothing parameter with $0 < \rho_r < 1$. Empirically, most central banks exhibit strong smoothing as in Clarida, Gali and Gertler (1998, 2000). θ_π is inflation gap response with $\alpha_\pi > 0$ and it captures how aggressively the central bank reacts to deviations of current inflation from its target. Woodford (2003) assert that based on the Taylor principle, $\alpha_\pi > 1$ is needed to stabilize inflation expectations Output Gap Response θ_y measures the extent to which the central bank supports the real economy. Output growth response θ_{dy} is weight on short-run output growth. The central bank reacts directly to GDP growth rather than only to the output gap. Mohanty and Klau (2005) suggest that the output growth response is important in the emerging market settings.

4.6 The shocking process specification

The law of motion for exogenous shocks is assumed to follow a first-order auto-regression process AR (1) and they can be expressed in log form around the steady state. The exogenous forcing processes are technology and government spending shown below:

$$log\left(\frac{A_t}{A}\right) = \rho_A log\left(\frac{A_{t-1}}{A}\right) + \epsilon_{A,t} \quad (17)$$

$$log\left(\frac{G_t}{G}\right) = \rho_G log\left(\frac{G_{t-1}}{G}\right) + \epsilon_{G,t} \quad (18)$$

The parameter ρ measures how persistent each shock is. The variables ϵ are innovations to each random shock and they are normally distributed and serially uncorrelated.

5. A banking sector in the New Keynesian model

The financial market friction in this model is driven by the costs of enforcing contracts. Financial frictions affect real activity via the impact of funds available to banks but there is no friction in transferring funds between banks and non-financial firms. Given a certain deposit level a bank can lend frictionlessly to non-financial firms against their future profits. The model follows Gertler et al. (2012) adding ingredient, the option to raise funds by issuing outside equity as well as household deposits.

Bank raises deposit and equity from the households. In the second phase banks use the deposits to make loans to firms. The level of the loans depends on the level of the deposits d_t, value of equity $q_t e_t$ and the net worth n_t of the intermediary. This implies a banking sector's balance sheet of the form:

$$Q_t s_t = n_t + q_t e_t + d_t \tag{19}$$

where s_t is the number of claims on non-financial firms on a unit of finance capital acquired at the end of period t for use in the period $t+1$, Q_t is the price of a unit of capital so that $Q_t s_t$ are the assets of the bank. The liabilities of the bank are household deposits d_t and net worth n_t. Net worth of the bank accumulates according to:

$$n_t = R_t^K Q_{t-1} s_{t-1} - R_t d_{t-1} - R_{e,t} q_{t-1} e_{t-1} \tag{20}$$

where R_t^K is the real return on bank assets and $R_{e,t}$ is the real return on equity.

Banks exit with probability $1-\sigma_B$ per period and therefore survive for $i-1$ periods and exit in the ith period with probability $(1-\sigma_B)\sigma_B^{i-1}$. Given the fact that bank pays dividends only when it exists. The banker's objective is to maximize expected discounted terminal wealth:

$$V_t = E_t \sum_{t=1}^{\infty} (1-\sigma_B)\sigma_B^i \Lambda_{t,t+i} n_{t+i} \tag{21}$$

where $\Lambda_{t,t+i}$ is the stochastic discount factor, subject to an inventive constraint for lenders (households) to be willing to supply funds to the banker. The borrowing constraint is now

$$V_t \geq \Theta(x_t) Q_t s_t \tag{22}$$

where $x_t \equiv \frac{q_t e_t}{Q_t s_t}$ is fraction of bank assets financed by outside equity, $\Theta_t' > \Theta_t'' > 0$ captures the idea that it is easier to divert assets funded by outside equity than by households. The incentive constraint states that for households to be willing to supply funds to a bank, the bank's franchise value must be at least as large as its gain from diverting funds.

6. Capital quality shock

Following the macro-finance literature, capital quality shock KQ_{t+1} is introduced in the model. The capital quality shock wipes out or enhances capital available in period t going into period $t+1$. Thus, capital process evolves according to

$$S_t = \left[(1-\delta)K_{t-1} + \big(1 - S(X_t)\big) I_t\right] \tag{23}$$

where S_t is now capital in process which is transformed into capital for next period's production according to $K_t = KQ_{t+1}S_t$. Capital quality shock also affects the balance sheet of the banks. We have

$$N_t = R_t^K(\sigma_B + \xi_B)Q_{t-1}S_{t-1} - \sigma_B R_t D_{t-1} \tag{24}$$

where R_t^K is the gross return on capital

$$R_t^K = KQ_t\left[\frac{r_t^K + (1-\delta)Q_t}{Q_{t-1}}\right] \tag{25}$$

It follows from equation (23) and $K_t = KQ_{t+1}S_t$ that capital accumulation with investment adjustment cost carried out by capital producers is given by

$$K_t = KQ_{t+1}((1-\delta)K_{t+1} + (1 - S(X_t))I_t) \tag{26}$$

The exogenous capital quality shock process can be expressed as

$$log\left(\frac{KQ_t}{KQ}\right) = \rho_{KQ} log\left(\frac{KQ_{t-1}}{KQ}\right) + \epsilon_{KQ,t} \tag{27}$$

Therefore, capital quality shock affects the capital in process as well as affects balance sheet of the banks. Capital quality shocks in the NK model only affect accumulation and the return on capital. But with a banking sector it also affects the accumulation of net worth and the spread. A negative capital quality shock both reduces output in the next period and the net worth of the banks thus tightening the credit constraint. A negative capital quality shock such as a sudden fall in the efficiency of capital, destruction of collateral value, or productivity collapse implies that even though the physical capital is unchanged, it generates lower returns, similar to asset devaluation during financial crisis.

7. The dynamic effects of the NK model with the banking sector

To gain insights into a framework for understanding monetary policy and its transmission, this section explores the impulse response functions allowing us to trace the dynamic effects of shocks on macroeconomic variables of the NK model with and without banking sector. When incorporating the banking sector into the model, the dynamics and implications of macroeconomic shocks become more nuanced as in Figure 2.

In this section, the models are calibrated using Thai data from 2001Q1 to 2019Q4. Following Gertler and Kiyotaki (2010), we choose the value of σ_B so that the bankers survive 32 quarters on average. The Thai economy wide leverage ratio is at 3.347 and has an average credit spread of 180 basis points per year. Inflation during the observation period is 2% annually. Thai growth on average is 2.72% annually. Government spending-GDP ratio is 0.183. Outside equity target for Thai economy is 0.088. The structural parameters are followed the standard values in the new

Keynesian model $\xi = 0.75$, $\beta = 0.99$, $\sigma_{es} = 2$, $\delta = 0.025$, $\chi = 0.7$, $\alpha = 0.7$, $\zeta = 7$, $\sigma_B = 0.9688$, $\emptyset_X = 2$, and $\varrho = 0.8629$.

Figure 2. The impulse responses of the NK model with banking sector for Thailand

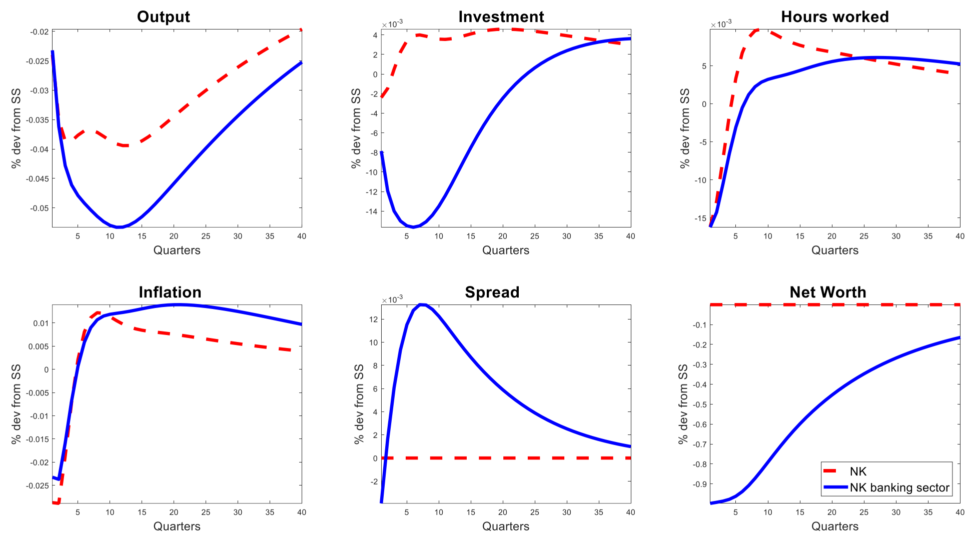


Figure 2.1 Capital quality shock

A negative shock to capital quality reduces the return on capital leading to a decline in the value of capital assets. When the value of capital drops, net worth absorbs the loss as in Figure 2.1. Investment falls because weaker banks lend less and the supply of credit to firm contracts. It is riskier for banks to lend, and they raise the required return to be compensated for the risk causing the spread to rise. Output decreases due to reduced capital and investment. Inflation and hours worked also fall as output reduces. The NK model with the banking sector is more persistent and amplified effects compared to the standard NK model.

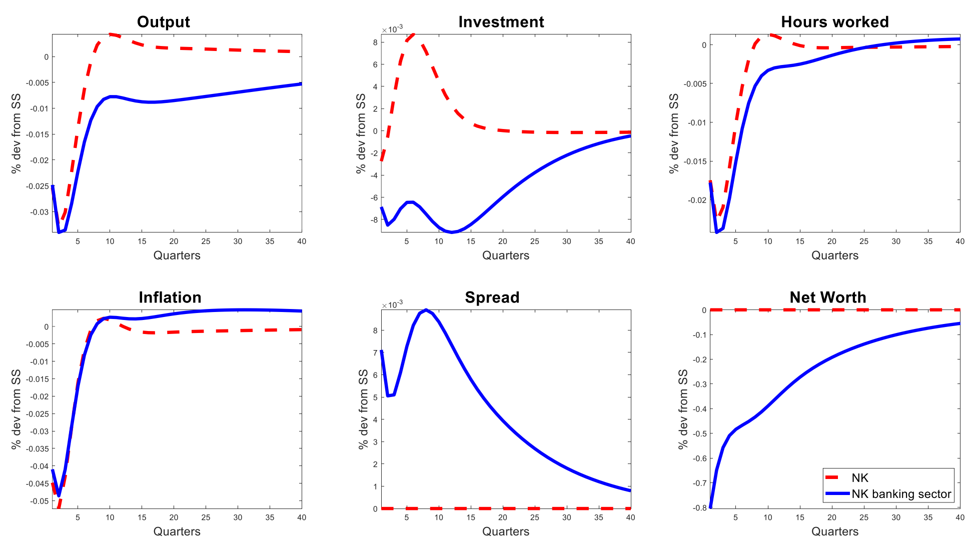


Figure 2.2 Interest rate shock

Monetary policy tightening has rich and amplified effects due to financial frictions for the model with banking sector as in Figure 2.2. Higher interest rates reduce capital value. Monetary tightening worsens bank balance sheets. Banks demand a higher premium to compensate for increased risk, widening interest rate spreads. Higher interest rate reduces aggregate demand. Firms cut prices and inflation falls. Hours work declines following output and investment.

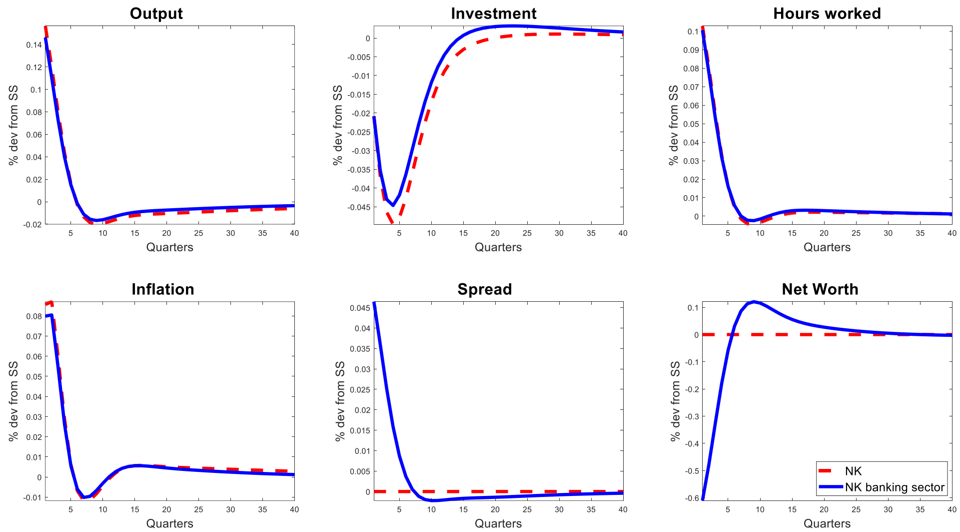


Figure 2.3 Government spending shock

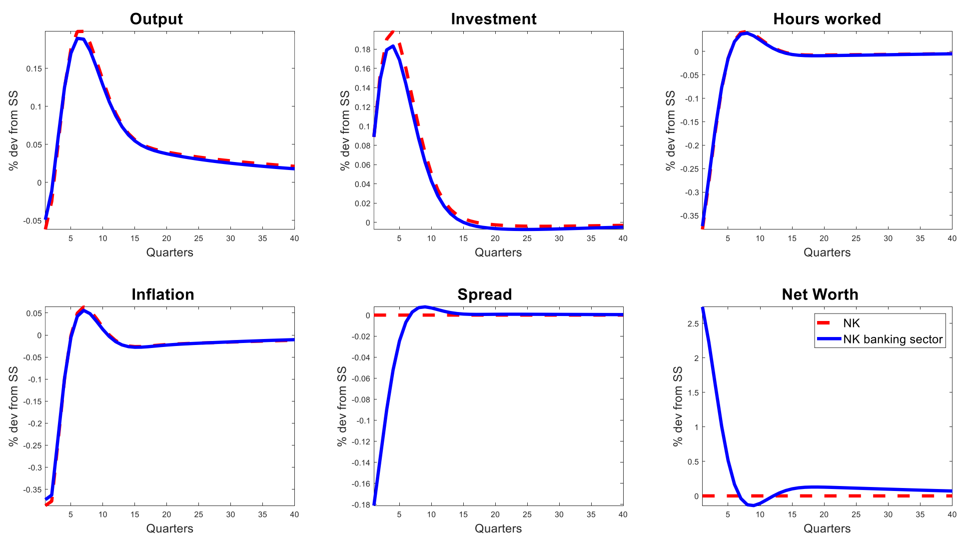


Figure 2.4 Technology shock

Figure 2.3 gives valuable insight into fiscal policy under financial frictions. A rise in government spending directly raises aggregate demand. As government spending competes for resources, investment is crowded out in short run. Firms respond to increased demand by hiring more labor. Hours increase in line with higher output.

Higher demand also puts upward pressure on prices. Inflation rises temporarily and then falls back as demand normalizes. Government spending pushes up aggregate demand. The central bank increases its policy rate and bank net worth erodes, causing spread to rise.

A positive technology shock increases the productivity of capital and labor, allowing the economy to produce more as illustrated in Figure 2.4. Wealth effects make households want more leisure, especially if productivity gains are large. Capital is now more productive, and return on investment is higher. Banks earn more profits because capital earns higher returns. When value of capital rises, bank balance sheets improve significantly, reducing the spread. Higher productivity results in lower marginal costs. This puts downward pressure on prices.

The impulse responses reveal that the responses are clearly differ from the standard NK model. Figure 2 shows that macroeconomic outcomes are highly sensitive to the condition of the banking sector. The conventional monetary policy alone may not stabilize the economy during banking distress. Well-designed macro-prudential regulation can mitigate amplification and stabilize the financial sector which leads to our next section.

8. Macro-prudential regulation (MPR)

The model allows the policymaker the use of further instruments apart from the nominal interest rate. They are in the form of unconventional monetary policy, specifically the macro-prudential regulation. The model can be used to examine the effects of financial macro-prudential regulation. This study considers a rule that directly regulates capital requirements in the form of the leverage defined as the proportion of total loans to inside equity (net worth) defined as:

$$lev_t = \frac{Q_t s_t}{N_{t+} q_t E_t} \tag{28}$$

Then the rule takes the form

$$log\left(\frac{lev_t}{lev}\right) = \rho_{lev} log\left(\frac{lev_{t-1}}{lev}\right) - lev_y log\left(\frac{Y_t}{Y}\right) + lev_s log\left(\frac{1+spread_t}{1+spread}\right) \tag{29}$$

The leverage smoothing parameter is ρ_{lev}. It captures inertia in leverage dynamics. If ρ_{lev} is high, leverage adjusts slowly to shocks or regulatory changes. The responsiveness of leverage to output $lev_y > 0$ so that when GDP is above its steady state, the rule reduces leverage. Leverage is required to respond counter-cyclically to output. If $lev_y = 0$, output fluctuations do not affect leverage. The responsiveness of leverage to financial spreads $lev_s > 0$ where $spread \equiv R_t^K - R_t$. If lev_s is high, the rule is more sensitive to financial instability. If the spread widens, meaning financial conditions tighten, regulators loosen leverage constraints.

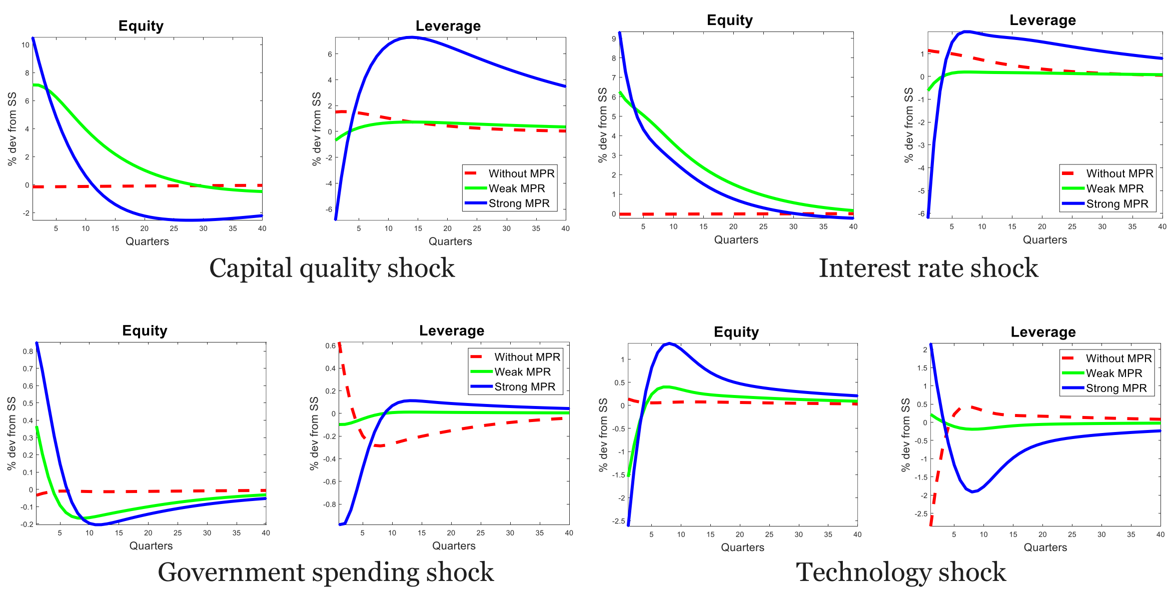
When output rises above potential, leverage is reduced because higher GDP tends to be associated with overheating risks. When output falls below potential, leverage is increased to cushion the downturn. MPR acts as an automatic stabilizer for the credit cycle. Policy goal is to lean against credit booms and support lending in recessions. When spreads widen or banks' borrowing costs rise or credit risk increases, regulators allow more leverage.

When spreads narrow or when credit markets are cheap, risk perception is low and regulators tighten leverage. MPR amplifies banks' risk-taking when credit becomes expensive to avoid credit crunches. Policy goal to avoid excessive deleveraging when financial conditions tighten. Essentially, the regulator leans against real economic cycles but accommodates financial stress. MPR design is stabilizing real cycles but protecting financial stability. It recognizes that output volatility and financial stress are not perfectly correlated.

For a weak rule, we set feedback coefficients of lev_y=lev_s $= 0.1$ whereas we set the feedback coefficients of lev_y=lev_s $= 1$ are for a strong rule. Stronger MPR reacts more aggressively to output changes and spread deviations. Stronger regulation implies stronger countercyclical adjustments. Leverage adjusts strongly. Financial stability maintained. Weaker MPR allows more room for leverage to fluctuate with less aggressive dampening. Leverage barely reacts.

To compare how MPR designed to be countercyclical to output and procyclical to spreads shapes equity and leverage responses, the model is calibrated using the same set of Thai data as previous section. The graphs in Figure 3 show how the macro-prudential rule regulates equity or the capital requirement and leverage for several shocks under three policy regimes, Without MPR, Weak MPR and Strong MPR.

Figure 3. The responses of equity and leverage of the macro-prudential regulations for Thailand



Capital quality shock

Interest rate shock

Government spending shock

Technology shock

A negative capital quality shock reduces the effective return on capital, which weakens banks' balance sheets. This raises perceived credit risk or wider spreads, forcing banks to deleverage. Leverage drops on impact due to balance sheet loss and sudden tightening by lenders. Lower leverage reduces credit supply, amplifying output decline. Thus, without MPR, the system is highly unstable. Without MPR, equity barely moves. Banks absorb the loss slowly and credit supply contracts moderately. Banks reduce lending only due to balance sheet losses, but no regulatory feedback. Under Weak MPR, the regulator allows some leverage support when spreads widen but still slightly restrains credit during output drops. However, Strong MPR aggressively adjusts leverage. Since output falls, banks are allowed to lend more. Additionally, spreads are also widening, it further encourages leverage. Equity drops sharply in the short run.

Monetary tightening triggers three main channels, higher funding costs, lower asset prices and higher spreads. Risk perception rises, amplifying financial frictions. Thus, the natural adjustment is deleveraging and rising equity. With Weak MPR, leverage slightly decreases initially, then stabilizes close to steady state. The regulator allows modest credit support when spreads widen, partially offsetting deleveraging. Under Strong MPR, leverage initially drops, then rebounds sharply above steady state. Falling in output relaxes leverage limits and spreads widening further loosens credit constraints.

Under high interest rate, the economy without MPR faces credit contraction and raises equity, leading to a deeper slowdown. However, with MPR, especially Strong MPR, the countercyclical output rule loosens credit conditions as GDP declines. The procyclical spread rule further supports leverage when funding costs rise. Therefore, banks lend more, leverage rebounds, and equity recovers faster.

A positive government spending shock increases aggregate demand and stimulates economic activity. Normally, this would lead to higher output, higher income, and potentially higher leverage as firms borrow to expand. Spreads often narrow slightly due to stronger demand. Without MPR, the rise in output encourages more borrowing and leverage increases. Equity barely moves. MPR responds counter-cyclically to output and pro-cyclically to spreads, forcing leverage downward. Strong MPR therefore forces sharper deleveraging and requires more equity adjustment.

A positive technology shock improves productivity, lowering marginal costs and boosting output. Spreads typically narrow as credit risk declines. Leverage rises slightly Without MPR, since firms become more profitable and banks extend more credit naturally. Leverage shows a small decline for Weak MPR, reflecting mild regulatory tightening. MPR restricts leverage slightly because output rises. Spreads narrow with procyclical MPR further reduces leverage, but weakly. Strong MPR tightens leverage aggressively. MPR controls credit-driven overheating after technology-driven booms.

9. The Bayesian estimation and empirical implementation

We use the Bayesian estimation which involve specifying priors and updating them based on observed data to estimating DSGE models with an integrated banking sector featuring endogenous leverage and credit spreads for 4 different countries in Asia, namely Thailand, China, Indonesia and South Korea. We focus on estimating the monetary policy parameters both the conventional Taylor rule and the macro-prudential rule parameters for these countries.

The Bayesian technique combines prior beliefs about model parameters with the likelihood of observing the data given those parameters, resulting in a posterior distribution of the model parameters. Using the Bayesian rule, the posterior distribution can be computed

$$p(\theta|\Upsilon^T, M) = \frac{p(\Upsilon^T|\theta, M)p(\theta|M)}{p(\Upsilon^T|M)} \tag{30}$$

where $p(.)$ stands for a probability density function and M stands for the model. The term $p(\Upsilon^T|\theta, M)$ is the likelihood density of the model parameter. The likelihood is the probability of obtaining the data given choices of parameter θ. Therefore, the $p(\theta|\Upsilon^T, M)$ is the posterior distribution of the parameters conditional on the model and the information set of an observed macro time series until period T or $\Upsilon^T = \{y_1, y_2, y_3, \dots, y_T\}$.

The prior is described by a density function of the form $p(\theta|M)$. The prior represents pre-experimental knowledge of parameter values and quantifies what is known about the parameters before observing the data. The probability of the data is denoted as $p(\Upsilon^T|M)$, which is the marginal density of the data conditional on the DSGE model. The likelihood and the prior distribution can be combined to form the posterior distribution providing information that combines both the data and the prior distribution.

Table 2. Prior distributions

Prior		Prior	
	Density	Mean	St.dev
Taylor rule parameters			
Persistence in interest rate ρ_r	Beta	0.75	0.10
Feedback of inflation θ_π	Gamma	2.00	0.25
Feedback of output θ_y	Gamma	0.125	0.05
Feedback output growth θ_{dy}	Beta	0.125	0.05
Macro-prudential parameters			
Persistence in leverage ρ_{lev}	Beta	0.75	0.10
Feedback of output lev_y	Gamma	0.50	0.05
Feedback of spread lev_s	Gamma	0.50	0.05
Shock parameters			
Persistence in capital quality	Beta	0.50	0.20
Persistence in government spending	Beta	0.50	0..20
Persistence in technology	Beta	0.50	0.20
Capital quality	Inv. gamma	0.10	2.00
Interest rate	Inv. gamma	0.10	2.00
Government spending	Inv. gamma	0.50	2.00
Technology	Inv. gamma	0.10	2.00
Trend	Normal	0.009	0.10

The same types of densities are used for all 4 countries. Nonetheless, the prior means of quarterly trend differ across countries. Thailand is 0.009, China is 0.02, Indonesia is 0.01 and South Korea is 0.009.

The prior distributions in Bayesian techniques are often chosen based on the domain of the parameters. Prior distributions for parameters on the real line could be Normal. The Inverse Gamma distribution has support on an open interval that excludes zero and is unbounded. It is commonly used as the distribution for the standard deviation of shock processes. Priors for parameters on a bounded interval could follow a truncated normal or a Beta distribution. (Herbst and Schorfheide, 2016). The prior distributions are in Table 2.

For each country, the observables are the log difference of real GDP, the log difference of the CPI and the central bank policy rate. All data are transformed to ensure that it is stationary. The observations are on a quarterly basis and from 2001Q1 to 2019Q4. All series are seasonally adjusted. The data is from CEIC that is a database system using data aggregated from the IMF. We maintain the values of non-policy parameters ξ β σ_{es} δ χ α ζ σ_B $\emptyset_X$ and ϱ as section 7 following the standard NK model.

The model parameters to be estimated are divided into two groups which are policy rules and shock parameters. The policy rule parameters consist of the conventional monetary policy parameters, ρ_r θ_Π θ_y and θ_{dy} and the macro-prudential regulation parameters, ρ_{lever} lev_y and lev_s. The shock persistent parameters are ρ_A ρ_G ρ_{MS} and ρ_{KQ}.

Table 3. Prudential indicators

Steady state	**Thailand**	**China**	**Indonesia**	**S. Korea**
Leverage	3.347	4.623	2.786	4.332
Spread	0.0045	0.0026	0.0027	0.003
Xeq	0.088	0.062	0.112	0.077

Leverage refers to the economy-wide leverage ratio; Spread is the quarterly interest rate spread; Xeq denotes the ratio of outside bank equity to total assets;

Table 3 presents the calibrated values of key prudential indicators for four selected countries including Thailand, China, Indonesia and South Korea. The benchmark parameter values are primarily based on Gertler and Kiyotaki (2010). The economy-wide leverage ratio in each country is defined as a weighted average of sectoral leverage ratios, with weights determined by the equity share of each sector. However, due to data limitations and considerable variation in leverage ratios across sectors, it is difficult to construct a fully disaggregated measure. To address this, we classify the economy into financial and non-financial sectors and compute the average leverage ratio across these two sectors over the period 1999–2015, treating it as the steady-state value for the economy-wide leverage ratio. For the non-financial sector, we adopt the leverage ratios reported by Vidhan and Frank (2017), available for Thailand, Indonesia, and South Korea. For China and India, the data are obtained from the International Monetary Fund (2015) and Linder and Jung (2014), respectively. Leverage ratios for the financial sector in all five countries are sourced from the Federal Reserve Bank of St. Louis (FRED) database.

The interest rate spread is defined as the difference between the interest rate charged by banks on loans to private sector customers and the interest rate paid by commercial or similar banks on demand, time, or savings deposits. This definition applies to all countries in the sample except India, for which the spread is measured as the difference between the lending rate and the long-term government bond rate. The data are obtained from the International Financial Statistics database of the International Monetary Fund (IMF). The variable Xeq, which reflects the degree of external financing, is proxied by the ratio of bank capital to total assets due to the unavailability of disaggregated data on outside equity. This proxy is sourced from the IMF's Financial Soundness Indicators database. Inflation and GDP per capita growth rates are drawn from the World Bank database. Additionally, the share of government consumption in output-side real GDP at current PPPs and the annual depreciation rate are obtained from the Penn World Table (PWT), version 10.01.[1] All steady-state values of these series reported in Table 3 are calculated as averages over the period 2000–2019.[2]

Table 4 reports on the posterior distribution of monetary policy parameters of each country.

Table 4. Posterior distributions

Posteriors		**Thailand**			**China**		
	Density	Mean	90% interval		Mean	90% interval	
Taylor rule parameters							
Persistence in interest rate ρ_r	Beta	0.973	0.9762	0.9784	0.979	0.9732	0.9854
Feedback of inflation θ_π	Gamma	2.066	1.7015	2.4013	1.710	1.3174	2.1291
Feedback of output θ_y	Gamma	0.100	0.0079	0.1938	0.162	0.1044	0.2261
Feedback output growth θ_{dy}	Beta	0.115	0.0323	0.2035	0.110	0.0480	0.1897
Macro-prudential parameters							
Persistence in leverage ρ_{lev}	Beta	0.764	0.6204	0.9427	0.750	0.5773	0.9171
Feedback of output lev_y	Gamma	0.504	0.4302	0.5836	0.499	0.4297	0.5866
Feedback of spread lev_s	Gamma	0.507	0.4187	0.5810	0.502	0.3389	0.6343
Shock parameters							
Persistence in capital quality	Beta	0.507	0.1868	0.8333	0.937	0.8818	0.9747
Persistence in government spending	Beta	0.479	0.1333	0.7461	0.506	0.2023	0.8372
Persistence in technology	Beta	0.991	0.9868	0.9958	0.991	0.9886	0.9943
Capital quality	Inv. gamma	0.071	0.0275	0.1282	0.906	0.4473	1.4987
Interest rate	Inv. gamma	0.087	0.0734	0.0979	0.058	0.0494	0.0655
Government spending	Inv. gamma	0.365	0.1395	0.5904	0.385	0.1413	0.6475
Technology	Inv. gamma	3.761	3.0708	4.3875	7.428	6.4485	8.2600
Trend	Normal	0.009	0.1479	-0.0017	0.151	-0.0027	0.3159

Table 4.1 Posterior distributions of Thailand and China

[1] The ratios of government consumption to real GDP and the depreciation rate are obtained from the series labeled *csh_g* and *delta*, respectively.

[2] The dataset is limited to observations up to the year 2019 to exclude the period affected by the COVID-19 pandemic.

As show in Table 3, Thailand has a moderate leverage suggesting that banks are not excessively exposed. Financial stability is relatively strong. Largest spread suggests higher risk premiums or less efficient intermediation. It could reflect structural credit risks. Relatively high outside equity participation, giving banks a stronger capital buffer. China has the highest leverage, implying greater risk-taking in the financial system, but also higher credit availability. This reflects China's growth-driven financial system but raises vulnerability to shocks. Lower spreads imply cheaper credit relative to risk. Lowest outside equity shows reliance on internal or state-backed equity, which could limit market discipline.

Indonesia has the lowest leverage, indicating a more conservative banking stance and tighter credit supply. It may enhance stability but constrain growth. Lower spreads imply cheaper credit relative to risk. However, highest outside equity indicating robust external equity participation—banks depend more on outside investors, which enhances capital resilience but also exposes them to investor sentiment. South Korea has a high leverage like China, showing an aggressive credit market, likely tied to advanced financial integration but also higher systemic risk. South Korea has a mid-range spread, consistent with a mature financial system that balances competition with risk assessment. Additionally, a moderate outside equity is consistent with balanced reliance on outside equity. After using the Bayesian estimation, the posterior distributions are shown in Table 4. Table 4.1 and Table 4.2 displays the posterior distribution of Thailand, China and Indonesia and South Korea respectively.

Posteriors		**Indonesia**			**South Korea**		
	Density	Mean	90% interval		Mean	90% interval	
Taylor rule parameters							
Persistence in interest rate ρ_r	Beta	0.929	0.9096	0.9456	0.955	0.9462	0.9648
Feedback of inflation θ_{Π}	Gamma	1.943	1.4444	2.4333	2.355	2.0644	2.6812
Feedback of output θ_y	Gamma	0.156	0.0704	0.2495	0.132	0.0483	0.2189
Feedback output growth θ_{dy}	Beta	0.111	0.0233	0.2011	0.131	0.0661	0.1945
Macro-prudential parameters							
Persistence in leverage ρ_{lev}	Beta	0.774	0.6312	0.9267	0.772	0.6362	0.9214
Feedback of output lev_y	Gamma	0.499	0.4210	0.5838	0.506	0.4321	0.5919
Feedback of spread lev_s	Gamma	0.504	0.3700	0.6207	0.499	0.4111	0.5744
Shock parameters							
Persistence in capital quality	Beta	0.926	0.8460	0.9952	0.545	0.1800	0.8815
Persistence in government spending	Beta	0.480	0.1081	0.7720	0.498	0.1363	0.8200
Persistence in technology	Beta	0.982	0.9715	0.9944	0.989	0.9829	0.9965
Capital quality	Inv. gamma	0.407	0.1087	0.8449	0.061	0.0263	0.0963
Interest rate	Inv. gamma	0.338	0.2837	0.3955	0.105	0.0883	0.1191
Government spending	Inv. gamma	0.330	0.1449	0.5349	0.309	0.1424	0.4710
Technology	Inv. gamma	7.434	6.1656	8.8802	3.159	2.6293	3.6247
Trend	Normal	0.088	-0.075	0.2549	0.213	0.0346	0.3695

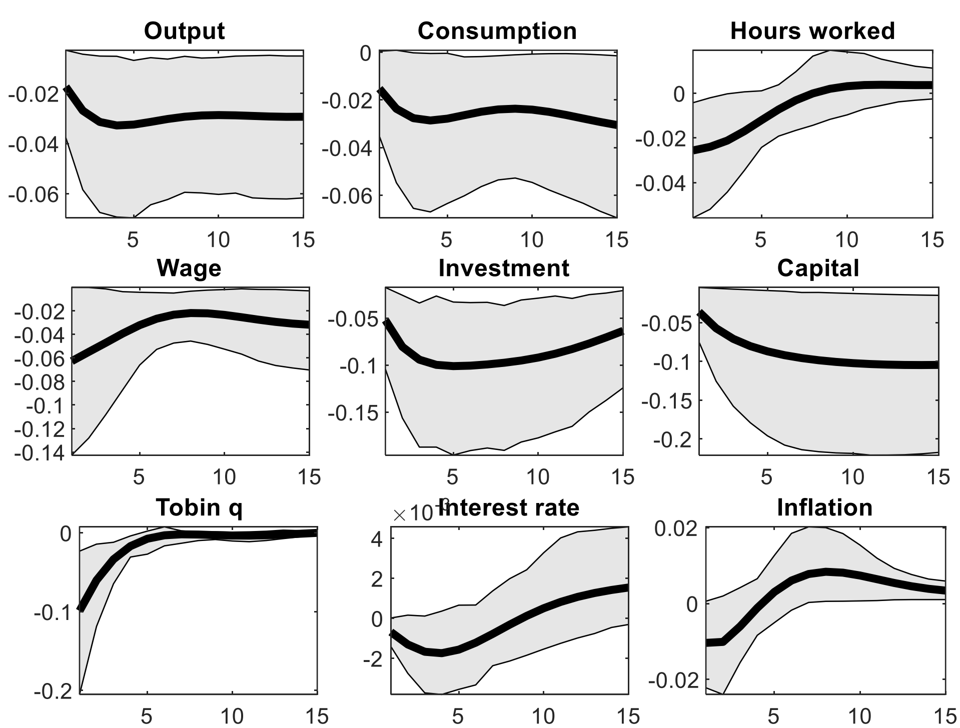
Table 4.2 Posterior distributions of Indonesia and South Korea

10. The dynamic effects of traditional monetary policy and macro-prudential regulation coordination.

This section investigates the impulse responses of the coordination of conventional monetary policy and MPR for Thailand using the Bayesian estimation from previous section. The experiment is done under four different kinds of shocks as shown in Figure 4. The monetary tightening is an interest rate shock set by central bank. A negative capital quality shock represents asset devaluation during financial crisis. We also introduce demand and supply shock by considering a positive government spending shock and a positive technology shock respectively.

As in Figure 4.1, a negative capital quality shock means the effective quality of physical capital deteriorates even if firms own the same amount of capital, its productivity declines. Lower capital quality lowers firm asset values and thus net worth fall, as a result lending becomes riskier and spread rises. Higher spread causes costlier borrowing and investment falls. Lower q reflects lower asset valuations. Output falls gradually. Inflation falls due to falling demand and investment. A contraction in aggregate demand leads to a fall in hours worked and wages. The central bank cuts its policy rate to stimulate the demand and investment. Leverage falls on impact because of balance sheet loss and sudden tightening by banks. Then the MPR loosens because output is below trend and spreads are above trend. Together they push leverage up, eventually offsetting the initial deleveraging. However, monetary policy cushions the slump at first by lowering interest rates but cannot directly fix risk premium. The MPR makes short run stabilization of credit supply.

Figure 4. Impulse responses of the macro-prudential regulations in case of Thailand



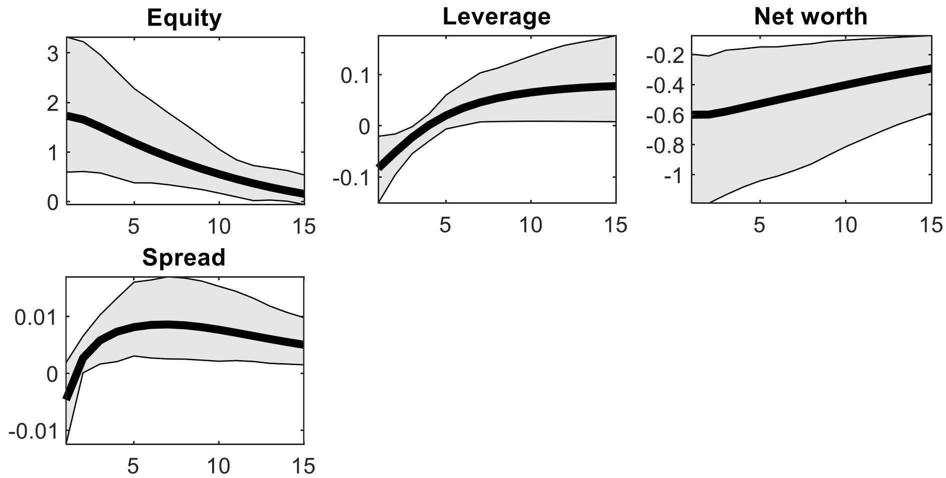
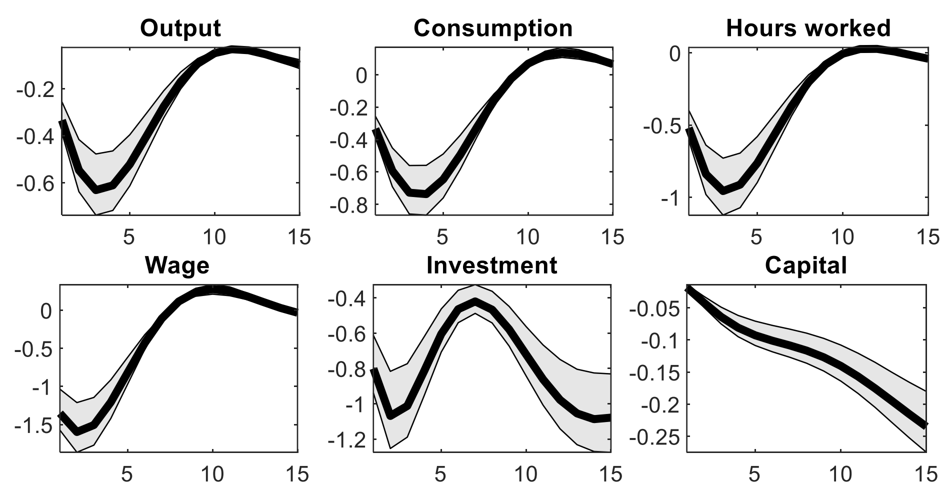


Figure 4. 1 Capital quality shock

Figure 4.2 explores macroeconomic effects of MPR under monetary tightening. An unexpected increase in the policy rate raises borrowing costs. A decline in consumption and investment leads to a contraction in aggregate demand. Firms cut labor when demand drops and real wages compress. Low investment cumulates into persistent capital shortfall. Demand-driven disinflation dominates early. As leverage or credit recovers and the output gap closes, inflation rises. Tightening reduces asset values and net worth falls. The initial balance sheet hit forces deleveraging, but the MPR loosens leverage constraints. Both falling in output and rising in spreads push leverage up. Under monetary tightening, the MPR which is designed to be counter-cyclical with respect to output but pro-cyclical with respect to spreads stabilizes activity early but could be leveraged into high risk.



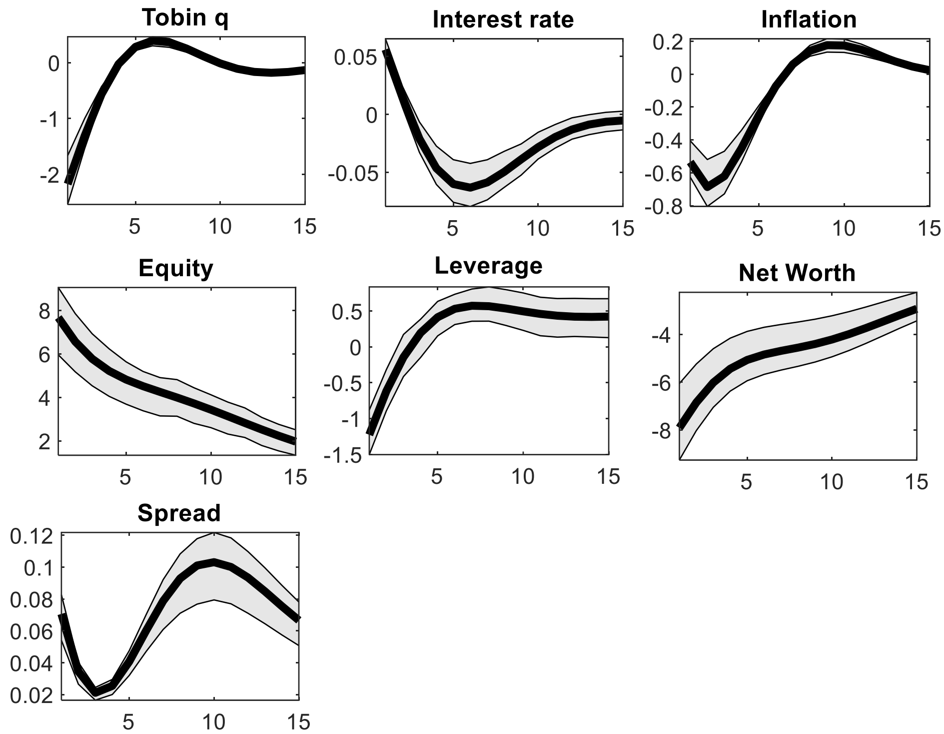
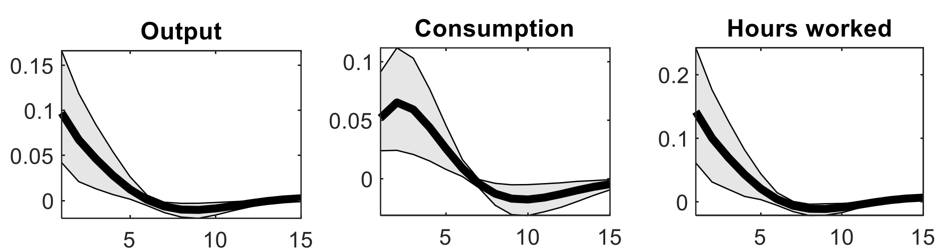


Figure 4. 2 Interest rate shock

A positive government spending shock increases aggregate demand, and output expands in Figure 4.3. Consumption rises early and crowds out later from higher interest rates and tighter credit. The demand pulls inflation and then drifts down because of monetary and MPR tightening. Labor demand rises with fiscal push. Investment early crowns out as policy normalizes and MPR eases, and investment recovers later. After the fiscal shock, firms and households borrow more. Banks' balance sheet expands and credit risk rises initially. Spreads then narrow following strong demand. The Taylor rule leans against overheating demand, tightening monetary policy after a positive fiscal shock. Policy rate rises as output and inflation increase, suppressing investment and q. Net worth rises after the impact as balance sheet initially improves. Even though output is above its trend and spreads rises, the MPR reduces the leverage. Credit supply is restrained and lean against overheating and credit boom.



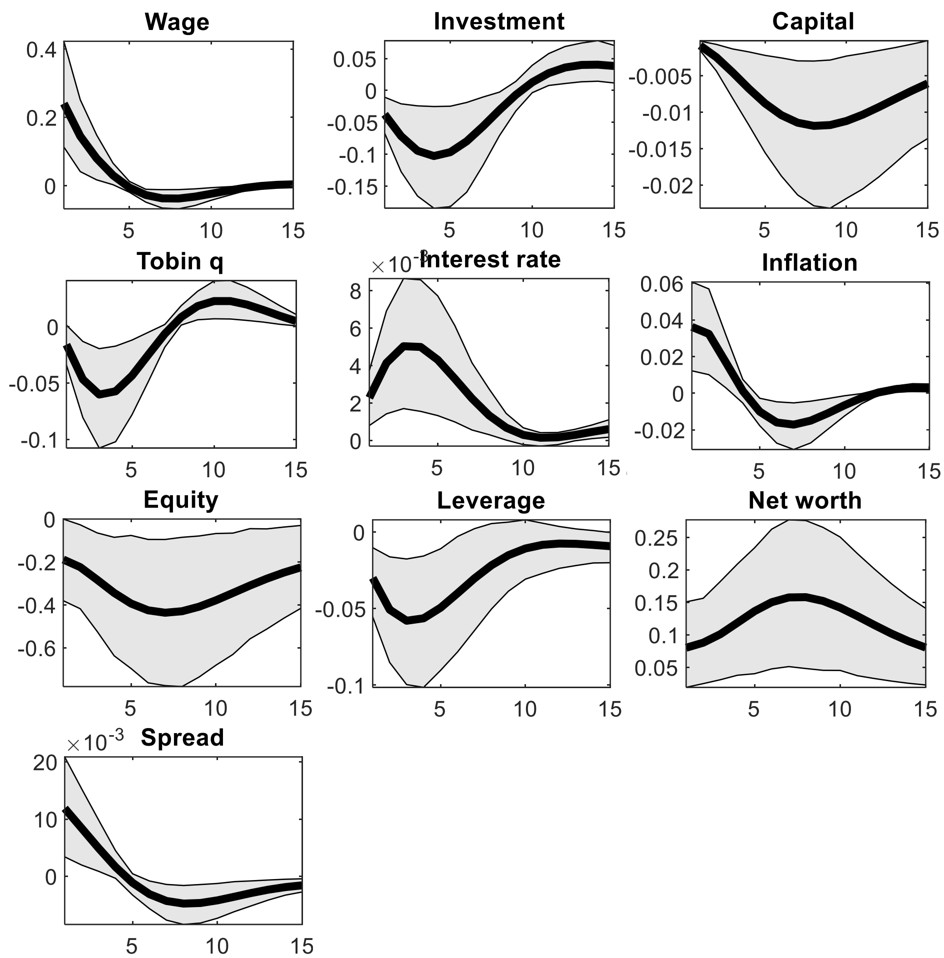


Figure 4. 3 Government spending shock

Figure 4.4 shows the impulse responses of macroeconomic variables for MPR under a technology shock, a positive technology shock leads to productivity improvement, increasing potential output and reducing marginal production costs. On the supply side effect, it lowers unit costs and creates disinflationary pressure initially. Firms are facing lower marginal costs, reflecting low wages and hours worked in the early stage. On the demand side effect, the shock raises productivity and expected income. Consumption and investment rise and capital increases persistently as aggregate demand expands. Since inflation falls, the Taylor rule suggests lowering policy rate or monetary easing initially. Later as demand and output expand, inflationary pressure returns, the central bank tightens policy to stabilize prices. Thus, the monetary policy switches from easing to tightening over time. Risk premium compresses and default risk falls as demand expands, causing spreads to fall significantly. Leverage is deleveraging in the boom because output is high while spreads are low. With MPR, credit growth is restrained despite better fundamentals. A positive technology shock leads to cost falling and potential rising. A conventional monetary policy sensibly eases on impact to avoid undershooting inflation, then tightens as economic activities rise. The MPR design leans against the boom from both output and spreads, producing lower leverage and smaller risk raking than without MPR.

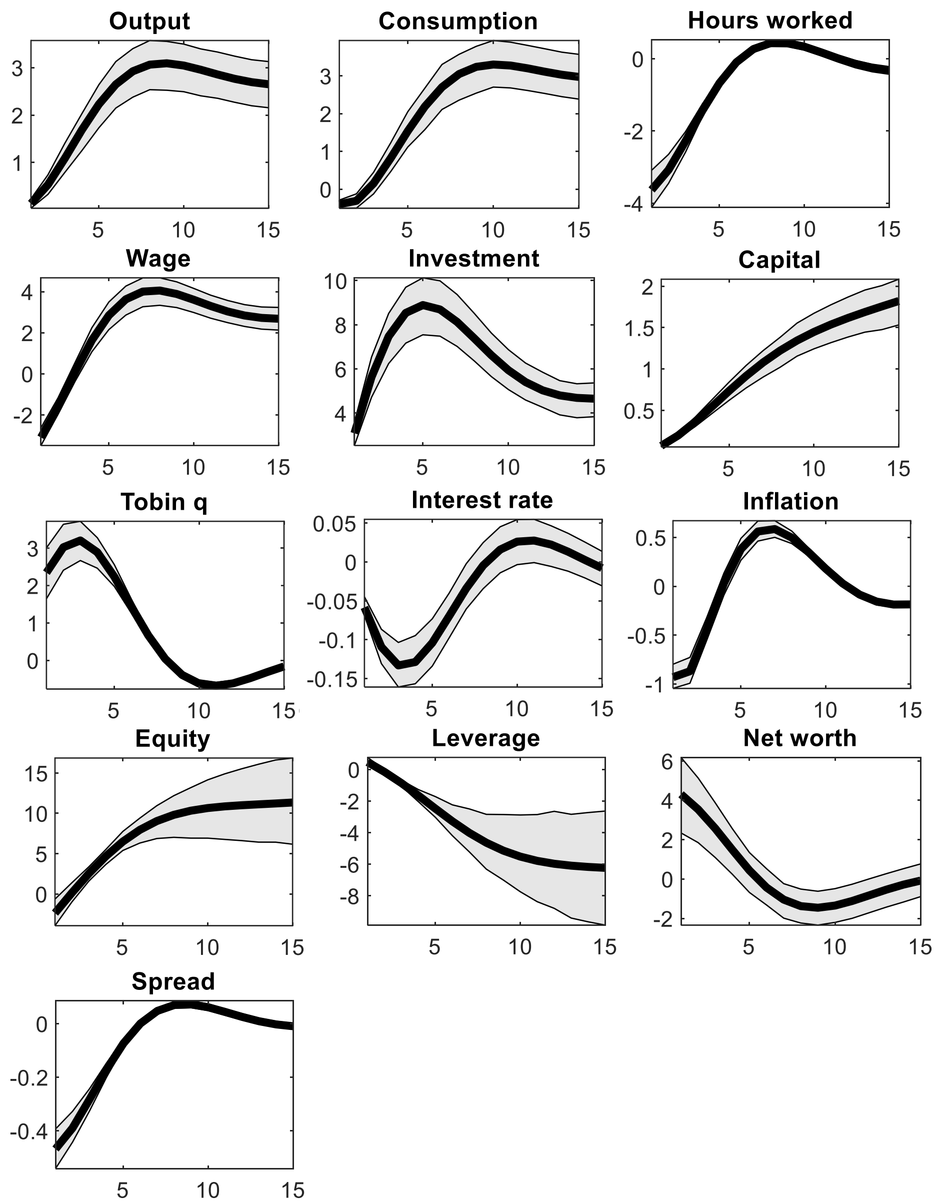


Figure 4. 4 Technology shock

The impulse responses make clear how the interaction of the two channels (output-counter cyclical but spreads-procyclical) of MPR produces very different MPR policy stances across shocks. The MPR loosens in downturns and tightens in booms. For the negative capital quality shock, net MPR stance is loosening because output falls and spread rises. Regarding monetary tightening, output falls and spread rises. Thus, net MPR stance is also loosening. Under positive technology shock, output rises and spreads fall. Net MPR stance is tightening. Nonetheless, because of a positive government spending shock, output rises and spreads rise.

Output channel tightens but spread channel loosens. Therefore, net MPR stance is ambiguous. Even though it is a conflicting signal, leverage falls in the beginning periods as in Figure 4.3. Fiscal stimulus may still create credit booms.

11. Model comparisons

This section investigates the hypothesis that central banks consider the macro-prudential regulation to conduct monetary policy. Following Koop (2003) we apply a Bayesian rule to derive a probability statement regarding the validity of a model, conditional on the data. The posterior model probability can be utilized to assess the level of support for the model. We compare two NK banking models with Taylor rule (M_1) and another with the combination of Taylor and MPR rules (M_2) to determine the most suitable one based on the data for our selected countries.

$$po_{12} = \frac{p(M_1|Y^T)}{p(M_2|Y^T)} = \frac{p(Y^T|M_1)p(M_1)}{p(Y^T|M_2)p(M_2)} \tag{31}$$

To compare these two models, we utilize the ratio of their posterior model probabilities, also known as the posterior odds ratio, as shown in equation (31). Using the same dataset for each country and the same priors for both models, we assign equal prior weight to each model, i.e., $p(M_1) = p(M_2)$. Thus, the prior odds ratio is 1. In our experiment, the posterior odds ratio becomes the Bayes factor or the ratio of marginal likelihoods. To obtain the marginal density of the data conditional on the model, we employ both the Laplace approximation and the harmonic mean estimator. The Laplace approximation assumes a functional form of the posterior kernel that can be integrated, while the harmonic mean estimator utilizes information from the Metropolis–Hastings algorithm. Both approximations yield consistent results, as shown in Table 5.

Table 5. Model comparison

Country	Thailand		China		Indonesia		South Korea	
Model	M2	M1	M2	M1	M2	M1	M2	M1
Priors	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Log marginal density	-229.29	-229.33	-175.61	-175.65	-330.95	-330.99	-165.81	-165.85
Bayes ratio	1.0000	0.9449	1.0000	0.9468	1.0000	0.9648	1.0000	0.9464
Posterior model prob.	0.5089	0.49107	0.5089	0.49106	0.5089	0.49106	0.5090	0.4909

M1 is the NK banking model with Taylor rule. M2 is the NK banking model with Taylor rule and MPR

The log marginal density of M2 is higher for all 4 countries, leading to a posterior odds ratio of 0.9649 for Thailand China and Indonesia and of 0.9644 for South Korea respectively. The Bayes factor supports M2. Therefore, based on the data during the observation period, there is weak evidence in favor of the simple model M1 for each country.

This indicates that it is not sufficient for central banks to pursue only traditional mandates. Our findings align with the notion that the central bank in Asian is attentive to price and output stability as well as financial stability. Central banks must prevent the buildup of financial risk through macro-prudential policies.

12. The combination of conventional monetary policy and Macro prudential regulation in Asian

Conventional monetary policy rules (Taylor-type rules) set the nominal policy rate based on inflation, output, and sometimes output growth to stabilize inflation and output. Its transmission channel is the aggregate demand. Nonetheless, the policy is less effective when binding leverage constraints, risk spreads widen and zero lower bound. The general rule for all four countries is:

$$log\left(\frac{R_{n,t}}{R_n}\right) = \rho_r log\left(\frac{R_{n,t-1}}{R_n}\right) + (1-\rho_r)\left[\theta_\pi log\left(\frac{\pi_t}{\pi}\right) + \theta_y log\left(\frac{Y_t}{Y}\right) + \theta_{dy} log\left(\frac{Y_t}{Y_{t-1}}\right)\right] + \epsilon_{M,t}$$

Table 6 Conventional monetary rule parameters for selected Asian countries

Taylor-type rule				
Policy parameters	ρ_r	θ_π	θ_y	θ_{dy}
Thailand	0.973	2.066	0.100	0.115
China	0.979	1.710	0.162	0.110
Indonesia	0.929	1.943	0.156	0.111
South Korea	0.955	2.355	0.132	0.131

Using the Bayesian estimation for each country, we analyze how each country differs in monetary policy aggressiveness and macroprudential strength. As in Table 6, Thailand demonstrates high monetary policy aggressiveness with a strong focus on controlling inflation, while giving relatively less weight to output stabilization. China shows moderate emphasis on inflation, but places a stronger role on output stabilization compared to Thailand and South Korea. Indonesia adopts a balanced approach, targeting both inflation and output, but with less smoothing in its policy response. South Korea exhibits the strongest inflation-targeting stance among the four countries, while maintaining a moderate role for output stabilization

Regarding interest rate smoothing ρ_r, China ρ_r=0.979 and Thailand ρ_r=0.973 exhibit high policy smoothing, meaning they adjust interest rates gradually over time, whereas Indonesia ρ_r= 0.929 responds more aggressively to economic shocks. In terms of the inflation weight θ_π, South Korea θ_π= 2.355 and Thailand θ_π= 2.066 are the most inflation-targeting economies, while China θ_π= 1.710 adopts a less aggressive stance, suggesting greater tolerance for temporary inflation fluctuations. Considering the output gap and output growth weights θ_y and θ_{dy}, China places more emphasis on the output gap θ_y =0.162 compared to Thailand θ_y =0.100, indicating a more growth-oriented monetary stance. Meanwhile, South Korea assigns the highest weight to output growth θ_{dy}=0.131, reflecting dual objectives of supporting growth while controlling inflation.

An unconventional monetary policy or macro-prudential regulation (MPR) focuses on financial stability by controlling bank leverage and credit growth using capital requirement, loan to value and countercyclical buffers. Its transmission channels are bank balance sheets, leading capacity, asset prices and financial stability. For all four countries, the leverage dynamics follow:

$$log\left(\frac{lev_t}{lev}\right) = \rho_{lev} log\left(\frac{lev_{t-1}}{lev}\right) - lev_y log\left(\frac{Y_t}{Y}\right) + lev_s log\left(\frac{1 + spread_t}{1 + spread}\right)$$

Regarding to the macroprudential strength as in Table 7, Thailand adopts a medium macroprudential stance, maintaining a balanced approach to leverage control without being overly restrictive. China exhibits a slightly weaker leverage control framework, allowing for more flexibility in credit and balance sheet adjustments. Indonesia shows the highest leverage persistence, indicating that banks adjust their leverage more slowly and rely on gradual regulatory interventions. South Korea implements tight leverage monitoring, reflecting a proactive macroprudential policy aimed at maintaining financial stability.

Table 7 Unconventional monetary rule parameters for selected Asian countries

Macro prudential regulation			
Policy parameters	ρ_{lev}	lev_y	lev_s
Thailand	0.764	0.504	0.507
China	0.750	0.499	0.502
Indonesia	0.774	0.499	0.504
South Korea	0.772	0.506	0.499

Regarding leverage persistence ρ_{lev}, Indonesia ρ_{lev}= 0.774 and South Korea ρ_{lev} = 0.772 exhibit the highest persistence, meaning that leverage adjusts more slowly in response to shocks, whereas China ρ_{lev} = 0.750 allows for greater flexibility in leverage adjustments. For the output effect on leverage lev_y, the relationship is negative across all countries, indicating that when GDP rises, banks tend to deleverage. Among them, Thailand lev_y= 0.504 and South Korea lev_y= 0.506 display the strongest macroprudential responses to output changes. Regarding the spread effect on leverage lev_s, the impact is almost identical across all countries (approximately 0.50), suggesting that wider credit spreads consistently loosen leverage constraints.

Table 6 and 7 demonstrates that Thailand is balanced but inflation oriented. Bank of Thailand maintains high inflation responsiveness θ_π= 2.066 and gradual policy adjustments ρ_r= 0.973, indicating a cautious and predictable approach. With a moderate macroprudential stance, Thailand can manage financial risks but may require tighter MPR during periods of booms. China has smoother monetary policy with higher growth sensitivity. China shows the highest interest rate smoothing ρ_r =0.979, suggesting a preference for gradual policy shifts to avoid disrupting growth.

Lower inflation targeting θ_{π}= 1.710 and stronger focus on the output gap indicate a growth-supportive monetary framework.

However, a less restrictive MPR allows greater leverage expansion, increasing vulnerability to credit booms and systemic risks. For Indonesia, monetary policy is aggressive and leverage adjustment is slow. Indonesia adopts a more aggressive monetary stance ρ_r= 0.929 and maintains a relatively high inflation weight θ_{π}= 1.943, prioritizing price stability. Nonetheless, its high leverage persistence ρ_{lev} = 0.774 suggests that macroprudential interventions take longer to influence banking behavior. South Korea is tight and proactive policy coordination. South Korea demonstrates the strongest inflation-targeting stance θ_{π}= 2.355, while also giving considerable weight to output growth θ_{dy}=0.131, reflecting a dual mandate. Its tight macroprudential stance and high leverage monitoring ρ_{lev}=0.772 indicate proactive financial risk management.

The comparative analysis highlights that conventional monetary policy (Taylor-type rules) alone is insufficient to ensure macro-financial stability in Asian economies. While interest rate rules target inflation and output stabilization, they are less effective when facing excessive credit growth, rising leverage and risk-taking behavior, asset price bubbles, and cross-border capital flow volatility. Thus, combining monetary policy with macroprudential regulation (MPR) becomes essential to maintain both price stability and financial stability.

13. Welfare analysis

Welfare analysis in MPR is an essential tool to evaluate whether introducing or strengthening financial stability policies improves overall social welfare. The MPR influences consumption and output volatility which in turn affect welfare. The weak MPR is a mild leverage control, leading to less volatility and small welfare gain whereas the strong MPR is tight leverage constraints, reducing probability of crises but potential cost from lower short term consumption and output. To rank alternative macro prudential policies, we use a welfare-based criterion based on the inter-temporal household expected utility.

$$\Omega_t = E_t \sum_{\tau=0}^{\infty} \beta^{t+\tau} U(C_{t+\tau}, C_{t+\tau-1}, N_{t+\tau}) \tag{32}$$

With $U(C_t, C_{t-1}, N_t)$ given by equation (3) and Ω_t represents the inter-temporal welfare. In a zero-growth steady state we can write equation (32) as

$$\Omega_t = U_t + \beta E_t \Omega_{t+1} \tag{33}$$

We can write the stationarized form used for the ranking of policy as

$$\Omega_t = U_t + \beta_{g,t+1} E_t[(1 + g_{t+1})\Omega_{t+1}] + \text{t.i.p}$$

Where $\beta_{g,t} = \beta(1 + g)^{(1-\varrho)(1-\sigma_c)-1}$ and the second term is a term independent of policy (t.i.p) which contributes to the impact of uncertainty on welfare under a stochastic shock. Given a particular equilibrium for C_t and N_t and single period utility, $U_t = U(C_t, C_{t-1}, N_t)$, we compute a consumption equivalent variation CEV_t, the increase in the given by a 1% increase in consumption by defining the variable

$$CEV_t = U_t(1.01C_t, 1.01C_{t-1}, N_t) - U_t + \beta_{g,t+1}E_t[(1 + g_{t+1})CEV_{t+1}]$$

Then we use the deterministic steady state of CEV_t or CEV to compare welfare outcomes: for two welfare outcomes, Ω_1 and Ω_2 we defined $\Phi = \frac{(\Omega_1 - \Omega_2)}{CEV}$. CEV measure how much households are willing to give up in steady state consumption to move from one policy regime to another. We calculate the welfare optimized from the rule with respect to the feedback $lev_y = lev_s$ given the values of the policy parameters of a conventional Taylor rule for each country based on the Bayesian estimation from the previous section.

To capture realistic aggregate dynamics, table 8 sets out the results of all shocks for the regulation rule with a conventional Taylor rule. When we simulate all shocks together, we evaluate the model's joint dynamics driven by the stochastic processes of all structural shocks simultaneously. For each country a mark increases in the volatility of equity which for higher values of the feedback coefficients involves a significant welfare cost. It reports on the welfare cost of regulation in consumption equivalent percentage units of the deterministic steady state. It is significantly at approximately 0.36%, 0.20%, 0.32% and 0.26% consumption equivalent for Thailand, China, Indonesia and South Korea respectively. Table 8 shows that for the selected Asian countries, the optimized regulatory rule in the macro-prudential regulation lev_y=lev_s is between 0.4 and 0.6.

In case of Thailand, the gain from using an optimized form of the regulatory rule with feedback coefficients $lev_y = lev_s = 0.5$ is more modest with CEV of 0.3613 compared with a Weak MPR of with feedback coefficients of 0.3 with CEV of 0.3678 or an aggressive rule with feedback coefficients of 0.7 with CEV of 0.3731. Therefore, for Thailand at the optimal regulatory rule $lev_y = lev_s = 0.5$, a 1% permanent increase in consumption gives a welfare gain of 6.1536. For China, the gain from using an optimized form of the regulatory rule with feedback coefficients lev_y=$lev_s = 0.6$ is more modest with CEV of 0.2029. At these optimal regulatory rules, a 1% permanent increase in consumption gives a welfare gain of 0.66 for China.

In case of Indonesia, the gain from using an optimized form of the regulatory rule with feedback coefficients lev_y=$lev_s = 0.4$ is more modest with CEV of 0.319 where as for South Korea an optimized form of the regulatory rule with feedback coefficients lev_y=$lev_s = 0.5$ is more modest with CEV of 0.261. At these optimal regulatory rules, a 1% permanent increase in consumption gives a welfare gain of 4.520.

Table 8. Optimized regulatory rule in the macro-prudential regulation for all shocks

Country	Feedback	Welfare	Equity	leverage	Sd Equity	Sd Leverage	CEV
Thailand	Taylor rule	-619.6562	0.3412	2.8035	0.0719	0.7007	0.000
MPR	0.3	-621.9196	0.1464	2.6209	0.3205	0.1567	0.368
	0.4	-621.8855	0.1499	2.6344	0.3222	0.2089	0.362
	0.5	-621.8795	0.1522	2.6492	0.3264	0.2611	0.361
	0.6	-621.9016	0.1529	2.6655	0.333	0.3133	0.365
	0.7	-621.9519	0.1521	2.6836	0.3419	0.3655	0.373
China	Taylor rule	-117.6099	0.1937	4.1264	0.0371	1.3596	0.000
MPR	0.4	-117.7439	0.0412	3.6435	0.2537	0.269	0.205
	0.5	-117.7429	0.0431	3.659	0.2539	0.3362	0.203
	0.6	-117.7426	0.0447	3.6759	0.255	0.4034	0.203
	0.7	-117.743	0.046	3.6942	0.2568	0.4707	0.204
	0.8	-117.7441	0.047	3.7141	0.2594	0.5379	0.205
Indonesia	Taylor rule	-404.7736	0.4161	2.2557	0.09	0.4747	0.000
MPR	0.2	-406.1245	0.2314	2.1479	0.2947	0.0942	0.335
	0.3	-406.0772	0.2361	2.1611	0.296	0.1414	0.323
	0.4	-406.0602	0.2386	2.1756	0.3019	0.1885	0.319
	0.5	-406.0735	0.2386	2.1914	0.3122	0.2356	0.322
	0.6	-406.1170	0.2358	2.2091	0.3264	0.2827	0.333
S. Korea	Taylor rule	-452.4202	0.2889	3.7487	0.0675	1.105	0.000
MPR	0.3	-453.6116	0.1329	3.2852	0.3425	0.2110	0.263
	0.4	-453.6006	0.1367	3.3002	0.3441	0.2814	0.261
	0.5	-453.6000	0.1399	3.3169	0.3475	0.3517	0.261
	0.6	-453.6098	0.1423	3.3355	0.3528	0.4221	0.263
	0.7	-453.6301	0.1439	3.3562	0.3598	0.4924	0.267

MPR policy parameters are set by lev_y=lev_s. A conventional Taylor rule is the model without MPR. Sd is standard deviation.

To understand the implication for the MPR to causal transmission of a single shock, we evaluate the optimized MPR under a capital quality shock as in Table 9 and monetary tightening as in Table 10. A negative capital quality shock reduces the effective return on assets. Because the shock directly destroys collateral values, leverage automatically falls or banks tighten themselves. The banks naturally deleverage without requiring strong regulatory intervention. If MPR is too aggressive, it would over-loosen leverage constraints in downturn. Banks are permitted to lever up too much, leading to risk-taking worsening fragility.

Hence, the optimal welfare-based policy usually prescribes moderate macroprudential tightening. For Thailand and South Korea, the MPR with feedback coefficients $lev_y = lev_s = 0.5$ is more modest with CEV of 0.185 and 0.141 respectively. The Chinese MPR with feedback coefficients lev_y=lev_s $= 0.6$ is more modest with CEV of 0.104 for the negative capital quality shock. In the case of Indonesia, the MPR with feedback coefficient lev_y=lev_s $= 0.4$ is more modest with

CEV of 0.141. We can see from Table 9 that when the shock itself reduces leverage, regulators do not need to push too hard. Moderate MPR balances financial stability and output stabilization.

Table 9. Optimized regulatory rule in the macro-prudential regulation for capital quality shock

Country	Feedback	Welfare	Equity	leverage	Sd Equity	Sd Leverage	CEV
Thailand	Taylor rule	-612.603	0.2861	2.795	0.0681	0.5217	0.000
MPR	0.5	-613.742	0.2421	2.602	0.2238	0.2369	0.185
China	Taylor rule	-117.025	0.098	4.2966	0.0344	0.9984	0.000
MPR	0.6	-117.093	0.1088	3.6162	0.1759	0.3452	0.104
Indonesia	Taylor rule	-398.948	0.3647	2.2562	0.0853	0.3336	0.000
MPR	0.4	-399.599	0.3304	2.1331	0.2035	0.1721	0.161
S. Korea	Taylor rule	-448.515	0.1925	3.8134	0.0638	0.8341	0.000
MPR	0.5	-449.154	0.215	3.2658	0.2467	0.3186	0.141

MPR policy parameters are set by lev_y=lev_s. A conventional Taylor rule is the model without MPR. Sd is standard deviation.

Table 10 demonstrates a monetary policy mix between a conventional monetary policy and unconventional monetary policy, MPR. It shows that the strong MPR is optimally required in response to monetary tightening for all four countries. When interest rate rises, banks' funding costs increase. Spreads can widen because risk perception rises. Net worth declines, meaning banks might maintain or even decrease leverage.

Table 10. Optimized regulatory rule in the macro-prudential regulation for monetary tightening

Country	Feedback	Welfare	Equity	leverage	Sd Equity	Sd Leverage	CEV
Thailand	Taylor rule	-617.512	0.3758	2.5919	0.0203	0.4645	0.000
MPR	0.8	-618.524	0.2266	2.6499	0.2276	0.1396	0.164
China	Taylor rule	-117.512	0.2653	3.4275	0.0133	0.9174	0.000
MPR	0.7	-117.574	0.1079	3.6567	0.1809	0.2209	0.096
Indonesia	Taylor rule	-403.423	0.4475	2.1207	0.0257	0.314	0.000
MPR	0.8	-403.998	0.2905	2.1945	0.2112	0.1218	0.143
S. Korea	Taylor rule	-451.535	0.384	3.1922	0.0195	0.7155	0.000
MPR	0.7	-452.042	0.2172	3.3096	0.2352	0.1657	0.112

MPR policy parameters are set by lev_y=lev_s. A conventional Taylor rule is the model without MPR. Sd is standard deviation.

The strong MPR is needed to force leveraging and contain credit growth. For Thailand and Indonesia, the aggressive MPR with feedback coefficients lev_y=$lev_s = 0.8$ are associated with the monetary tightening. In the case of China and South Korea, the strong MPR with feedback coefficients lev_y=$lev_s = 0.7$ are required in response to an increase in interest rate. The Monetary tightening alone does not ensure financial stability. The strong MPR acts as a complement to monetary policy. Nonetheless, the optimal response of MPR to interest rate changes is not symmetric. The moderate MPR is needed to manage leveraging for monetary loosening for all countries. The moderate MPR with feedback coefficients approximately lev_y=lev_s $= 0.5$ are associated with the monetary loosening.

14. Conclusions

This study develops a New Keynesian DSGE framework with financial frictions and an active macro-prudential regulation (MPR) rule to examine the interaction between monetary policy and financial stability in Asian economies. By integrating a banking sector with endogenous leverage, capital quality shocks, and credit spreads, the model captures the amplification channels that traditional DSGE frameworks often overlook. Using Bayesian estimation for Thailand, China, Indonesia, and South Korea, the analysis provides several key insights.

In the absence of MPR, leverage and spreads respond excessively to financial and real shocks, amplifying output and credit volatility. By explicitly incorporating MPR—designed to be countercyclical with respect to output and procyclical with respect to spreads, the MPR smooths credit cycles by tightening leverage constraints during booms and relaxing them during downturns. This reduces systemic risk, mitigates excessive credit growth, and prevents sharp deleveraging, thereby enhancing financial stability. The results show that MPR produces very different policy stances across shocks. For the negative capital quality shock and monetary tightening, the MPR stance is loosening. On the other hand, the MPR stance is tightening for the positive technology shock. However, under the positive fiscal policy shock, the MPR stance is mixed. Output channel tightens but spread channel loosens. Fiscal driven credit boom may still occur.

The Bayesian estimates reveal important structural differences. The empirical results highlight important cross-country heterogeneity. Thailand and South Korea emphasize strong inflation targeting and balanced prudential frameworks, China prioritizes output stabilization but maintains relatively weaker MPR, while Indonesia combines aggressive monetary policy with high leverage persistence. Despite these heterogeneities, the model comparison results indicate that across all four economies, the combined framework (Taylor rule and MPR) consistently outperforms a simple Taylor rule in terms of posterior likelihood.

Welfare analysis further indicates that moderate MPR rules are optimal and deliver the greatest consumption-equivalent gains under a negative capital quality. In contrast, strong MPR is particularly valuable in the face of monetary tightening, when rising spreads and declining net worth call for regulatory support to prevent excessive deleveraging.

The findings suggest that relying on conventional monetary policy alone is insufficient to ensure macro-financial stability, particularly in emerging Asian economies characterized by high leverage and bank-dependent credit systems. An integrated policy framework combining interest-rate rules with macro-prudential tools is necessary to contain systemic risks, improve monetary transmission, smooth credit and business cycles, and enhance welfare by reducing output volatility and financial fragility. This coordinated framework enhances the central bank's ability to manage both price stability and financial stability, which is particularly important in economies where credit cycles and business cycles are imperfectly synchronized

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