Australian National University

Crawford School of Public Policy

CAMA

Centre for Applied Macroeconomic Analysis

Adding Macroprudential Policy to the Mix: When Monetary, Fiscal and Macroprudential Authorities Interact

CAMA Working Paper 64/2025
November 2025

Richard Dennis
University of Glasgow
Centre for Applied Macroeconomic Analysis, ANU

Pelin Ilbas
National Bank of Belgium

Abstract

We examine a framework in which fiscal, monetary, and macroprudential policies interact. We study a range of settings in which policy is conducted optimally, allowing for cooperative, non-cooperative and leadership policy frameworks. We find that there are important interactions between the three policies such that (full) cooperation involving all three policymakers offers substantial advantages over non-cooperation. Importantly, we find that much of the gain to full cooperation can be achieved through a partial cooperation setting whereby monetary policy and macroprudential policy cooperate while remaining independent of fiscal policy. This finding supports institutional frameworks in which macroprudential policy is conducted by central banks or from within central banks. Partial cooperation involving fiscal policy and macroprudential policy performs poorly, leading to worse outcomes than non-cooperation. Our findings are robust to a range of alternative settings involving different assignment of objectives. For our model, we find little or no advantage to policy leadership.

Keywords

Monetary policy, macroprudential policy, fiscal policy, policy interaction, policy coordination

JEL Classification

E42, E44, E52, E58, E61

Address for correspondence:

(E) cama.admin@anu.edu.au

ISSN 2206-0332

Adding Macroprudential Policy to the Mix: When Monetary, Fiscal and Macroprudential Authorities Interact*

Richard Dennis[†]
University of Glasgow and CAMA

Pelin Ilbas[‡]
National Bank of Belgium

November, 2025

Abstract

We examine a framework in which fiscal, monetary, and macroprudential policies interact. We study a range of settings in which policy is conducted optimally, allowing for cooperative, non-cooperative and leadership policy frameworks. We find that there are important interactions between the three policies such that (full) cooperation involving all three policymakers offers substantial advantages over non-cooperation. Importantly, we find that much of the gain to full cooperation can be achieved through a partial cooperation setting whereby monetary policy and macroprudential policy cooperate while remaining independent of fiscal policy. This finding supports institutional frameworks in which macroprudential policy is conducted by central banks or from within central banks. Partial cooperation involving fiscal policy and macroprudential policy performs poorly, leading to worse outcomes than non-cooperation. Our findings are robust to a range of alternative settings involving different assignment of objectives. For our model, we find little or no advantage to policy leadership.

Key words: Monetary policy, macroprudential policy, fiscal policy, policy interaction, policy coordination

JEL codes: E42, E44, E52, E58, E61

*The views and opinions expressed in this paper are our own and do not necessarily reflect those of the National Bank of Belgium or the Eurosystem. The authors would like to thank participants at the Computational Economics and Finance conference, Santiago, 2025, the Money, Macro, and Finance conference, Reading, 2025, the Frontiers of Macro-Labour workshop, Edinburgh, 2025, and our discussant Subhadeep Halder, and seminar participants at the Reserve Bank of New Zealand, Wellington, 2025.

[†]Address for Correspondence: University of Glasgow, email: richard.dennis@glasgow.ac.uk

[‡]Address for Correspondence: National Bank of Belgium; email: pelin.ilbas@nbb.be

1 Introduction

In the aftermath of the Global Financial Crisis (GFC), governments realized the importance of financial stability and began assigning more explicit roles and mandates to macroprudential policy. In some countries and jurisdictions, this has led to the creation of new institutional setups, making macroprudential policy an explicit player in a policy scene previously dominated by fiscal and monetary policy. For example, in the United Kingdom, financial supervision at the time of the GFC operated according to the tripartite system, which divided responsibility among the Bank of England, the Treasury, and the Financial Services Authority. The Financial Policy Committee (FPC) was established within the Bank of England in 2013 as part of a new regulatory system charged with improving financial stability in the aftermath of the financial crisis. The FPC contains internal and external members and meets regularly, much like the Monetary Policy Committee (MPC) that deliberates on monetary policy.[1]

In Europe, specific macroprudential powers and responsibilties were assigned to the ECB and the national prudential authorities in the context of the Single Supervisory Mechanism (SSM). However, in Canada, macroprudential policy is largely the responsibility of the Office of the Superintendent of Financial Institutions, which is a federal institution separate from the Bank of Canada. The Ministry of Finance also has powers to regulate banks and financial institutions. In New Zealand, macroprudential policy is the responsibility of the Reserve Bank of New Zealand, which has a dedicated Financial Stability department within the Bank focused on monitoring, analyzing, and regulating New Zealand's financial sector. In Australia, monetary policy is conducted by the Reserve Bank of Australia while macroprudential policy is the remit of the Australian Prudential Regulation Authority. Meanwhile, in the U.S., several institutions are responsible for banking and financial supervision, including the Office of the Comptroller of the Currency, the Federal Reserve System, and the Securities and Exchange Commission, all coordinated by the Financial Stability Oversight Council from within the U.S. Treasury.

The literature on policy interaction is large and diverse. Prominent early examples include Sargent and Wallace (1981) and Leeper (1991) in the context of monetary and fiscal policy and Cooper (1971) in the context of competitive devaluations. Reflecting macroprudential policy's more prominent role following the GFC, a body of literature developed that

[1] There is overlap among the internal members that serve on each committee. However, the FPC meets four times per year whereas the MPC meets eight times per year.

focused on the interaction between macroprudential policy and monetary policy. Examples include Angelini et al. (2012), Bean et al. (2010), Beau and Mojon (2014), Quint and Rabanal (2014), De Paoli and Paustian (2017), Gelain and Ilbas (2017), and Dennis and Ilbas (2023), and the references therein. During the Covid-pandemic, considerable interest re-centered on cooperation between monetary and fiscal policy, leading to increased policy debates and economic analyses with little or no explicit attention to the role of active macroprudential policy therein (see, for example, the 23rd Geneva report on the World Economy by Bartsch et al. (eds), 2020). However, now that macroprudential policy is an important player in the policy field, the appropriate policy mix following shocks and crises should include macroprudential policy in addition to monetary and fiscal policy. Accordingly, this paper contributes to the policy and academic literature by extending the two-policymaker setup, which has so far focused on either the monetary-fiscal or the monetary-macroprudential mix, by assigning each of the three policies an explicit role in the mix. We therefore consider a framework consisting of three policymakers operating interactively, in the context of a calibrated general equilibrium model featuring nominal, real and financial frictions.

As emphasized above, different countries have adopted widely varying institutional policy frameworks, frameworks that grant macroprudential policy, in particular, with quite different levels of operational independence from monetary and fiscal authorities. The policy instruments and level of operational independence granted to macroprudential policy can be important for the business cycle, particularly during times of financial stress or crisis. Therefore, setting appropriate coordination mechanisms among the three policies is important for efficient policy design. By allowing fiscal, monetary and macroprudential policy to strategically interact, we aim to distinguish between policy coordination schemes that perform best in terms of achieving macroeconomic stability. This will also allow us to assess to which extent those schemes are facilitated by the existing institutional (non-)cooperative frameworks in which these policies currently operate.

The model we study is closely related to Gertler and Karadi (2011), extended to have roles for fiscal policy alongside monetary and macroprudential policy and for these policies to be conducted optimally under discretion. Each policymaker is assigned a loss function according to its mandate, to be minimized in the context of a dynamic game that is either cooperative or non-cooperative. Following the methodology outlined in Dennis and Ilbas (2023), we consider simultaneous-move and leadership settings under non-cooperative discretionary policy. To our knowledge, the three-policymaker setting, where monetary, macroprudential and fiscal policy with separate instruments and separate objectives strategically interact, has not been analyzed previously.

Our main findings are fourfold. First, full cooperation between the three policies, i.e. the case where the individual objectives are combined and all three policies act as a single policy maker, outperforms non-cooperation. Of course, full cooperation might not be feasible and/or desirable in practice.[2] Second, we show that the case of partial cooperation in which monetary policy and macroprudential policy cooperate closely, and act independently of fiscal policy, approaches the stabilization benefits of the full cooperation case. This finding supports an institutional framework in which the central bank is charged with macroprudential policy, or when there is close cooperation between monetary and macroprudential entities within the central bank. Third, the alternative case of partial cooperation involving fiscal and macroprudential policy performs poorly, leading to worse outcomes than non-cooperation. Fourth, we find little or no advantage to policy leadership in the model we study. Our findings are robust to a range of alternative settings that involve different assignment of objectives, including the case where monetary policy shares with fiscal policy the objective of stabilizing government debt.

The remainder of this paper is organized as follows. We describe the modeling framework in Section 2. Section 3 explains the monetary, macroprudential and fiscal policy framework adopted throughout the paper. Section 4 presents the results of the strategic interactions between the three policies, while Section 5 explores a range of partial cooperation settings where the policies are paired. Section 6 presents alternative scenarios to assess the robustness of the benchmark policy setting. Finally, Section 7 concludes.

2 Model

The model that we use takes its market-structure from Gertler and Karadi (2011). To provide an overview, the economy is populated by households, retail firms, intermediate-good producing firms, capital-good producing firms, and banks, and on the policy-side by a central bank, a fiscal authority, and a macroprudential authority. Intermediate-good producing firms hire labor from households and purchase capital from capital-good producing firms, selling their output to retail firms in a perfectly competitive market. Retail firms purchase

[2]For instance, the political economy considerations that motivate monetary policy's independence (Cukierman, 1992; Alesina and Summers, 1993) from fiscal policy and central government are not reflected in the Gertler-Karadi model.

intermediate goods, re-brand them, and sell the re-branded goods in a monopolistically competitive market at a price that is subject to a Calvo-style price rigidity. Banks take deposits from households and make one-period loans to intermediate-good producers, who use the loans to purchase capital. Once production occurs, the undepreciated capital is sold back to the capital-good producers, with the proceeds used to repay the loan. Households consist of workers and bankers; workers supply labor to intermediate-good producing firms, consume goods purchased from retail firms, purchase government bonds, and place deposits with banks, which are modeled according to Gertler and Karadi (2011).

2.1 Households

There is a unit-continuum of households that gain utility by consuming goods (subject to an internal consumption habit) and leisure and that can save by either purchasing one-period nominal bonds from the government or by placing deposits with banks. The decision problem for the representative household is to choose $\left\{c_t, h_t, d_{t+1}^n, b_{t+1}^n\right\}_{t=0}^{\infty}$ to maximize their expected discounted lifetime utility:

$$U = E_0\left[\sum_{t=0}^{\infty}\beta^t\left(\frac{\left(\left(e^{\vartheta_t}\left(c_t - bc_{t-1}\right)\right)^{1-\phi}\left(1-h_t\right)^{\phi}\right)^{1-\sigma} - 1}{1-\sigma}\right)\right], \tag{1}$$

where $\beta \in (0,1)$, $\sigma \in (0,\infty)$, $\phi \in (0,1)$, $b \in (0,1)$, and ϑ_t is a consumption preference shock, subject to the (real) flow-budget constraint:

$$c_t + \frac{d_{t+1}^n}{P_t} + \frac{b_{t+1}^n}{P_t} = \left(1-\tau_t\right) w_t h_t + \frac{R_{t-1} d_t^n}{P_t} + \frac{R_{t-1}^b b_t^n}{P_t} + \Gamma_t. \tag{2}$$

In terms of notation, c_t denotes consumption, h_t denotes hours-worked, d_t^n denotes nominal deposits held with banks at the beginning of period t, b_t^n denotes nominal bond-holdings at the beginning of period t, P_t denotes the price of the consumption aggregate, w_t denotes the hourly real wage, R_t denotes the gross nominal interest rate on deposits made during period t, R_t^b denotes the gross nominal interest rate on bonds, τ_t denotes the tax rate on labor income, and Γ_t denotes real earning from the household's ownership of banks and firms.

The first-order conditions from the household's decision problem can be expressed in the form:

$$
\begin{aligned}
u_{ct} &= (1-\phi)e^{\vartheta_t}\left(e^{\vartheta_t}\left(c_t - bc_{t-1}\right)\right)^{(-\phi-\sigma(1-\phi))}\left(1-h_t\right)^{(\phi(1-\sigma))}, && (3)\\
u_{ht} &= -\phi\left(e^{\vartheta_t}\left(c_t - bc_{t-1}\right)\right)^{((1-\sigma)(1-\phi))}\left(1-h_t\right)^{(\phi-1-\sigma\phi)}, && (4)\\
\lambda_t &= u_{ct} - \beta b E_t\left[u_{ct+1}\right], && (5)\\
\lambda_t &= \beta E_t\left[R_t\frac{\lambda_{t+1}}{\pi_{t+1}}\right], && (6)\\
-\frac{u_{ht}}{\lambda_t} &= (1-\tau_t)w_t, && (7)\\
R_t^b &= R_t, && (8)
\end{aligned}
$$

where λ_t is the Lagrange multiplier on the budget constraint and represents the marginal value of an extra unit of consumption, u_{ct} is the derivative of momentary utility with respect to consumption, and u_{ht} is the derivative of momentary utility with respect to hours-worked.

2.2 Retail firms

The retail sector is monopolistically competitive and firms set prices subject to a Calvo-style price rigidity. The representative retail-firm purchases intermediate goods at the competitive (real) market price, p_t^m. These goods are then transformed costlessly into a differentiated retail good that is sold to a final-good aggregator. There is a unit-continuum of retail firms indexed by $j \in [0,1]$. The decision problem for the j'th retail firm is to choose its price, $p_t(j)$, to maximize:

$$
\Omega_t(j) = E_t\left[\sum_{s=0}^{\infty}(\beta\zeta)^t\frac{\lambda_{t+s}}{\lambda_t}\left(\frac{p_t(j)}{P_{t+s}} - p_{t+s}^m\right)y_{t+s}(j)\right], \tag{9}
$$

where $y_t(j)$ denotes the quantity of intermediate-goods purchased (and the quantity of retail-goods sold) and $\zeta \in (0,1]$, the probability that the retail-firm cannot change its price, governs the Calvo-price rigidity. Differentiating equation (9) with respect to $p_t(j)$, the first-order condition is:

$$
E_t\left[\sum_{s=0}^{\infty}(\zeta\beta)^t\frac{\lambda_{t+s}}{\lambda_t}\left(\frac{y_{t+s}(j)}{P_{t+s}} + \left(\frac{p_t(j)}{P_{t+s}} - p_{t+s}^m\right)(-\varepsilon_t)\left(\frac{p_t(j)}{P_{t+s}}\right)^{-\varepsilon_t-1}\frac{Y_{t+s}}{P_{t+s}}\right)\right] = 0, \tag{10}
$$

where $\varepsilon_t > 1$ is the (stochastic) price elasticity of demand. Equation (10) can be written recursively as:

$$\frac{p_t(j)}{P_t} = \frac{s_t}{f_t}, \tag{11}$$

$$s_t = \frac{\varepsilon_t}{\varepsilon_t - 1}\lambda_t Y_t p_t^m + \zeta\beta E_t\left[\pi_{t+1}^{\varepsilon_t} s_{t+1}\right], \tag{12}$$

$$f_t = \lambda_t Y_t + \zeta\beta E_t\left[\pi_{t+1}^{\varepsilon_t - 1} f_{t+1}\right]. \tag{13}$$

The goods that retail firms produce are subsequently aggregated into a final good that is sold to households for consumption and to capital-good producers for investment. Final goods, Y_t, are produced according to the constant return to scale Dixit-Stiglitz technology:

$$Y_t = \left[\int_0^1 y_t(j)^{\frac{\varepsilon_t - 1}{\varepsilon_t}} dj\right]^{\frac{\varepsilon_t}{\varepsilon_t - 1}}, \tag{14}$$

so demand for the good produced by the j'th retail-firm is given by:

$$y_t(j) = \left(\frac{p_t(j)}{P_t}\right)^{-\varepsilon_t} Y_t. \tag{15}$$

Aggregating across retail-firms, price inflation for final goods, π_t, must satisfy:

$$1 = \zeta\pi_t^{\varepsilon_t - 1} + (1 - \zeta)\left(\frac{s_t}{f_t}\right)^{-\varepsilon_t}, \tag{16}$$

with price dispersion (the dispersion of relative prices across retail firms) evolving over time according to:

$$\Delta_t = (1 - \zeta)\left(\frac{s_t}{f_t}\right)^{-\varepsilon_t} + \zeta\pi_t^{\varepsilon_t}\Delta_{t-1}. \tag{17}$$

Due to monopolistic competition, retail firms earn profits in equilibrium. These profits, aggregated across retail-firms, are remitted lump-sum to households and form part of Γ_t.

2.3 Intermediate-good firms

The intermediate-good sector is perfectly competitive with firms making zero-profits in equilibrium. Intermediate goods are produced using capital and labor according to the Cobb-Douglas technology:

$$y_t = e^{a_t} k_t^{\alpha} h_t^{1-\alpha}, \tag{18}$$

where k_t denotes capital, a_t denotes an aggregate technology shock and the elasticity of output with respect to capital is $\alpha \in (0, 1)$. Intermediate-good producers hire labor in a perfectly competitive spot market. They do not own any capital, but purchase capital from capital-good producers, use it for production and then resell the undepreciated capital back to the capital-good producers. The capital that is to be used for production in period t is purchased at the beginning of period t at (real) price p_{t-1}^k. The undepreciated capital that remains after production occurs is sold back to the capital-good producers at the end of period t at price p_t^k. To purchase capital, the intermediate-good producers obtain state-contingent loans from banks.

Recall that the intermediate goods are sold at price p_t^m, so the decision problem for the representative intermediate-good producer is to choose k_t and h_t to maximize:

$$\Phi_t = p_t^m e^{a_t} k_t^{\alpha} h_t^{1-\alpha} - w_t h_t + p_t^k (1-\delta) k_t - \left(1 + r_t^k\right) p_{t-1}^k k_t, \tag{19}$$

taking p_t^m, w_t, p_t^k and r_t^k. The first-order conditions can be expressed as:

$$w_t = (1-\alpha) p_t^m \frac{y_t}{h_t}, \tag{20}$$

$$1 + r_t^k = \frac{\left(\alpha p_t^m \frac{y_t}{k_t} + p_t^k (1-\delta)\right)}{p_{t-1}^k}, \tag{21}$$

where r_t^k is the (net) real interest rate that the firm pays on its bank-loan.

2.4 Capital-good firms

Capital-good producing firms operate in a perfectly competitive market. They sell new capital to the intermediate-good producers, purchase the used capital after production has occurred, and they undertake (gross) investment, i_t, in order to repair capital and to produce new capital. Taking the real price of new capital, p_t^k, as given, their decision problem is to choose $\{i_t, k_{t+1}\}_{t=0}^{\infty}$ to maximize:

$$\Psi_t = E_0 \left[\sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \left(p_t^k k_{t+1} - p_t^k (1-\delta) k_t - i_t \right) \right], \tag{22}$$

subject to the production function for new capital:

$$k_{t+1} = (1-\delta) k_t + e^{\zeta_t} \left(1 - \frac{\psi}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 \right) i_t, \tag{23}$$

which reflects an investment adjustment cost that is regulated by $\psi \in [0, \infty)$ and allows for an investment-specific technology shock ζ_t.

Denoting the Lagrange multiplier on the capital accumulation equation (equation (23)) by q_t^k, the first-order conditions are:

$$p_t^k = q_t^k, \tag{24}$$

$$\begin{aligned} \lambda_t &= \lambda_t q_t^k e^{\zeta_t} \left(1 - \frac{\psi}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2 - \psi\left(\frac{i_t}{i_{t-1}}\right)\left(\frac{i_t}{i_{t-1}} - 1\right)\right) \\ &\quad + \psi\beta E_t\left[e^{\zeta_{t+1}}\lambda_{t+1}q_{t+1}^k\left(\frac{i_{t+1}}{i_t}\right)^2\left(\frac{i_{t+1}}{i_t} - 1\right)\right], \end{aligned} \tag{25}$$

which say that the real price of capital is equal to the marginal value to the firm of an addition unit of installed capital (equation 24) and that (gross) investment occurs up to the point where the value to the capital-good producing firm of an extra investment good (expressed in terms of consumption goods) is equal to the value to households of an additional consumption good (equation 25).

2.5 Banks

We will consider a stand-in representative bank to describe the banking/financial intermediation sector. Banks/financial intermediaries take deposits from households and lend these to the intermediate-good producers, who use these loans to finance the purchase of capital from the capital-good producers. In addition to the deposits from households, banks are also the recipient of capital injections from the government. These capital injections are financed by selling bonds to households that offer a return equal to that on deposits, while the injections themselves receive the expected real gross return $E_t\left[1 + r_{t+1}^k\right]$. As such, although there is a proportional efficiency cost, $\iota > 0$, on the capital injections that the government supplies, overall the government's macroprudential policy provides a positive net-return.

Following Gertler and Karadi (2011), we assume that the government finances a proportion of total intermediated assets, so that the aggregate balance sheet for financial intermediaries is:

$$q_t^k k_{t+1} = N_t + d_{t+1} + \varsigma_t q_t^k k_{t+1}, \tag{26}$$

where ς_t is the macroprudential policy instrument and d_{t+1} represents deposits (in real terms) received during period t. Equation (26) says that total bank lending (to finance the acquisition of capital for production in period $t + 1$) is equal to banks' net worth at the end of period t, N_t, plus deposits placed with banks during period t, plus the proportion of total lending financed by the government, $\varsigma_t q_t^k k_{t+1}$. Banks have the opportunity to divert a proportion of deposits, $\gamma \in (0,1)$, giving rise to a moral hazard problem. Therefore, in order for households to be willing to place deposits with banks it must be the case that:

$$V_t \geq \gamma \left(1 - \varsigma_t\right) q_t^k k_{t+1}, \tag{27}$$

which requires that the value of the operating bank, V_t, be no less that the value of the assets that the bank could divert.

Following Gertler and Karadi (2011), the value of operating banks can be written as a linear function of their lending and their net worth:

$$V_t = \nu_t \left(1 - \varsigma_t\right) q_t^k k_{t+1} + \eta_t N_t. \tag{28}$$

Banks optimally lend to intermediate good producers such that equation (27) holds as an equality. After substituting $V_t = \gamma \left(1 - \varsigma_t\right) q_t^k k_{t+1}$ into equation (28), total lending can be expressed as a multiple of net worth according to:

$$q_t^k k_{t+1} = \varphi_t N_t, \tag{29}$$

where:

$$\varphi_t = \left(\frac{1}{1 - \varsigma_t}\right) \left(\frac{\eta_t}{\gamma - \nu_t}\right), \tag{30}$$

is the leverage ratio. An increase in the proportion of lending financed by the government facilitates greater total lending from a given level of net worth and leads to an increase in the leverage ratio.

With banks receiving the gross real return $1 + r_{t+1}^k$ on their lending and paying the gross nominal rate R_t on deposits, the law-of-motion for real net worth is given by:

$$\begin{aligned}
N_{t+1} &= \left(1 + r_{t+1}^k\right) \left(1 - \varsigma_t\right) q_t^k k_{t+1} - \left(\frac{R_t}{\pi_{t+1}}\right) d_{t+1}, && (31)\\
&= \left(1 + r_{t+1}^k\right) \left(1 - \varsigma_t\right) q_t^k k_{t+1} - \left(\frac{R_t}{\pi_{t+1}}\right) \left(\left(1 - \varsigma_t\right) q_t^k k_{t+1} - N_t\right), && (32)\\
&= \left(1 + r_{t+1}^k - \frac{R_t}{\pi_{t+1}}\right) \left(1 - \varsigma_t\right) \varphi_t N_t + \frac{R_t}{\pi_{t+1}} N_t, && (33)\\
&= z_{t+1} N_t, && (34)
\end{aligned}$$

where:

$$z_t = \left(1 + r_t^k - \frac{R_{t-1}}{\pi_t}\right) \left(1 - \varsigma_{t-1}\right) \varphi_{t-1} + \frac{R_{t-1}}{\pi_t}. \tag{35}$$

Every period there is the probability $\theta \in [0, 1]$ that a banker will not survive (continue as a bank), but will instead be replaced by a new banker and revert to being a household. Accordingly, total net worth can be divided into the net worth contributed by incumbent bankers, Ne_t, and that contributed by new bankers, Nn_t:

$$N_t = Ne_t + Nn_t. \tag{36}$$

new bankers are capitalized according to a share, $\omega \in [0, 1]$, of bank lending:

$$Nn_t = \omega(1 - \varsigma_t)q^k_{t-1}k_t, \tag{37}$$

while the net worth of incumbent banks is given by:

$$Ne_t = \theta z_t N_{t-1}. \tag{38}$$

Because there is a credit spread such that the return on lending is higher than the deposit interest rate, bankers aim to maximize the consumption value of their expected terminal net worth, i.e., they maximize:

$$V_t = (1 - \theta)\, E_t \left[\sum_{i=0}^{\infty} \theta^i \beta^{i+1} \frac{\lambda_{t+1+i}}{\lambda_t} N_{t+1+i} \right], \tag{39}$$

subject to equation (33). Provided there is a positive credit spread in equilibrium, banks maximize their value by lending until equation (27) holds with equality (equality holds with positive lending and with banks having positive value provided $\gamma > \nu_t$). Equation (39) can be written recursively as:

$$V_t = (1 - \theta)\, \beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t} N_{t+1} \right] + \theta\beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t} V_{t+1} \right], \tag{40}$$

where net worth changes over time according to equation (33). With the conjectured solution taking the form of equation (28), equating coefficients gives:

$$\nu_t = (1 - \theta)\beta E_t \left[\left(\frac{\lambda_{t+1}}{\lambda_t} \right) \left(1 + r^k_{t+1} - \frac{R_t}{\pi_{t+1}} \right) \right] + \beta\theta E_t \left[\left(\frac{\lambda_{t+1}}{\lambda_t} \right) j_{t+1}\nu_{t+1} \right], \tag{41}$$

$$\eta_t = (1 - \theta) + \beta\theta E_t \left[\left(\frac{\lambda_{t+1}}{\lambda_t} \right) z_{t+1}\eta_{t+1} \right], \tag{42}$$

$$j_t = \frac{\varphi_t (1 - \varsigma_t)}{\varphi_{t-1} (1 - \varsigma_{t-1})} z_t, \tag{43}$$

where equation (41) is obtained after making use of equations (29) and (34) and equation (42) is obtained after making use of equations (6) and (34).

2.6 Government

The government has three policy instruments at its disposal: 1) the gross nominal interest rate, R_t, on nominal deposits and nominal government bonds, reflecting monetary policy; 2) the labor-income tax rate, τ_t, reflecting fiscal policy, and; 3) government financed bank lending, ς_t, reflecting macroprudential policy. On the spending side, government spending, G_t, is assumed to follow the process:

$$G_t = \overline{g} Y_t e^{g_t}, \tag{44}$$

where Y_t is aggregate real output, $\overline{g}$ is the steady state share of output devoted to government spending, and g_t is a government spending shock that is assumed to follow an AR(1) process. The government is not required to balance its budget each period, financing deficits by issuing nominal bonds, b_t^n, that are bought by households. Expressed in real terms, the government's budget constraint is given by:

$$b_{t+1} = \frac{R_{t-1}}{\pi_t} b_t + \overline{g} Y_t e^{g_t} - \tau_t w_t h_t - (r_t^k - \iota) \varsigma_t q_t^k k_{t+1}, \tag{45}$$

where $b_t = \frac{b_t^n}{P_{t-1}}$ represents the real value of outstanding nominal government bonds.

2.7 Aggregation

Aggregating across households and firms, we get the aggregate production function and the resource constraint:

$$\begin{aligned} \Delta_t Y_t &= e^{a_t} k_t^{\alpha} h_t^{1-\alpha}, & (46) \\ Y_t &= c_t + i_t + \overline{g} Y_t e^{g_t} + \iota \varsigma_t q_t^k k_{t+1}, & (47) \end{aligned}$$

where $\overline{g}$ denotes the steady state share of output devoted to government spending and g_t represents a government spending shock.

2.8 Parameterization

The model is parameterized to the quarterly frequency. For the banking sector specifically, the parameter values are drawn from Gertler and Karadi (2011). In particular, we set the deposit diversion fraction, γ, to 0.381, the transfer proportion to capitalize new banks, ω, to 0.002, the banking survival rate, θ, to 0.972, and the cost to government intermediation, ι, to 0.001. With these parameter values the steady state credit spread is equal to 98 basis points per year and the steady state leverage ratio is 4.8. These are very similar to Gertler and Karadi (2011), who have a 100 basis point credit spread and a leverage ratio of 4.

Table 1a: Parameter Values		
β	Discount factor	0.99
ϕ	Leisure's share in utility	0.60
σ	Intertemporal elasticity in utility	1.00
b	Consumption habit formation	0.70
ζ	Calvo price rigidity	0.70
$\overline{\varepsilon}$	Price elasticity of substitution	21.0
α	Cobb-Douglas production elasticity	0.36
δ	Depreciation rate	0.025
ψ	Investment adjustment cost	1.70
γ	Deposit diversion fraction	0.381
θ	Bankers' survival rate	0.972
ω	Proportional transfer to new banks	0.002
ι	Cost to government intermediation	0.001
$\overline{g}$	Steady state share of government spending	0.20
$\overline{\tau}$	Steady state tax rate	0.32
$\overline{\varsigma}$	Steady state lending fraction	0.15

For the parameters that guide household behavior, we set the discount factor, β, to 0.99, which is very standard, used across a wide range of general equilibrium models (see for example Smets and Wouters, 2003). The (inverse) elasticity of intertemporal substitution, σ, is set to 1, implying that momentary utility is linear-in-logs. The parameter, ϕ, which governs the weights assigned to leisure and habit-adjusted-consumption in utility is set to 0.6, producing a steady state share of time spent working equal to 0.33, which was suggested by Prescott (1986). The habit formation parameter, b, is set to 0.7, similar to Boldrin, Christiano, and Fisher (2001). Common values for b range from around 0.8 (Dennis, 2009; Gruber, 2004) to about 0.6 (Christiano, Eichenbaum and Evans, 2005). In the retail goods sector, the steady state price elasticity of demand, $\overline{\varepsilon}$, is set to 21, implying a steady state markup over material inputs of 5 percent and the Calvo price rigidity, ζ, is set to 0.7, implying an average duration between price changes of 10 months, or just over 3 quarters (Nakamura and Steinsson, 2008). In the intermediate-goods sector, the elasticity of output with respect to capital, α, is 0.36 and the rate of capital depreciation, δ, is equal to 0.025, or 10 percent per year. Finally, in the capital-goods sector, the investment adjustment cost parameter, ψ, is set to 1.7 (Gertler and Karadi, 2011). With regard to the government—monetary policy, fiscal policy, and macroprudential policy—these policies are all set optimally about an imposed steady state. In this imposed steady state, government spending makes up 20 percent of real GDP, tax revenues are 32 percent of real GDP, the debt-to-GDP ratio is 1.05, and the annualized inflation rate is 2 percent.

There are five shocks in the model: an aggregate technology shock, a government spending shock, a price elasticity shock, a consumption preference shock, and an investment-specific technology shock. These shocks are all assumed to follow AR(1) processes and are summarized in Table 1b.

Table 1b: Shock Processes

ρ_a	Aggregate technology persistence	0.95
ρ_g	Government spending persistence	0.90
ρ_ε	Price elasticity persistence	0.60
ρ_ϑ	Consumption preference persistence	0.95
ρ_ζ	Investment-specific technology persistence	0.76
σ_a	Aggregate technology sd	0.008
σ_g	Government spending sd	0.03
σ_ε	Price elasticity sd	0.04
σ_ϑ	Consumption preference sd	0.01
σ_ζ	Investment-specific technology sd	0.05

The shock-parameterizations shown in Table 1b are largely standard. The aggregate technology shock has a persistence of 0.95 and a standard deviation of 0.008 (Faia, 2008). The process for the consumption preference shock is similar to Furlanetto and Groshenny (2016) while that for the investment-specific technology shock is parameterized similarly to Greenwood, Hercowitz, and Krusell (2000). The process for the price elasticity shock draws on Dennis and Kirsanova (2025) while that for the government spending shock on Faia (2008).

3 Policy objectives

The environments that we study are all ones in which policy is undertaken purposefully in order to achieve a set of goals, or policy objectives. One common approach to determining an appropriate set of policy objectives is to focus on timeless-perspective commitment and to derive the objectives as a second-order accurate Taylor approximation of household welfare, an undertaking that is made easier when there is an optimal production subsidy in place so that the model's steady state is efficient. This approach leads to a quadratic loss/objective function that is molded by the various frictions/rigidities and market imperfections present in the model.

In what follows we take the alternative—primal approach—of specifying the policy objectives directly rather than formally deriving the second-order welfare approximation. We take the primal approach for several important reasons. First, we do not introduce a production subsidy in the model and income taxation is distortionary, and hence the model's nonstochastic steady state is inefficient. Second, although we investigate the nature and magnitude of time-inconsistency in the model, our focus is primarily on environments in which policy is conducted under discretion; Dennis (2022) shows that second-order accurate welfare approximation are generally unavailable under discretion when the steady state is inefficient. Third, the quadratic objective offered by a welfare approximation, is less meaningful in a non-cooperative policy setting because it is ambiguous how the various terms in the approximation should be parceled out to each policymaker.

Although our policy objectives are not derived from a welfare approximation, they are still guided by the frictions/rigidities and market imperfections in the model. At the same time, the policy objective functions are also guided by the explicit objectives typically delegated to operationally independent policy institutions, particularly in regard to monetary policy.

Two of the main inefficiencies in the model have their main impact on the model's steady state. First, monopolistic competition in the retail-goods sector leads retail firms to price above real marginal costs and to under-produce relative to the efficient equilibrium. This under-production of retail goods cascades down to lower demand for intermediate goods and capital goods. Second, government spending, while providing the need for taxation in the model, is an exogenous source of uncertainty that takes resources, wastefully preventing them from being used for consumption or investment. In addition to the above, the following frictions and market imperfections affect welfare through their impact on economic volatility:

- Sticky goods' prices. Goods prices in the retail sector are subject to a Calvo (1983) price rigidity that generates relative price heterogeneity and inefficient production across the retail sector. This inefficiency becomes more acute with higher inflation and gives rise to an inflation stabilization objective.

- Investment adjustment costs. The process by which existing capital is combined with new investment to produce new capital goods is subject to an investment adjustment cost. Investment volatility leads to inefficient capital-goods production and motivates an investment smoothing/volatility objective that we capture through an output gap stabilization objective.

- Distortionary taxation. The key source of government revenue is a distortionary proportional labor-income tax. The substitution effects arising from this labor income tax mean that Ricardian equivalence does not hold in its strictest form and the deadweight losses arising from the tax motive a tax-smoothing objective.

- Moral hazard in the banking sector. The banking sector admits a moral hazard problem whereby bankers can abscond with a proportion of assets when a bank's value is low. The value of a bank and the value of a bank's assets are driven by the product of leverage and net worth. We capture the cost associated with this moral hazard problem through stabilization objectives for banks' leverage and net worth.

3.1 Non-cooperative objectives

In non-cooperative settings each policymaker has its own distinct policy objective function. Although the objectives may have some terms in common, they are not perfectly aligned so that the policymakers are ultimately trying to achieve different things, and the actions of one policymaker may interfere or attempt to offset the actions of another. Motivated by the frictions and market imperfections described above, the objectives attributed to fiscal policy, monetary policy, and macroprudential policy are now discussed in turn.

3.1.1 Fiscal policy objective

The policy goals attributed to the fiscal authority are summarized through the objective function:

$$L^f = E_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\widehat{y}_t^2 + \lambda_b \widehat{b}_t^2 + \lambda_\tau \tau_t^2 \right) \right], \tag{48}$$

where $\beta \in (0,1)$, $\lambda_b \in (0,\infty)$, and $\lambda_\tau \in (0,\infty)$. With this objective function, the fiscal authority is assumed to be concerned about output gap stability, keeping government debt-to-GDP stable, and ensuring that tax rates are not too volatile. The fiscal authority's concern for debt stability helps to ensure that fiscal policy is passive while the tax-stability objective is motivated on the welfare benefits of tax-smoothing (Barro, 1979). As a benchmark, we set $\lambda_b = 1.0$, and $\lambda_\tau = 0.1$.

3.1.2 Monetary policy objective

The monetary policy objective function is standard:

$$L^m = E_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\widehat{y}_t^2 + \lambda_\pi \pi_t^2 + \lambda_R R_t^2 \right) \right], \tag{49}$$

where $\beta \in (0,1)$, $\lambda_\pi \in (0,\infty)$, and $\lambda_R \in (0,\infty)$. The central bank seeks to keep inflation and the output gap stable, while ensuring that nominal interest rates are not overly volatile, which is justified by financial stability and zero lower bound concerns, as discussed in Giannoni and Woodford (2003). The inflation stabilization goal is motivated on minimizing the welfare cost of inefficient retail-goods production and by helping to ensure that monetary policy is active in equilibrium. The benchmark loss function for monetary policy has $\lambda_\pi = 1.0$ and $\lambda_R = 0.1$.

3.1.3 Macroprudential objective

We assume that the policy objectives for the macroprudential authority are given by:

$$L^p = E_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\widehat{y}_t^2 + \lambda_\varphi \widehat{\varphi}_t^2 + \lambda_n \widehat{n}_t^2 + \lambda_\varsigma \varsigma_t^2 \right) \right], \tag{50}$$

where $\beta \in (0,1)$, $\lambda_\varphi \in (0,\infty)$, $\lambda_n \in (0,\infty)$, and $\lambda_\varsigma \in (0,\infty)$. This objective function assumes that the macroprudential authority seeks to keep the output gap stable while also being focused on ensuring stability in the banking/financial sector by stabilizing variation in leverage, net-worth, and the level of government intermediation. The benchmark loss function has $\lambda_\varphi = 0.5$, $\lambda_n = 0.5$, and $\lambda_\varsigma = 0.1$.

3.2 Cooperative objective

The non-cooperative objective functions presented above are intended to reflect a particular parceling out of a combined cooperative objective function. Accordingly, in cooperative policy settings the objective function—shared by all three policymakers—is taken to be:

$$L = E_0 \left[\sum_{t=0}^{\infty} \beta^t \left(3\widehat{y}_t^2 + \lambda_b \widehat{b}_t^2 + \lambda_\pi \pi_t^2 + \lambda_\varphi \widehat{\varphi}_t^2 + \lambda_n \widehat{n}_t^2 + \lambda_\tau \tau_t^2 + \lambda_R R_t^2 + \lambda_\varsigma \varsigma_t^2 \right) \right], \tag{51}$$

which is simply the sum of L^f, L^m, and L^p.

As mentioned previously, it is ambiguous how the various terms in a cooperative policy objective functions should get divvied out to fiscal policy, monetary policy, and macroprudential policy in non-cooperative settings. For this reason, in Section 6.2 we consider an alternative allocation whereby debt stabilization is shared by both fiscal and monetary policy, ensuring monetary policy must be cognizant of the effects its interest rate decisions have on government debt, a characteristic of passive monetary policy (Leeper, 1991).

4 Results

In this Section we consider a range of cooperative and non-cooperative policy environments, focusing initially on the case where the three policies are conducted simultaneously (Section 4.1). We begin by quantifying the nature of the stabilization bias in the model, and by identifying the various sources of time-inconsistency. We do so by focusing on a setting where policies are undertaken simultaneously, with the optimal commitment policy serving as a benchmark against which cooperative and non-cooperative discretionary policies can be compared. We introduce the policy objectives associated with fiscal, monetary, and macroprudential policy and explain the relationship between these objectives under cooperation and non-cooperation. Subsequently, we consider leader-follower policymaking in the non-cooperative setting in Section 4.2, where one of the three polices acts as the leader, and show that policy leadership does not impact greatly our results.

4.1 Time inconsistency

We begin our analysis by considering decision-making environments in which all three policy instruments, i.e. the nominal interest rate, the average tax rate, and the government lending fraction, are set simultaneously. These three policy instruments will be set optimally to minimize a set of objectives, subject to the constraints provided by the model's structure. We examine frameworks in which the three policies are set optimally with commitment with cooperation, set optimally with discretion with cooperation, and set optimally with discretion with non-cooperation, where cooperation means that policy is conducted based on a common objective and non-cooperation allows each policymaker to have its own distinct objective function. By comparing commitment outcomes to discretionary outcomes with cooperation we can quantify the nature and magnitude of the discretionary stabilization bias present in the model, and by comparing discretionary outcomes with cooperation to discretionary outcomes with non-cooperation we can quantify the importance of cooperation to each of the three policymakers.

4.1.1 Sources of time-inconsistency

There are four core sources of time-inconsistency in the model, revealed by comparing the first-order conditions associated with commitment-policy to those with discretionary policy.

- Promises about future policy are used to manage expectations about future consumption/demand operating through the consumption-Euler equation. This channel is standard in models where there is a penalty applied to interest rate volatility, because the penalty prevents the interest rate from costlessly adjusting to offset demand shocks, so the central banks attempts to offset demand shocks by guiding private sector expectations about future demand.

- Promises about future policy are used to manage expectations about future inflation operating through the "Phillips curve". This channel is standard in sticky-price models where announcements about future policy can be used to better stabilize inflation today.

- Promises about future policy are used to manage expectations about the future real price of capital operating through the investment equation. A higher expected real price of capital in the future raises the real price of capital today, which increases the real value of the capital stock, increases banks' total lending, and exacerbates the banks' moral hazard problem.

- Promises about future policy are used to manage expectations about the future value/net-worth of banks operating through the banks' Bellman equation. A higher future expected net worth raises the value of banks today, which allows them to expand total lending and increases their moral hazard problem.

Because there are three policy instruments, each source of time-inconsistency is not uniquely associated with a single policy instrument. In particular, the time-inconsistency channel operating through the banks' Bellman equation is shaped importantly by both monetary policy and macroprudential policy.

4.1.2 Stabilization bias with simultaneous moves

To quantify the discretionary stabilization bias we focus on the cooperative problem where each policymaker's objective is given by equation (51) and solve the policy-problem under both commitment and discretion. For this exercise, we assume that the three policies are chosen simultaneously, although, because their objectives are the same, no policymaker would gain any advantage from being the policy leader. As an extension, we also solve the problem under discretion for the non-cooperative case where the policy objective functions are given by equations (48), (49), and (50). The results are shown in Table 2, where we report the standard deviations of the key macroeconomic variables and the policy instruments as well as the losses accruing to each policymaker and the cooperative loss. Differences in volatility between commitment and discretion arise because time-inconsistency causes discretionary policy to respond inefficiently to shocks, giving rise to a discretionary stabilization bias.

Table 2: Volatilities and Losses under Commitment and Discretion

	Cooperation		Non-cooperation
	Commitment	Discretion	Discretion
Variable	(1)	(2)	(3)
b	0.0019	0.0119	0.0084
$\widehat{c}$	0.0183	0.0166	0.0200
$\widehat{y}$	0.0087	0.0174	0.0271
π	0.0141	0.0111	0.0087
φ	0.0218	0.0232	0.0271
n	0.0234	0.0199	0.0199
τ	0.0175	0.0225	0.0231
R	0.0303	0.0238	0.0197
ς	0.0122	0.0134	0.0152
L^f		0.0480	0.0816
L^m		0.0463	0.0805
L^p		0.0737	0.1213
L	0.1019	0.1680	0.2833

Comparing columns (1) and (2), the cooperative loss under discretion (0.1680) is about 65 percent higher than that under commitment (0.1019), which corresponds to an inflation equivalent of about 0.25 percentage point per quarter (Jensen, 2002; Dennis and Söderström, 2005). Unlike for the canonical new Keynesian model (Clarida, Gali, and Gertler, 1999), where the discretionary stabilization bias manifests itself through higher inflation volatility and lower output volatility, here we see the opposite result, reflecting the many varied channels through which time-inconsistency operates in the model. In the canonical model, the central bank's inability to accurately guide private-sector inflation expectations leads to inflation being understabilized relative to output. In this model, however, the central bank operating with discretion cannot accurately guide private-sector expectations that operate through the banking sector and through investment adjustment costs, leading to output being understabilized relative to inflation, a result that is in line with Dennis and Ilbas (2023), and confirms the finding that the discretionary stabilization bias works differently in models with financial frictions. In our model, however, time-inconsistency matters for more than just the inflation-output trade-off, and higher inflation volatility can arise under commitment when policy promises are directed towards stabilizing the debt-to-GDP ratio rather than towards stabilizing inflation. Table 2 indeed shows that commitment does very well at stabilizing the debt-to-GDP ratio.

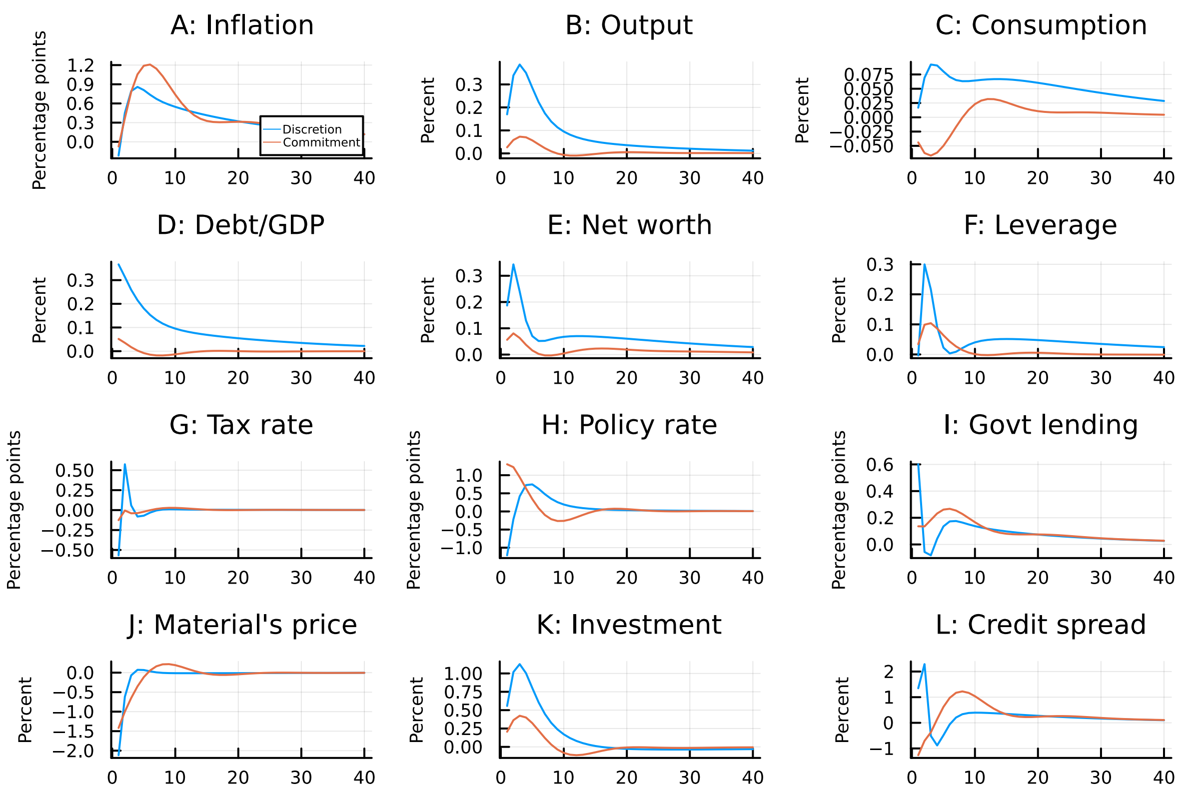
Looking now at columns (2) and (3), it is clear that economic outcomes and losses are much worse in the non-cooperative setting (column 3) than in the cooperative one (column 2). Not only does the combined loss increase in the non-cooperative setting, but each individual policymaker is worse off—no policymaker feels that the non-cooperative setting is to their advantage, despite the fact it allows each policymaker to focus on its own objectives and does, in fact, lead to lower inflation volatility. Interestingly, the percentage increase in loss each policymaker experiences when moving from the cooperative to the non-cooperative setting is similar, suggesting that the benefits to cooperation are shared proportionally.

4.1.3 Impulse response functions

Figure 1 compares the impulse responses to an aggregate technology shock under commitment and discretion. As expected, on impact the positive technology shock lowers the price of material inputs (panel J), which exerts downward pressure on inflation (panel A). At the same time, the technology shock leads to higher real output (panel B), which in turn causes consumption (panel C) and investment spending (panel K) to increase. With higher real income, households save more leading to an increase in banks' net worth (panel E). The real and financial variables turn out to be less responsive to this shock under commitment, while inflation spikes more under commitment, with monetary and fiscal policy instruments reacting more than macroprudential policy to counter the effects of the shock.

Figure 2 looks at a government spending shock. A shock to government spending acts much like a shock to aggregate demand. On impact, the government spending shock causes output to rise (panel B), along with the price of material inputs (panel J) and inflation (panel A). However, higher government spending has to be financed so the tax of labor income initially rises (panel G) and the goods that are allocated to government spending come at the cost of reduced consumption (panel C) and investment (panel K). Comparing the responses

Fig. 1: Responses to an aggregate technology shock

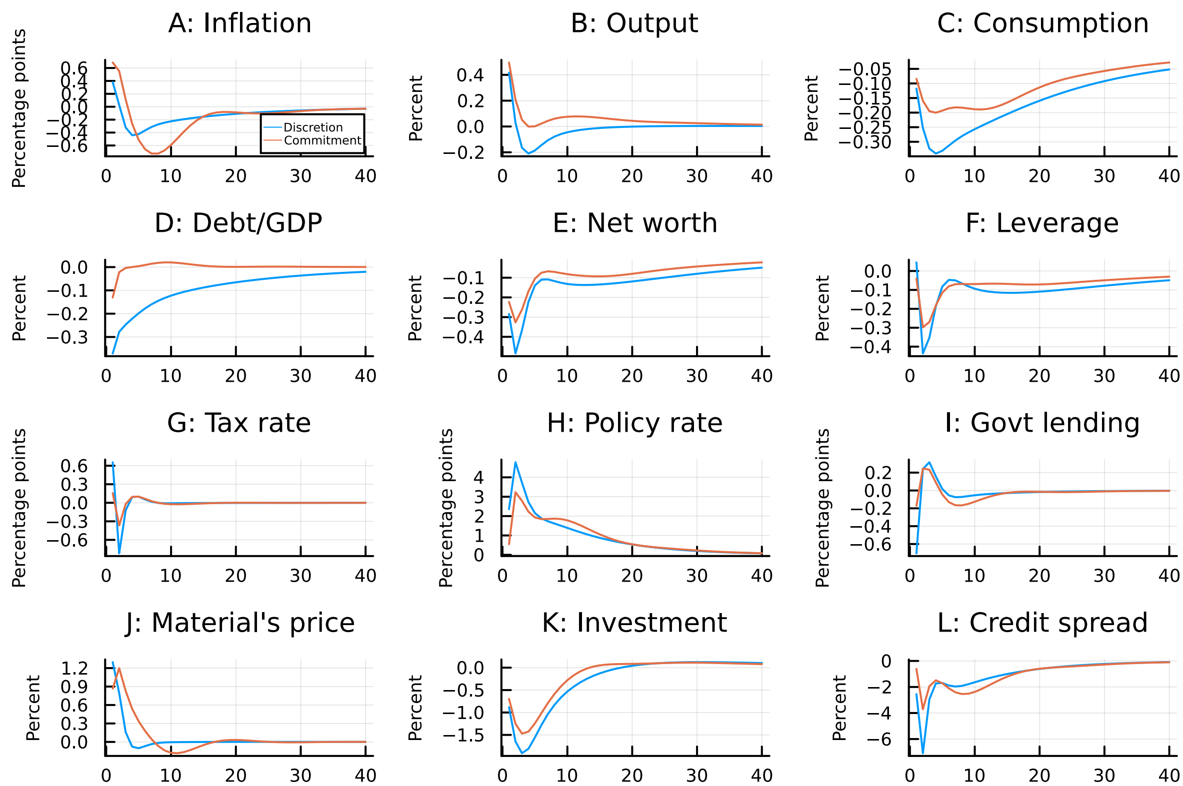


The figure considers the cooperative setting and shows the responses to a one standard deviation aggregate technology shock that arise under commitment and discretion.

with commitment to those with discretion it is noticeable that the policy responses are all largely similar (panels G, H, and I), suggesting that time-inconsistency problems do not materially alter how policy responds to government spending shocks.

Turning to Figure 3, through the utility function, a positive consumption preference shock raises both the marginal utility of consumption and the marginal utility of leisure. It may seem surprising, therefore, that on impact the positive consumption preference shock leads to a fall in consumption. However, in this case, the increased demand for consumption goods generated by the shock is more than offset by a decline in consumption demand caused by rising interest rates (panel H). On balance, consumption falls (panel C), but only slightly. Two main results emerge from figure 3. First, quantitatively the responses caused by the shock are very small, suggesting that consumption preference shocks are not a large source of volatility in this model. Second, qualitatively the responses produced when policy is conducted with commitment are similar to those when it is conducted with discretion; the

Fig. 2: Responses to a government spending shock

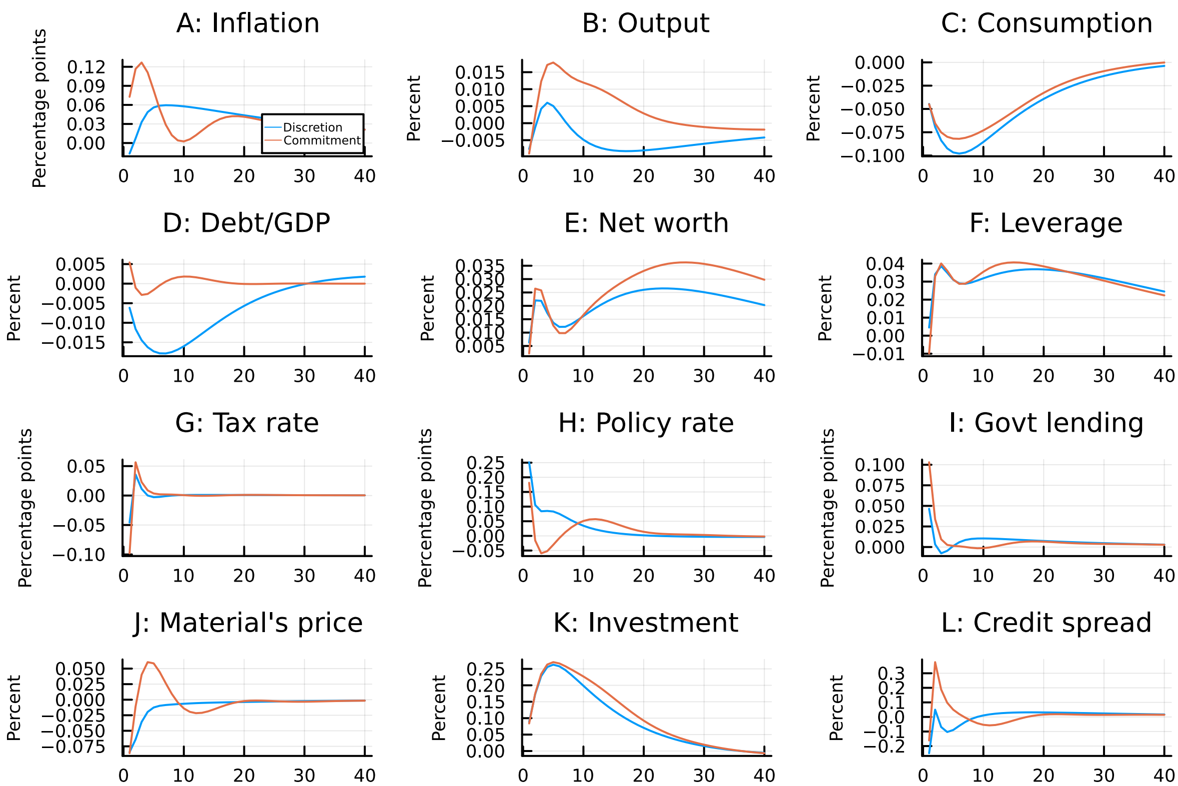


The figure considers the cooperative setting and shows the responses to a one standard deviation government spending shock that arise under commitment and discretion.

exception being inflation which rises slightly on impact with commitment but falls slightly with discretion.

Figure 4 displays the effect of a positive shock to the price elasticity of demand. An increase in the price elasticity of demand translates into a decline in the price markup. Accordingly, output rises (panel B) while the price of material inputs (panel J) and inflation (panel A) both fall. In this respect, the price elasticity shock behaves similarly to an aggregate technology shock (Figure 1). Higher output leads to higher consumption (panel C) and investment (panel K), and it increases banks' net worth (panel E). Qualitatively, the policy responses are different between commitment and discretion. Looking at the responses on impact, when policy is set with discretion the tax rate falls (panel G), the nominal interest rate falls (panel H), and the government lending fraction rises (panel I) whereas under commitment the tax rate rises and the government lending fraction falls. Beyond the impact period, qualitative differences between commitment and discretion persist, indicating

Fig. 3: Responses to a consumption preference shock

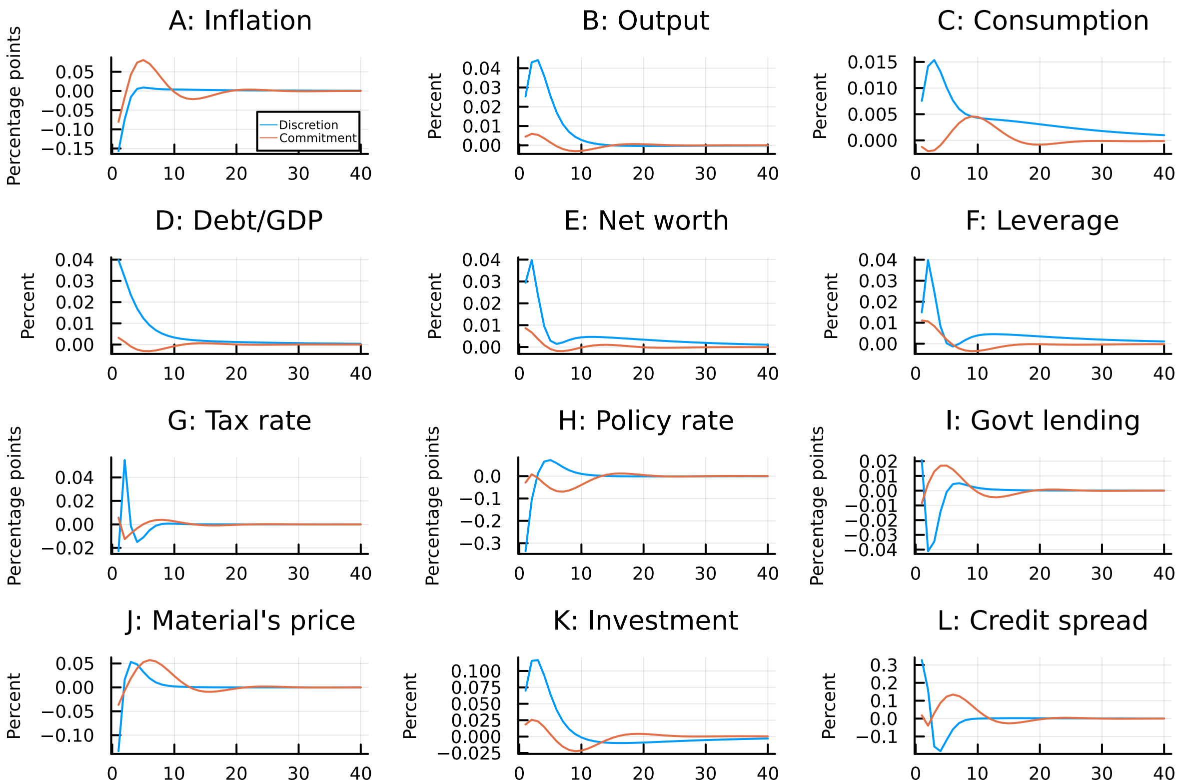


The figure considers the cooperative setting and shows the responses to a one standard deviation consumption preference shock that arise under commitment and discretion.

the importance of time-inconsistency in how policy responds to the shock.

The responses to an investment-specific technology shock are shown in Figure 5. A positive shock leads to a rise in investment (panel K) and output (panel B) and causes the price of material inputs (panel J) and inflation (panel A) to rise. In a non-cooperative setting monetary policy would respond to the higher inflation and higher output by raising the policy rate. In the cooperative setting, however, with the three policies working together, it is fiscal policy that responds by raising the marginal tax rate to damp aggregate demand. With more capital goods produced from investment spending there is a decline in Tobin's q and the price of capital goods goes down, driving down banks' net worth (panel E) and leverage (panel F). Monetary policy and macroprudential policy respond to cutting the nominal interest rate (panel H) and lowering the government lending fraction (panel I). The responses under commitment and discretion are very similar, which shows that time-inconsistency is not an important factor governing how policy responds to investment-specific technology shocks.

Fig. 4: Responses to a price elasticity shock



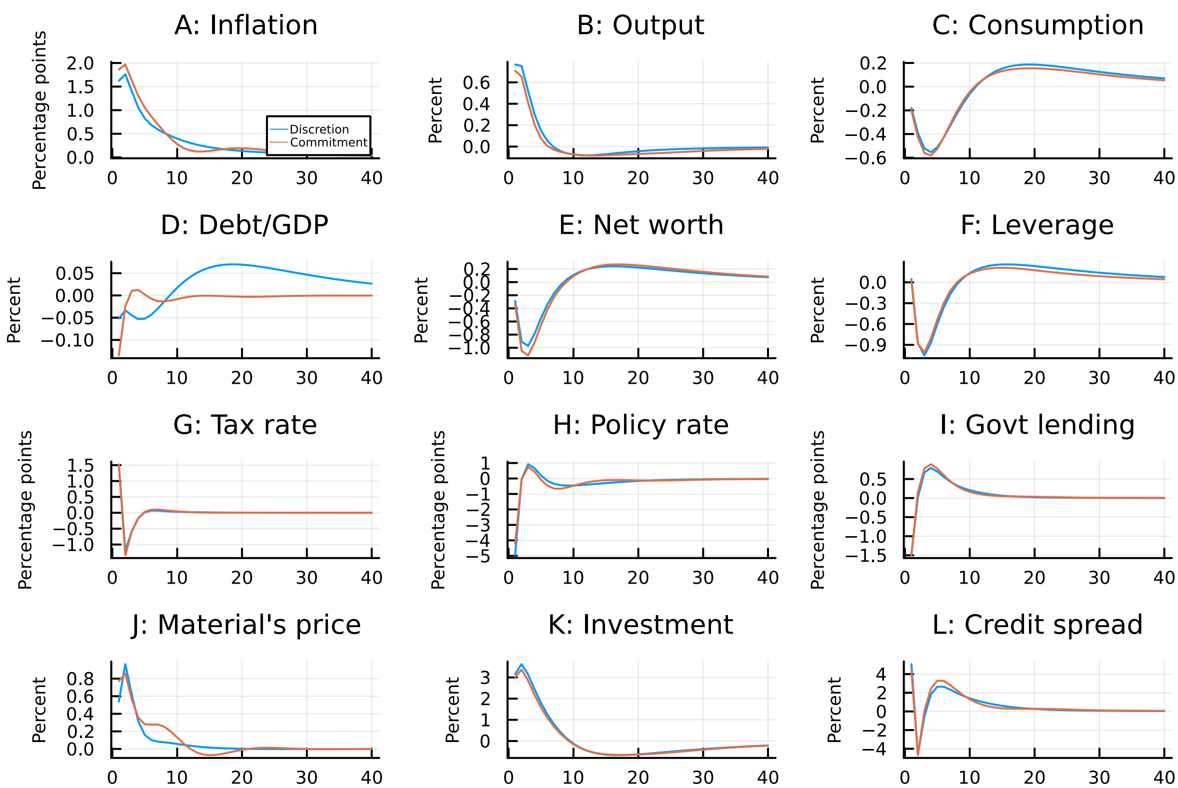
The figure considers the cooperative setting and shows the responses to a one standard deviation price elasticity shock that arise under commitment and discretion.

4.2 Non-cooperative cases

The previous Section focused on the cooperative decision-making environment. In this Section we look more closely at non-cooperative decision-making, where each policymaker operates independently and has its own objectives, expanding on the case shown in Table 2, column 3. Specifically, Table 2, column 3, assumed non-cooperation and that each policymaker operated independently although setting policy simultaneously. In contrast, here we consider the case where one policymaker has a leadership—first-mover—advantage over the remaining two policymakers.

A policymaker that has leadership, or a first-mover advantage, is assumed to choose and reveal its policy prior to the other two policymakers (which in turn make and reveal their decisions prior to the private sector). As a consequence, just as policymakers take the private sector's reaction into account when formulating policy, a policymaker with leadership will

Fig. 5: Responses to an investment-specific technology shock



The figure considers the cooperative setting and shows the responses to a one standard deviation investment-specific technology shock that arise under commitment and discretion.

take the reactions of the other policymakers (as well as the private sector) into account when formulating policy. In the cooperative setting, leadership does not offer any policymaker an advantage because all policymakers are working toward a common objective. However, in the non-cooperative setting leadership gives a policymaker the ability to guide or nudge the other policymakers in order to better satisfy its own objective function.

In what follows, we allow each of the three policymakers to have the leadership role while assuming that the remaining two policymakers choose their policies simultaneously with each other. Clearly, other scenarios are possible: two policymakers could choose simultaneously while having a leadership advantage over the third policymaker, or one policymaker could have leadership over the second policymaker who in turn has leadership over the third policymaker—the possibilities proliferate.[3] Details regarding the solution algorithm can be

[3]We have examined all of the many possible leadership combinations; the differences in outcomes produced was small.

found in the technical Appendix of Dennis and Ilbas (2023).

Based largely on the frequency with which various policymakers formulate their policies, one might argue that fiscal policy and macroprudential policy have leadership over monetary policy. After all, fiscal policy is usually formulated at an annual frequency with little opportunity to react to other policies whereas monetary policy is routinely formulated at a much higher frequency providing ample opportunity to react to other policies. Similarly, macroprudential policy also tends to be formulated less frequently than monetary policy[4], suggesting that macroprudential policy might too have leadership over monetary policy.

For the results shown in Table 3 the objective functions summarized by equations (48), (49) and (50) are assigned to fiscal policy, monetary policy, and macroprudential policy, respectively. Columns (1), (2), and (3) respectively correspond to fiscal leadership, macroprudential leadership and, thirdly, monetary leadership. To provide a benchmark for comparison, also shown in Table 3 (column 4) are the results obtained when the three policies are chosen simultaneously.

Table 3: Volatility and Losses in the Non-Cooperative Setting with Leadership

	Leadership			Simultaneous
	Fiscal	Macroprudential	Monetary	
Variable	(1)	(2)	(3)	(4)
b	0.0083	0.0081	0.0087	0.0084
$\widehat{c}$	0.0200	0.0198	0.0201	0.0200
$\widehat{y}$	0.0271	0.0269	0.0273	0.0271
π	0.0087	0.0088	0.0085	0.0087
φ	0.0271	0.0253	0.0273	0.0271
n	0.0199	0.0213	0.0200	0.0199
τ	0.0230	0.0235	0.0233	0.0231
R	0.0197	0.0197	0.0201	0.0197
ς	0.0152	0.0146	0.0153	0.0152
L^f	0.0817	0.0807	0.0834	0.0816
L^m	0.0807	0.0799	0.0815	0.0805
L^p	0.1215	0.1187	0.1228	0.1213
L	0.2838	0.2793	0.2877	0.2833

From Table 3 we find that, although the differences across cases are quantitatively very small, macroprudential leadership yields the best outcome in terms of the overall loss (L), as well as from the perspective of the three individual policymakers. While the result

[4]As we noted in the Introduction, the Bank of England's FPC meets four times per year where its MPC meets eight times.

that monetary and fiscal policies do not gain as much from their own leadership may seem counter-intuitive, this result arises due to the out-sized impact that macroprudential policy has in this model. In this model, a financial disruption has large real effects making banking stability paramount. As a consequence, to better satisfy its own objectives any policy leader must first ensure that the banking sector is stable. This is one of the main lessons learned from the GFC.

In general, however, the main message from Table 3 is that although macroprudential policy has a leadership advantage, quantitatively the value of this advantage is small in this model, producing relatively negligible differences in performance across cases. For this reason, in the following sections we limit our attention to settings in which all policymakers move simultaneously.

5 Partial cooperation

Previous sections have shown that overall loss, L, as well as the losses received by each of the three policymakers, L^f, L^m, and L^p, are all lower in the cooperative setting than in the non-cooperative setting. When policy objectives are not aligned, separate policy instruments operating through closely related economic channels can interfere and disrupt each other, causing each policymaker to be worse off. Although having a single authority operate all three policy instruments may seem attractive in the discretionary setting, political economy considerations, separating economic policy from the political electoral cycle, for example, mean that it is generally thought to be desirable for the monetary authority and the macroprudential authority to have operational independence. However, granting monetary policy and macroprudential policy operational independence does not necessarily mean that these policies need to be conducted by separate authorities—rather that they should be separate from fiscal policy.

In this section, we explore several partial cooperation settings involving two of the three policymakers. Specifically, we ask how much of the gain from full cooperation can be achieved through partial cooperation settings whereby the macroprudential policy authority cooperates solely with either fiscal or monetary policy. Specifically, we consider the following partial cooperation settings: 1) fiscal and macroprudential cooperation; 2) monetary and macroprudential cooperation, and; 3) monetary and fiscal cooperation.[5] In the partial

[5]This third case is included largely for completeness. As noted in the Introduction the political economy considerations that normally motivate monetary policy being separated from government (Cukierman, 1992;

cooperation setting, the cooperative loss function for the two cooperating authorities is given by the sum of their respective loss functions. Thus, in the case of cooperation between fiscal and macroprudential policy their loss function is given by the sum of equations (48) and (50) while the loss function for the monetary authority is given by equation (49). As mentioned above, for these exercises we assume that all three policies are conducted simultaneously and that no authority has a leadership advantage. The results of these partial cooperation cases together with those for full cooperation and non-cooperation are shown in Table 4.

Table 4: Volatilities and Losses with Partial Cooperation

	Fiscal-Prud.	Mon.-Prud.	Fiscal-Mon.	Full Coop.	Non-Coop.
Variable	(1)	(2)	(3)	(4)	(5)
b	0.0221	0.0052	0.0121	0.0119	0.0084
$\widehat{c}$	0.0198	0.0172	0.0181	0.0166	0.0200
$\widehat{y}$	0.0274	0.0195	0.0227	0.0174	0.0271
π	0.0087	0.0107	0.0095	0.0111	0.0087
φ	0.0249	0.0242	0.0256	0.0232	0.0271
n	0.0227	0.0196	0.0195	0.0199	0.0199
τ	0.0275	0.0193	0.0249	0.0225	0.0231
R	0.0195	0.0225	0.0220	0.0238	0.0197
ς	0.0145	0.0138	0.0146	0.0134	0.0152
L^f	0.1236	0.0429	0.0697	0.0480	0.0816
L^m	0.0822	0.0521	0.0626	0.0463	0.0805
L^p	0.1229	0.0826	0.0973	0.0737	0.1213
L	0.3287	0.1777	0.2296	0.1680	0.2833

Table 4 illustrates several important results. First, the majority of the gains achieved from full cooperation can be obtained from a partial cooperation framework where the cooperation occurs between monetary and macroprudential policy. In this case, the combined loss, L, is approximately only six percent higher than full cooperation. Second, in addition to the partial cooperation involving monetary and macroprudential policy being better than the fiscal and macroprudential pairing, all three policymakers are better off in this case in the sense that the loss that each policy receives is lower than with non-cooperation. Third, the outcome when fiscal policy and macroprudential policy are asked to cooperate is very poor. Not only is the combined loss generated nearly three times larger than that for full-cooperation, but it is also 16 percent higher than the non-cooperative case and all three policymakers are worse off.

Alesina and Summers, 1993) are absent from the model, so this case is not of primary consideration.

Clearly, the key to whether partial cooperation can be successful resides with macroprudential policy cooperating with monetary policy; cooperation between fiscal policy and macroprudential policy is highly inefficient. In order to understand why cooperation involving monetary policy is so beneficial for macroprudential policy, it is important to recognize that the channels through which monetary policy operate in the model overlap greatly with macroprudenital policy and with fiscal policy, whereas there is little overlap in the channels through which fiscal policy and macroprudential policy operate. Monetary policy affects fiscal policy outcomes through the debt accumulation process whereby higher interest rates impact the level of taxation required to finance the increased cost of debt-servicing. At the same time, monetary policy interacts with macroprudential policy through the evolution of banks' net-worth and leverage, both of which affect how much capital banks can finance by extending loans to capital-producing firms. Cooperation involving monetary policy and macroprudential policy is important because it internalizes the interaction between monetary policy and macroprudential policy, prevents them from interfering or working against each other in the pursuit of their own independent objectives.

The results reported in Table 4 demonstrate that the best macroeconomic outcomes outside of full-cooperation are reached when monetary policy and macroprudential policy are asked to cooperate. This finding supports the institutional framework that is currently in place in the UK, New Zealand, and Europe, where central banks are charged with macroprudential policy tasks, or there is close cooperation between monetary and macroprudential entities within the same institution.

6 Alternative scenarios

In this section we focus on three alternatives to the benchmark policy setting analyzed above. The first alternative is a policy setting in which the banking sector variables that enter the macroprudential objective function receive greater weight. This scenario aims to reflect the greater emphasis placed on financial and banking sector stability following the GFC and the European debt crisis that followed. The second scenario is one in which inflation stabilization receives greater relative weight in the central bank's objective function, a setting designed to capture the behavior of a hawkish central bank. The final scenario we analyze is one in which monetary policy becomes less active in the sense of Leeper (1991). Here, although inflation stabilization remains a central feature in the central bank's policy objective function, it is also assumed that the central bank shares a concern with fiscal policy for debt stabilization.

With a weight assigned to debt stability in the central bank's loss function monetary policy becomes concerned with the implications their policy decisions have for government debt (somewhat similar to when monetary policy is passive), not just for inflation and the output gap.

6.1 Greater concern for financial stability

Here we consider a scenario in which macroprudential policy objectives are assigned greater importance, perhaps informally reflecting a greater awareness of the turmoil that can follow a financial sector crisis. To implement this scenario, we increase the weights assigned to bank leverage and net-worth from 0.5 to 1.0, so that the macroprudential loss function becomes:

$$L^p = E_0 \left[\sum_{t=0}^{\infty} 0.99^t \left(\widehat{y}_t^2 + 1.0\widehat{\varphi}_t^2 + 1.0\widehat{n}_t^2 + 0.1\varsigma_t^2 \right) \right], \tag{52}$$

while the objectives for monetary policy and fiscal policy remain unchanged. The policy setting is assumed to be one in which the three policymakers move simultaneously. The results are shown in Table 5, and can be compared to Tables 2 and 4.

Table 5: Greater Concern for Financial Stability

	Fiscal-Prud.	Mon.-Prud.	Fiscal-Mon.	Full Coop.	Non-Coop.	Commit.
Variable	(1)	(2)	(3)	(4)	(5)	(6)
b	0.0083	0.0082	0.0087	0.0101	0.0083	0.0022
$\widehat{c}$	0.0200	0.0198	0.0201	0.0162	0.0200	0.0175
$\widehat{y}$	0.0271	0.0269	0.0273	0.0161	0.0271	0.0105
π	0.0087	0.0088	0.0086	0.0120	0.0087	0.0140
φ	0.0270	0.0254	0.0271	0.0225	0.0270	0.0212
n	0.0197	0.0212	0.0198	0.0195	0.0197	0.0214
τ	0.0233	0.0234	0.0236	0.0190	0.0234	0.0172
R	0.0198	0.0197	0.0202	0.0236	0.0198	0.0272
ς	0.0152	0.0146	0.0152	0.0132	0.0152	0.0124
L^f	0.0817	0.0808	0.0835	0.0386	0.0816	
L^m	0.0807	0.0800	0.0816	0.0440	0.0805	
L^p	0.1693	0.1665	0.1711	0.1087	0.1691	
L	0.3317	0.3272	0.3362	0.1912	0.3312	0.1468

Comparing commitment to cooperative and non-cooperative discretion, the magnitude of the discretionary stabilization bias is smaller in Table 5 than for the benchmark case, while the benefits to full cooperation increase slightly. As in the previous Section, we focus on the comparison between the partial-cooperation pairings: monetary-macroprudential and fiscal-macroprudential. Similar to the benchmark policy setting, cooperation between fiscal and macroprudential policy performs worse than non-cooperation. The only improvement over non-cooperation comes when monetary policy and macroprudential policy cooperate, and even then the advantages over non-cooperation are small. Notably, all three policymakers are best off in the case where monetary policy and macroprudential policy cooperate. Table 5 suggests that when the three policymakers have objectives that are quite distinct from each other the benefits to partial cooperation are small, or non-existent.

6.2 Greater concern for inflation stability

The benchmark policy setting gave the central bank an objective function in which the output gap and inflation were each assigned weights equaling 1.0. In the cooperative setting, this led to a cooperative objective function in which the weight assigned to the output gap is three times that assigned to inflation. For the policy scenario considered here we increase the relative weight assigned to inflation stabilization in the central bank's loss function to 3.0 Accordingly, the central bank is assumed to be "Hawkish" and output gap stabilization and inflation stabilization are weighted equally in the (fully) cooperative loss function.

In this alternative setting, the monetary policy objective function becomes:

$$L^m = E_0\left[\sum_{t=0}^{\infty} 0.99^t\left(\widehat{y}_t^2 + 3.0\pi_t^2 + 0.1R_t^2\right)\right], \tag{53}$$

while the policy objectives for fiscal and macroprudential policy remain unchanged. The results are presented in Table 6.

Table 6: Greater Concern for Inflation Stability

	Fiscal-Prud.	Mon.-Prud.	Fiscal-Mon.	Full Coop.	Non-Coop.	Commit.
Variable	(1)	(2)	(3)	(4)	(5)	(6)
b	0.0360	0.0085	0.0165	0.0173	0.0131	0.0028
$\widehat{c}$	0.0251	0.0201	0.0207	0.0179	0.0254	0.0186
$\widehat{y}$	0.0351	0.0249	0.0270	0.0206	0.0345	0.0098
π	0.0061	0.0085	0.0078	0.0096	0.0061	0.0124
φ	0.0272	0.0275	0.0281	0.0242	0.0320	0.0214
n	0.0283	0.0206	0.0204	0.0210	0.0215	0.0238
τ	0.0313	0.0205	0.0259	0.0244	0.0242	0.0186
R	0.0240	0.0246	0.0248	0.0256	0.0235	0.0321
ς	0.0156	0.0149	0.0154	0.0138	0.0169	0.0119
L^f	0.2407	0.0696	0.1015	0.0751	0.1319	
L^m	0.1305	0.0844	0.0917	0.0724	0.1262	
L^p	0.1824	0.1133	0.1243	0.0890	0.1765	
L	0.5535	0.2673	0.3175	0.2365	0.4346	0.1334

The increased emphasis on inflation stabilization raises the losses for all policy settings shown, however it has little impact on the discretionary stabilization bias or on the relative inefficiency of non-cooperation. For the partial cooperation settings, very much like the benchmark case reported in Table 4, asking fiscal policy and macroprudential policy to cooperate leads to outcomes that are worse than non-cooperation and most of the benefits to full cooperation are achieved when monetary policy and macroprudential policy cooperate. Outside of full cooperation, all three policymakers are best off when cooperation between monetary policy and macroprudential policy occurs.

6.3 Less "active" monetary policy

The third alternative scenario we examine is one in which monetary policy is required to keep an eye on the direct implications that its policy decisions have for government debt. In this respect, we are examining a setting in which monetary policy is less "active" in the Leeper (1991) sense—monetary policy is still required to stabilize inflation, but it also now shares with fiscal policy the objective of stabilizing real government debt. We implement this alternative scenario by reducing the weight assigned to debt stabilization in the fiscal objective function from 1.0 to 0.5 and adding debt stabilization to the monetary policy objective function with a weight of 0.5. With these changes, the objective for monetary policy becomes:

$$L^m = E_0 \left[\sum_{t=0}^{\infty} 0.99^t \left(\widehat{y}_t^2 + 1.0\pi_t^2 + 0.5\widehat{b}_t^2 + 0.1R_t^2 \right) \right], \tag{54}$$

the objective for fiscal policy becomes:

$$L^f = E_0 \left[\sum_{t=0}^{\infty} 0.99^t \left(\widehat{y}_t^2 + 0.5\widehat{b}_t^2 + 0.1\tau_t^2 \right) \right], \tag{55}$$

while the macroprudential objective function remains unchanged from the benchmark. The results are shown in Table 7.

Table 7: Less Active Monetary Policy						
	Fiscal-Prud.	Mon.-Prud.	Fiscal-Mon.	Full Coop.	Non-Coop.	Commit.
Variable	(1)	(2)	(3)	(4)	(5)	(6)
b	0.0216	0.0095	0.0121	0.0119	0.0141	0.0019
$\widehat{c}$	0.0164	0.0173	0.0181	0.0166	0.0190	0.0183
$\widehat{y}$	0.0216	0.0186	0.0227	0.0174	0.0254	0.0087
π	0.0102	0.0109	0.0095	0.0111	0.0091	0.0141
φ	0.0233	0.0242	0.0256	0.0232	0.0263	0.0218
n	0.0195	0.0192	0.0195	0.0199	0.0196	0.0234
τ	0.0274	0.0206	0.0249	0.0225	0.0249	0.0175
R	0.0206	0.0226	0.0220	0.0238	0.0199	0.0303
ς	0.0137	0.0140	0.0146	0.0134	0.0149	0.0122
L^f	0.0746	0.0419	0.0697	0.0480	0.0770	
L^m	0.0809	0.0538	0.0626	0.0463	0.0824	
L^p	0.0883	0.0788	0.0973	0.0737	0.1109	
L	0.4429	0.1746	0.2296	0.1680	0.2703	0.1019

Interestingly, the results in Table 7 are qualitatively consistent with those for the benchmark setting reported in Tables 2 and 4. Specifically, cooperation between fiscal and macroprudential policy leads to worse outcomes than non-cooperation, notably for macroprudential policy, while cooperation between monetary and macroprudential policy reaps most of the benefits of full cooperation and all three policymakers are best off in this partial cooperation setting, including fiscal policy. In fact, the fiscal authority is better off when monetary policy and macroprudential policy cooperate than it is in the full-cooperation case.

7 Conclusions

We employ a variant of the Gertler and Karadi (2011) model to analyze the interactions among monetary policy, macroprudential policy, and fiscal policy. In this model, monetary policy interacts with macroprudential policy through the banking sector via the effects that interest rates have on banks' leverage and net worth. At the same time, monetary policy interacts with fiscal policy through the government's budget constraint and the effect that interest rate have on government financing and the dynamics of real government debt. Within this model, we consider a range of policy settings in which fiscal, monetary, and macroprudential policy are undertaken optimally while allowing for both cooperative and non-cooperative behavior. We also consider leadership environments, as well as environments in which partial cooperation takes place—partial cooperation meaning that two of the three policymakers cooperate while the third conducts policy non-cooperatively.

We examined two baseline policy environments. One in which policy is conducted under commitment the other in which policy is conducted under discretion, but where the policymakers cooperate and make their decisions simultaneously—so there is no leadership advantage. Comparing these two baseline environments provides a sense of the importance of time-inconsistency in the model, which operates through in this model through a much broader array of channels than for the canonical new Keynesian model. In addition to the usual channel operating through the Phillips curve, in this model time-inconsistency also operates through expectations channels present in the investment equation as well as through expectations relating to banks' net worth. These additional sources of time-inconsistency mean that the discretionary stabilization bias actually leads to the output gap being understabilized and inflation being overstabilized (relative to commitment), a result that is consistent with Dennis and Ilbas (2023).

Looking at non-cooperative settings where policy is conducted with discretion, non-cooperation leads to a substantial decline in performance, adversely affecting all three policymakers, a result that continues to hold in leadership settings. In fact, our results suggest that there is little if anything for a policymaker to gain by having leadership in this model. There are, however, important gains to be made from partial cooperation. A key finding of our analysis is that although partial cooperation in the form of cooperation between fiscal policy and macroprudential policy leads to poor outcomes for all policymakers, partial cooperation in the form of cooperation between monetary policy and macroprudential policy performs well, garnering most of the gains of full cooperation. This finding suggests that it is advantageous for macroprudential policy to be conducted alongside monetary policy and supports institutional arrangements whereby macroprudential policy is housed and conducted within the central bank, such as in the case of the UK, New Zealand, and Europe. We examined a range of alternative policy scenarios involving differing policy objectives and found that the benefits of cooperation between monetary and macroprudential policy were robust to these alternatives.

References

[1] Alesina, A., and L. Summers, (1993), "Central Bank Independence and Macroeconomic Performance: Some Comparative Evidence." *Journal of Money, Credit and Banking*, 25, 2, pp, 151-62.

[2] Angelini, P., Neri, S., and F. Panetta, (2012), "Monetary and Macroprudential Policies", ECB Working Paper No. 1449.

[3] Bartsch, E, A Bénassy-Quéré, G Corsetti and X Debrun (eds) (2020), 'Geneva 23: It's All in the Mix: How Monetary and Fiscal Policies Can Work or Fail Together', CEPR Press, Paris & London.

[4] Bean, C., Paustian, M., Penalver, A., and T. Taylor, (2010), "Monetary Policy After the Fall", Proceedings–Economic Policy Symposium–Jackson Hole. Federal Reserve Bank of Kansas City, pp. 267–328.

[5] Beau, D., Clerc, L., and B. Mojon, (2014), "Macroprudential Policy and the Conduct of Monetary Policy", Bauducco, S., Christiano, L., Raddatz, C. (Eds.), *Central Banking, Analysis, and Economic Policies Book Series (1st ed.), vol. 19, Macroeconomic and Financial Stability: Challenges for Monetary Policy*, pp. 273–314.

[6] Boldrin, M., Christiano, L., and J. Fisher, (2001), "Habit Persistence, Asset Returns, and the Business Cycle", *American Economic Review*, 91, 1, pp. 149–166.

[7] Cooper, R., (1971), *Competitive Devaluations in Developing Countries*, Princeton University Press, Princeton, New Jersey.

[8] Cukierman, A., (1992), *Central Bank Strategy, Credibility, and Independence: Theory and Evidence*, MIT Press.

[9] Calvo, G., (1983), "Staggered Prices in a Utility Maximizing Framework", *Journal of Monetary Economics*, 12, pp. 383–398.

[10] Christiano, L., Eichenbaum, M., and C. Evans, (2005), "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy", *Journal of Political Economy*, 113, pp. 1–45.

[11] De Paoli, B., and M. Paustian, (2017), "Coordinating Monetary and Macroprudential Policies", *Journal of Money Credit and Banking*, 49, pp. 319–349.

[12] Dennis, R., (2009), "Consumption Habits in a New Keynesian Business Cycle Model", *Journal of Money Credit and Banking*, 41, 5, pp. 1015–1030.

[13] Dennis, R., and P. Ilbas, (2023), "Monetary and Macroprudential Policy Interactions in a Model of the Euro Area", *Journal of Economic Dynamics and Control*, 154, article 104706.

[14] Dennis, R., and T. Kirsanova, (2025), "Policy Biases in a Model with Labor Market Frictions", *Journal of Money Credit and Banking*, forthcoming.

[15] Faia, E., (2008) "Optimal Monetary Policy Rules with Labor Market Frictions", *Journal of Economic Dynamics and Control*, 32, 5, pp. 1600–1621.

[16] Furlanetto, F., and N. Groshenny, (2016) "Mismatch Shocks and Unemployment During the Great Recession", *Journal of Applied Econometrics*, 31, pp. 1197–1214.

[17] Gelain, P., and P. Ilbas, (2017), "Monetary and macroprudential policies in an estimated model with financial intermediation", *Journal of Economic Dynamics and Control*, 78, pp. 164–189.

[18] Gertler, M., and P. Karadi, (2011), "A Model of Unconventional Monetary Policy", *Journal of Monetary Economics*, 58, pp. 17–34.

[19] Giannoni M., and M. Woodford, (2003), "Optimal Inflation Targeting Rules", *NBER working paper No. 9939*.

[20] Greenwood, J., Hercowitz, Z., and P. Krusell, (2000), "The Role of Investment-Specific Technological Change in the Business Cycle", *European Economic Review*, 44, pp. 91–115.

[21] Gruber, J., (2004), "A Present Value Test of Habits and the Current Account", *Journal of Monetary Economics*, 51, pp. 1495–1507.

[22] Kirsanova, T., Campbell, L., and S. Wren-Lewis, (2009), "Monetary and Fiscal Policy Interaction: The Current Consensus Assignment in the Light of Recent Development", *The Economic Journal*, Volume 119, Issue 541, pp. F482-–F496.

[23] Leeper, E., (1991), "Equilibria under 'Active' and 'Passive' Monetary and Fiscal Policies", *Journal of Monetary Economics*, 27, 1, pp. 129–147.

[24] Nakamura, E., and J. Steinsson, (2008), "Five Facts about Prices: A Reevaluation of Menu Cost Models", *The Quarterly Journal of Economics*, 123, 4, pp. 1415–1464.

[25] Prescott, E., (1986), "Theory Ahead of Business-Cycle Measurement", *Carnegie-Rochester Conference Series on Public Policy*, 25, pp. 11–44.

[26] Quint, D., and P. Rabanal, (2014), "Monetary and Macroprudential Policy in an Estimated DSGE Model of the Euro Area", *International Journal of Central Banking*, 10, 2, pp. 169–236.

[27] Sargent, T., and N. Wallace, (1981), "Some Unpleasant Monetarist Arithmetic", *Federal Reserve Bank of Minneapolis Quarterly Review*, 5, pp. 1–17.

[28] Smets, F., and R. Wouters, (2003), "An Estimated Dynamic Stochastic General Equilibrium Model of the Euro Area", *Journal of the European Economic Association*, 1, 5, pp. 1123–1175.